Industry Canada Industrie Canada

INTEGRATED SPECTRUM OBSERVATION CENTRE

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MANUAL

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INTEGRATED SPECTRUM OBSERVATION CENTRE

MANUAL

Version 2.15
February 2013

A MIRS (Mobile ISOC Remote System) installation

Introduction

Industry Canada's Integrated Spectrum Observation Centre (ISOC), a result of many years of continuous development, is a comprehensive software suite that allows users to monitor the radio frequency spectrum using a multitude of instruments.

The main purpose of the ISOC is remote monitoring: to provide Spectrum Management Officers (SMOs) with the ability to connect to instruments installed at remote locations, and to utilize these instruments through a Windows-based graphical interface that presents a "virtual" view of these devices on the officer's desktop. The suite provides for two modes of operation: in interactive mode, the user directly manipulates the instrument's controls through the virtual interface, while in scheduled mode, the instrument performs unattended measurements and records the results in data files for later processing.

This manual is intended for persons using, installing, and troubleshooting ISOC configurations. Part 1, the *Concepts Guide*, provides an overview of the ISOC system and its many features. Part 2, *Operator's Manual*, is a detailed handbook for ISOC users, presenting many typical scenarios involving the use of spectrum analysers, receivers, and other equipment. Part 3, *Reference*, is divided into two sections: the first provides comprehensive reference information about all the features of the ISOC suite and its program components, while the second part lists all supported ISOC instruments and details their features. Lastly, Part 4, *Installation and Configuration*, provides instructions for setting up ISOC client and server systems and configuring instruments; a troubleshooting guide is also included in this part.

The ISOC is an evolving system; as new instruments are introduced by Industry Canada, support may be added. Existing features may also be updated in response to user requests. This version of the manual describes ISOC version 2.15, as of February, 2013.

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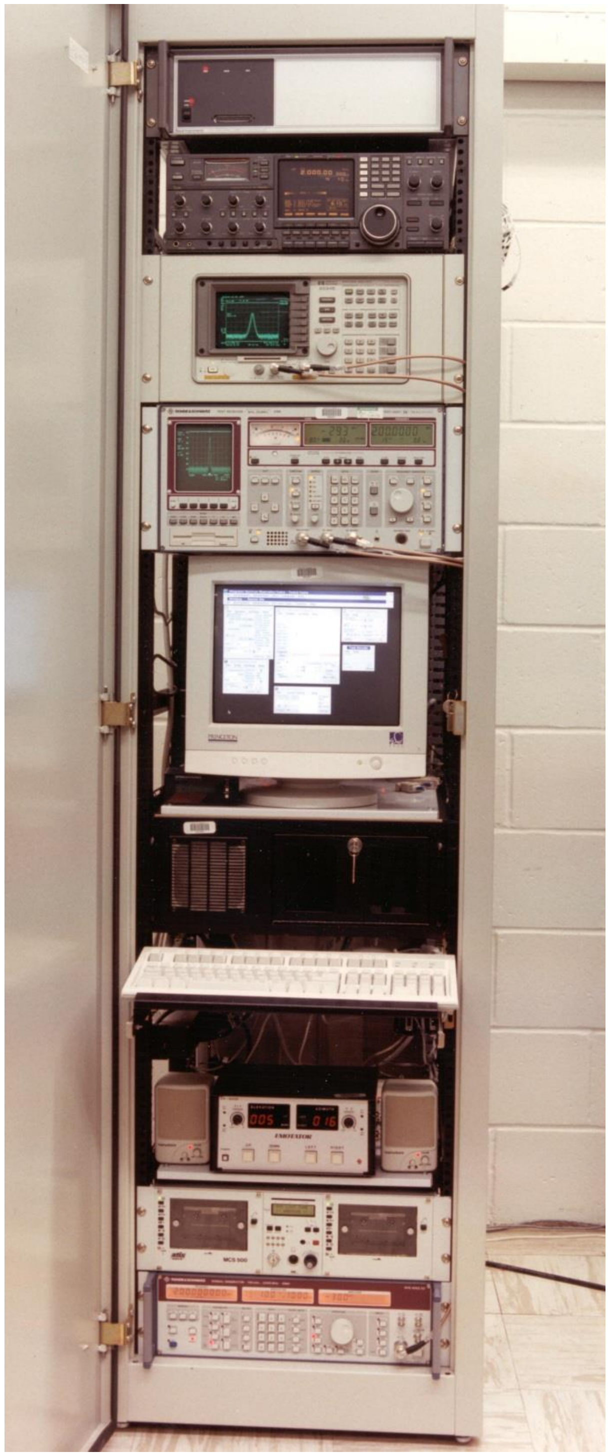


Rack-mounted ISOC equipment

1. Concepts Guide

This section presents a conceptual overview of the ISOC system and its main capabilities. A detailed introduction into the many features of the ISOC can be found in section 2; section 3 contains a complete reference of the ISOC system.

1.1. Getting started: The ISOC client-server architecture

ISOC, which stands for Integrated Spectrum Observation Centre, is a collection of software programs designed to allow an operator access to remote radio spectrum monitoring instrumentation.

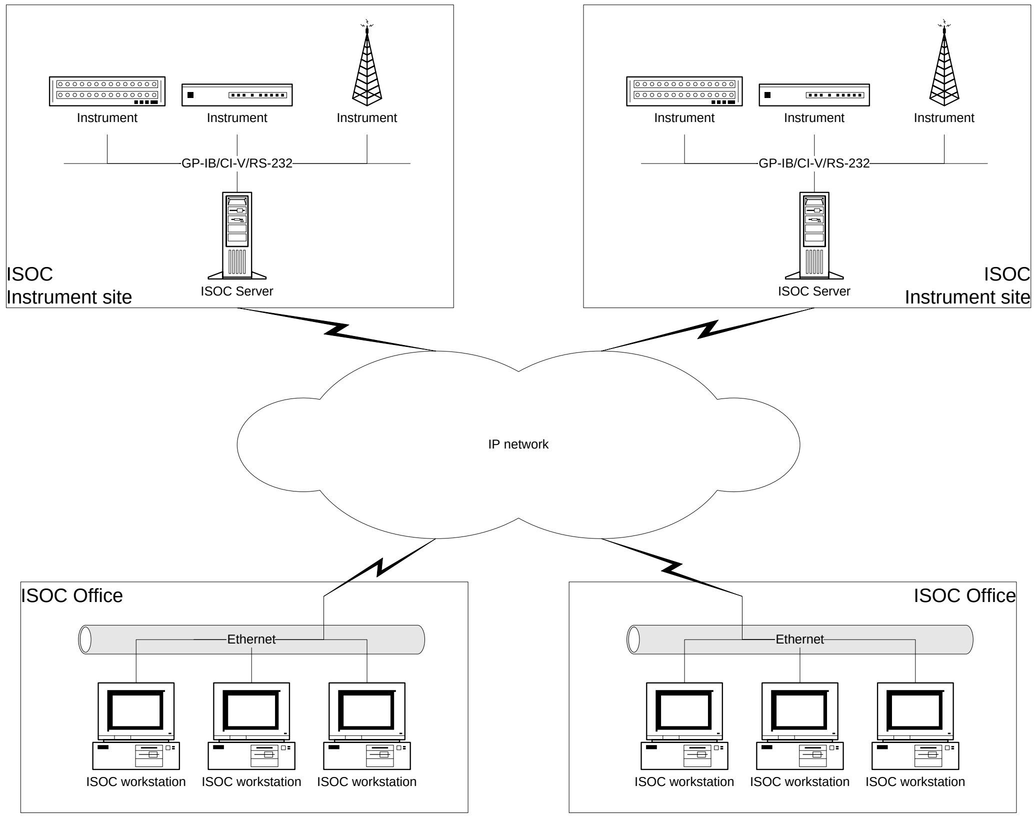
The ISOC can control a large variety of instruments, including receivers, spectrum analysers, signal generators, tone decoders, DF processors, and many other devices.

This is accomplished through what is called a client-server architecture.

The operator's workstation, the *client*, is located where convenient; for instance, it may be a computer situated at an office location.

The client connects to a remote computer, the *server*, which is collocated with the test instruments that it controls. The server may be placed at a remote site, for instance at an antenna location.

A typical ISOC configuration is illustrated below:



The actual network configuration may differ from this diagram. For instance:

- A mobile office may employ only a single computer that serves both as ISOC workstation and server. The server and client components can be installed on a single machine without difficulty.
- A remote server location may only be accessible through a dial-up modem. For the ISOC, this makes no difference; so long as a connection exists, the ISOC will be able to utilize it. The ISOC is designed to operate reliably over slow connections, though some types of operation (e.g., remote audio) may not always work when the bandwidth is too low.

Whether or not an entire ISOC installation consists of a single computer or it utilizes many workstations and servers, we always refer to the suite as a client-server system. That is because the software components of the ISOC always communicate with each other the same way regardless of how an installation is configured.

1.2. Servers and connections

To establish a connection between the client and the server, the ISOC utilizes IP (the Internet Protocol). This does not mean that either the client or the server must be on the public Internet; they may be connected through a private network ("intranet") or through a point-to-point connection such as a dial-up connection.

1.2.1. IP connectivity

However the network is configured, the client and the server must be able to "see" each other in order for the ISOC to work.

On an IP network, every computer has a unique identifier called its IP address[1]. The IP address is a numeric address consisting of four numbers between 0–255, separated by a period: e.g., 192.168.3.1. In order for the ISOC client to connect to the ISOC server, it must know the server's IP address.

Often, instead of a numeric IP address a symbolic name is provided. Symbolic names will work so long as the network on which the ISOC computers reside is equipped with a DNS (Domain Name System) server. Symbolic names make it possible for you to type `google.com`, for instance, in a Web browser instead of the numeric address of one of Google's Web servers.

The ISOC works with either numeric addresses or symbolic names. To connect with an ISOC client to an ISOC server, you need to know either the server's numeric address or its symbolic name.

> **Tip:** If the client and the server are the same physical machine, the server's numeric address is 127.0.0.1; its symbolic address is `localhost`. These are the addresses of the local "loopback" interface, which is like a fictitious network interface card that is present in every computer, even a computer with no outside network connection, such as a stand-alone laptop.

Before you can successfully establish a connection to an ISOC server, two requirements must be met: the client must be connected to the server via an IP network, and the ISOC server software components must be running on the server.

The easiest way to verify that the client computer and the server computer have a working IP connection to each other is with the `ping` command. `PING.EXE` is a standard Windows utility that can be used from the command prompt. To start a command prompt on a Windows XP machine, click the *Start* menu, select *All Programs*, then *Accessories*; one of the menu items here will be called *Command Prompt*.

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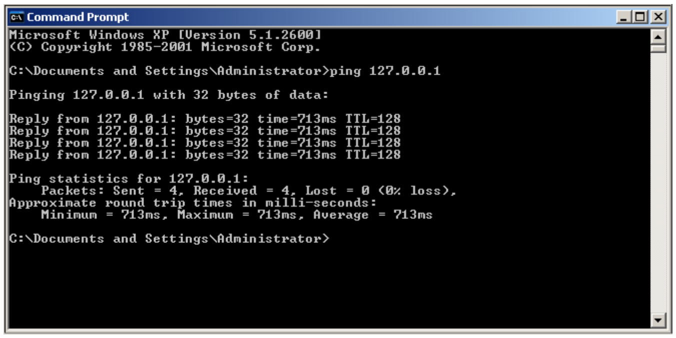
[1] Actually, the identifier is assigned to the network interface, so a computer with multiple network connections can have multiple IP addresses. In a typical ISOC configuration, however, neither servers nor clients are expected to be so configured.

Once a command prompt has been opened, you can type the following:

```
ping 127.0.0.1
```

replacing the 127.0.0.1 part with the actual IP address or symbolic name of the ISOC server. Here is the result of the `ping` command with a good connection to a server:



In case the server is not reachable via an IP connection, the ping command will return an error. The most common error is Request timed out, although other errors (e.g., Network unreachable) also occur frequently. In this case, before you can continue with the ISOC, it is necessary to correct whatever problems may be interfering with your network connection.

1.2.2. The ISOC Server

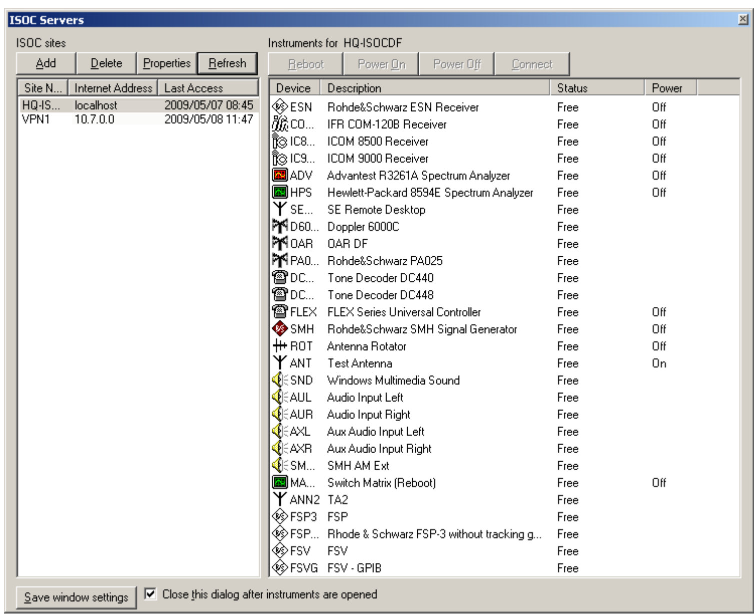
In a typical configuration, two programs are running all the time on an ISOC Server: the ISOC Service application and the ISOC Scanner application.

Normally, both these programs are run as Windows service applications. A service application is an application that runs in the background, independent of what the user is doing on the desktop. Indeed, a service application can run even when no user is logged on to the server computer.

You can manage services on a server computer through the Control Panel. On Windows XP, you need to select the *Control Panel* from the *Start* menu, click *Administrative Tools*, and then select *Services*. The list of services includes many essential programs installed with Windows, as well as service applications installed subsequently. The two ISOC service applications are called *ISOC Service* and *ISOC Scanner*. They are installed as “Manual” services, meaning that they need to be explicitly started by the server operator before the ISOC can be used. To start a service, right-click its name and select *Start* from the context menu.

Tip: To manage services, you must have Administrator privileges on the server computer. If you wish to make sure that the services start automatically when Windows is started, change their startup type from Manual to Automatic.

How can you tell that the ISOC services are up and running, functioning properly? The easiest way is to start up the main ISOC client program on the server itself, and use it to connect to the `localhost` address (127.0.0.1). The main ISOC client program is called *ISOC for Windows* and by default, it is installed under the *Start* menu in the folder *WinISOC*. To start the client, just click the link here labelled "ISOC for Windows". When this application starts, it begins with a blank window. To establish a connection to a site, select *Connect…* from the *Site* menu, or if you prefer to use the keyboard, hit Ctrl-N. This will present a dialog labelled "ISOC Servers". Check to see if a site with the address `localhost` is already present on the left side of this dialog. If not, click the **Add** button and enter the name `localhost` as the **Internet Address**, click **OK**, and then click the **Load** button. In a few seconds, the list of instruments installed on the local server will appear:



Needless to say, the list of instruments at any particular site will differ from the list of instruments presented here. It is also possible that you will see no instruments listed, if it is a site on which the ISOC server has not yet been configured.

1.3. Instruments and signal sources

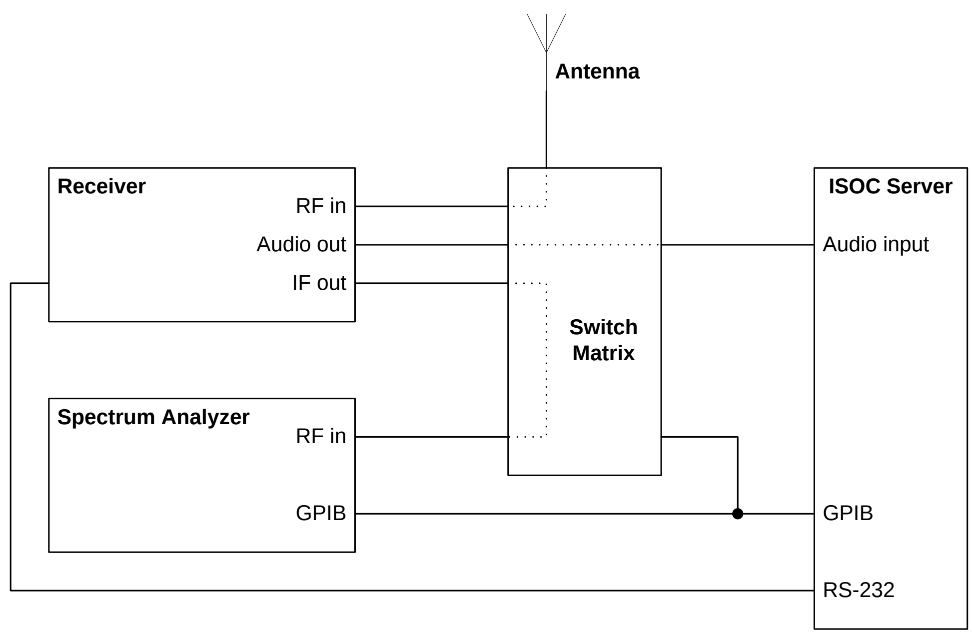
An instrument in the ISOC is any device that the ISOC can control, or from which the ISOC can obtain measurements. Examples include spectrum analysers, receivers, or signal generators. These are the obvious examples, but the ISOC also recognizes as “instruments” various pieces of additional (real or virtual) hardware.

To understand the rationale for this, it is necessary to absorb some important concepts.

First, the ISOC can control both radio frequency devices, such as a spectrum analyser, and audio frequency devices, such as the sound card on the server computer that is used to capture sound from an instrument.

Second, the ISOC can control how the instruments are interconnected using a remote control *switch matrix*. Not all sites are equipped with a switch matrix, but at those that are, it is possible to route, by computer control, both radio frequency and (optionally) audio frequency signals between instruments.

As an example, you may configure a measurement as follows. You start with an antenna; its RF signal is connected to the RF input of a test receiver, controlled via an RS-232 serial connection (e.g., an ICOM receiver). The IF output of the receiver is connected to a spectrum analyser, which, along with the switch matrix, is controlled through a GPIB interface. The AF output from the test receiver’s demodulator is connected in turn to the computer’s sound card. The complete setup may look similar to the following:



The RF connections between the antenna and the receiver, the receiver and the spectrum analyser, and the AF connection between the receiver and the computer’s sound card are all managed by the switch matrix.

To accomplish this, the ISOC server must know, in addition to instruments, about *signal sources*. Signal sources in the preceding example are the antenna, the IF output of the receiver, and the audio output of the receiver. The first two of these are RF signals, while the last is an AF signal.

The situation is further complicated by the fact that some devices have multiple input connectors. For instance, the ICOM R-9000 receiver has three separate connectors, one for the 0–30 MHz, one for the 30–1000 MHz, and one for the 1000–2000 MHz range.

The complete picture, therefore, includes signal sources, instruments, and *input connectors* on the instruments. This explains why, in addition to physical instruments, an ISOC server also has “instruments” whose sole purpose is to serve as a placeholder for an input connector. One example is the “test antenna” instrument that has no controls other than a control for selecting a signal source that is connected to this (transmitting) antenna; another example is the “audio input” instrument which is a representation of the “Line in” connector of the ISOC server and makes it possible to connect to the server an audio signal source.

What about ISOC sites with no switch matrix? In such configurations, signal sources are usually permanently connected, i.e., hard-wired. When an ISOC server is configured, such hard-wired connections can be set up, and if their configuration information is properly added to the ISOC, they are displayed for informational purposes whenever an instrument is used by the ISOC client.

1.4. The ISOC client: Virtual instruments

The main purpose of the ISOC server is to provide a means for ISOC clients to connect to remote instruments. Whereas the server works in the background (once configured, typically there is no need to interact with the server directly), the ISOC client provides a rich graphical interface for interactive use.

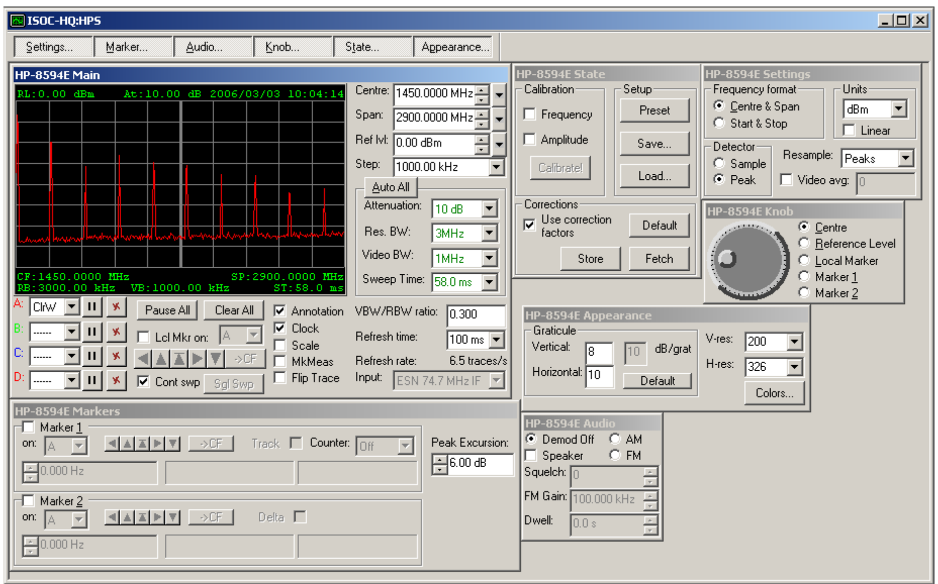
The key feature of the ISOC graphical interface is the “virtual instrument” concept. The virtual instrument is a window that represents a physical instrument at the remote site. Within that window, there are controls through which you can interact with the remote instrument and view its measurements. The virtual instrument communicates with the server at a high enough speed so that near real-time measurements are possible: for instance, with a spectrum analyser, you are able to change the instrument’s settings and view changes in the graphical trace essentially instantaneously.

Indeed, as the HP-8594E Spectrum Analyser was historically the first instrument that ISOC for Windows supported, it is a very good example through which to demonstrate the ISOC’s features. Connecting to a physical instrument is easy:

you just need to select the instrument in the ISOC Servers window and click the **Connect** button. (Simply double-clicking the instrument's name also does the trick).

> **Tip:** The ISOC client program can be connected to multiple servers simultaneously. For instance, you may wish to monitor the same signal using receivers located at different monitoring sites.

It takes a few seconds for the connection to be established (more if the connection to the ISOC server is low-speed, such as a dial-up or ISDN connection); if all goes well, you will shortly see a window appear that looks similar to the following:



This window provides a representation of a functioning HP-8594E spectrum analyser that is connected to its own calibration output.

> **Tip:** When you open a virtual instrument for the first time, the panels (small child windows) within the virtual instrument window may not be well arranged. You can change the position of the panels and, in some cases, their size; you can also turn off unwanted panels by clicking the corresponding button in the toolbar. Afterwards, select the *Save Settings Now!* Command from the *Window* menu and the arrangement for the virtual instrument will be saved. Next time you open the same instrument on the same server, the saved arrangement will be used.

The HP-8594E virtual instrument has most of the features that you will find in other virtual instruments. Perhaps the most prominent is the graphical trace window; at the default setting, this window receives 6-7 trace updates per second, providing a smooth, near real-time representation of the screen of the actual physical instrument:

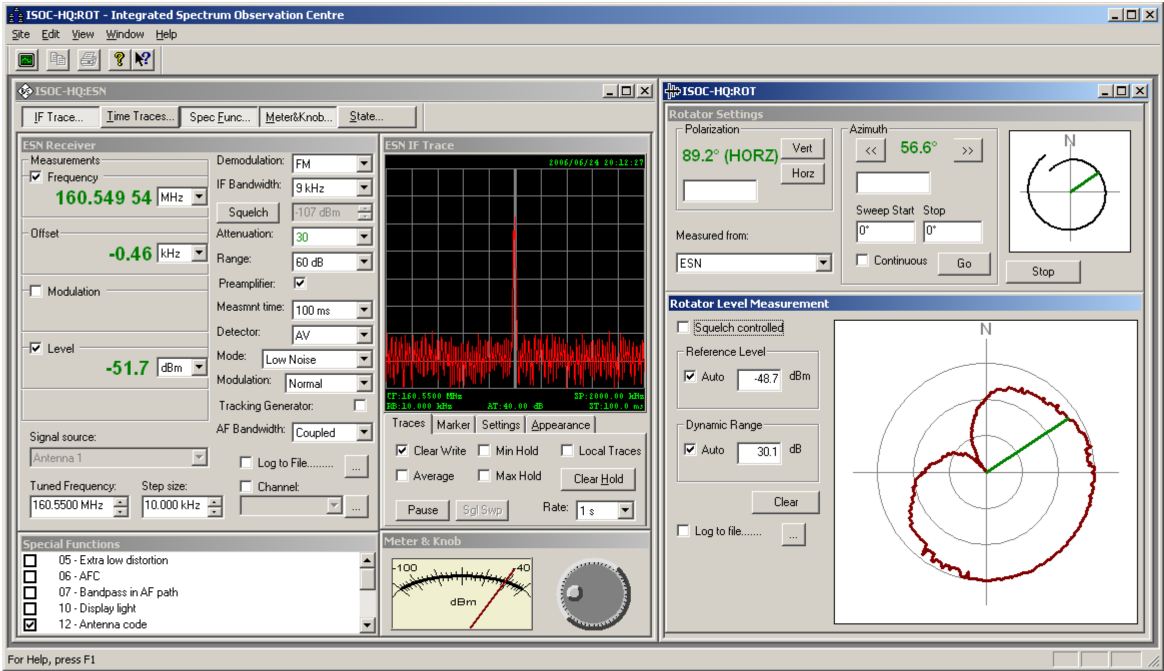
Though the virtual and physical instruments have similarities, they also have numerous differences. The intent was not to slavishly copy the physical instrument in appearance and layout: the needs are different when you operate the virtual instrument on a computer desktop. For instance, why waste valuable screen space with the graphical representation of a numeric keypad, when a perfectly functioning numeric keypad is already present as part of your computer keyboard? The physical instrument is also limited by a fixed arrangement of keys and controls; in contrast, the virtual instrument offers a great deal more flexibility, allowing you to show or hide panels, and rearrange them in accordance with your needs.

However, in terms of functionality, the virtual instrument offers all the features of the spectrum analyser that were deemed important for the purposes of the ISOC. Indeed, in some cases the virtual instrument offers more; for instance, the virtual instrument may have a greater number of traces, and custom trace colours, features that are not available on the physical device.

Moreover, the virtual instruments are approximately uniform in appearance regardless of the physical instrument used. That is not to say they are identical: since not all features are available on all physical instruments, and some features are implemented differently, essential differences also exist in the virtual instruments. But to the extent possible, all virtual instruments follow a similar design, making it easier to learn to operate them all. The following list, certainly not exhaustive, summarizes some of the main features present in most of the ISOC virtual instruments:

- Full control over the main instrument settings such as frequency, span, and bandwidth;
- Up to 4 high resolution, real-time, customizable graphical traces;
- Markers and delta markers;
- Line markers and on-screen controls;
- Printing and clipboard support for graphical trace;
- Miscellaneous settings (e.g., detector, demodulator);
- Audio control;
- Access to setup/calibration functions;
- Support for different units of measurement (e.g., Hz/kHz/MHz/GHz, dBm/dBμV).

A unique feature of the ISOC is its ability to control not just single instruments, but sets of instruments that are used together to perform a measurement. One obvious example for this type of operation is the use of an antenna rotator in conjunction with a receiver. As an individual instrument, a receiver can be used to monitor signal levels, while the antenna rotator can be used to orient an antenna and/or read back its present orientation. Combined, however, the two instruments together provide new capabilities:



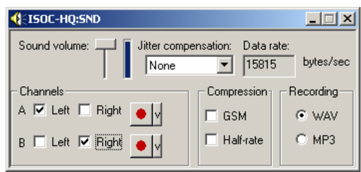
As the example in this screen capture demonstrates, the antenna rotator virtual instrument provides a display that combines direction readings from the rotator with signal level readings from the receiver; this synthesized display is, in fact, used in some cases as a crude direction finding instrument.

Other examples of instruments being combined together in software to achieve new capabilities include the use of Telonic-Berkeley filters together with ICOM receivers for improved selectivity; the use of direction finding (DF) processors together with ICOM and other types of receivers; or, the use of spectrum analysers together with receivers for improved analysis capabilities on the received signal.

The ISOC also has the ability to deliver audio from a remote site to the operator's workstation. For this purpose, the ISOC utilizes a custom streaming audio format, in conjunction with industry-standard audio compression algorithms. This makes it possible for the ISOC to deliver low-quality audio even over a low-speed (e.g., dial-up) connection, while simultaneously leaving sufficient bandwidth available for interactive instrument control and graphical trace display.

Tip: No audio? No graphical traces? Most ISOC communication takes place over a TCP connection, which is one type of connection available on an IP network. Traces and audio, however, utilize another connection type, a UDP connection. If you can connect to an ISOC server and control instruments, but you see no graphical traces and hear no audio, chances are that your connection is routed through a network router or firewall that does not permit the ISOC server to send UDP packets to your computer workstation.

The ISOC's audio interface allows you to simultaneously listen to two audio channels. You can also decide to direct the channels to a specific speaker on your computer:



Some very important concepts are worth emphasizing here.

First, the audio device is an example of a "shared device": multiple ISOC client computers can listen to the same audio source on a server simultaneously without interfering with each other. This is possible because the audio virtual instrument is a "passive" instrument: it does not actually control what happens on the server, merely lets you choose which audio stream(s) to listen to.

Second, the ISOC server supports multiple audio cards. While each individual audio card provides only two channels of (monaural) audio[2], with multiple cards installed, it is possible to have more independent audio channels available. Each audio card is presented as an individual audio device (with two audio channels); so a server with three audio cards, for instance, would be configured with three audio devices, offering six audio channels in total.

Third, the ISOC client program contains built-in audio mixing capabilities. This makes it possible to open multiple audio devices and direct them to specific speakers on your computer. For instance, if you were to connect to the above-mentioned server with three audio devices, you could establish three simultaneous connections, and decide for each of the six individual audio signals which speaker they be routed to.

[2] At the time of this writing, the ISOC suite does not support multichannel (e.g., "5.1") audio cards for input or output.

The audio device demonstrates another important ISOC feature: the ability to dynamically adapt to network conditions. If you are connected to a server via a limited bandwidth connection, opening one or more audio channels can quickly result in data traffic that exceeds the bandwidth capabilities of that connection. When that happens, the ISOC normally detects the congestion and automatically forces the audio transmission to fall back to more aggressive compression; in extreme cases, an audio transmission may stop completely if the network bandwidth is insufficient. Although there are no miracles, this feature makes it possible to use the ISOC over a low bandwidth connection reliably; the software will do what it can to ensure that the connection is not interrupted due to congestion, and that you always retain the ability to command instruments.

1.5. Scheduled tasks

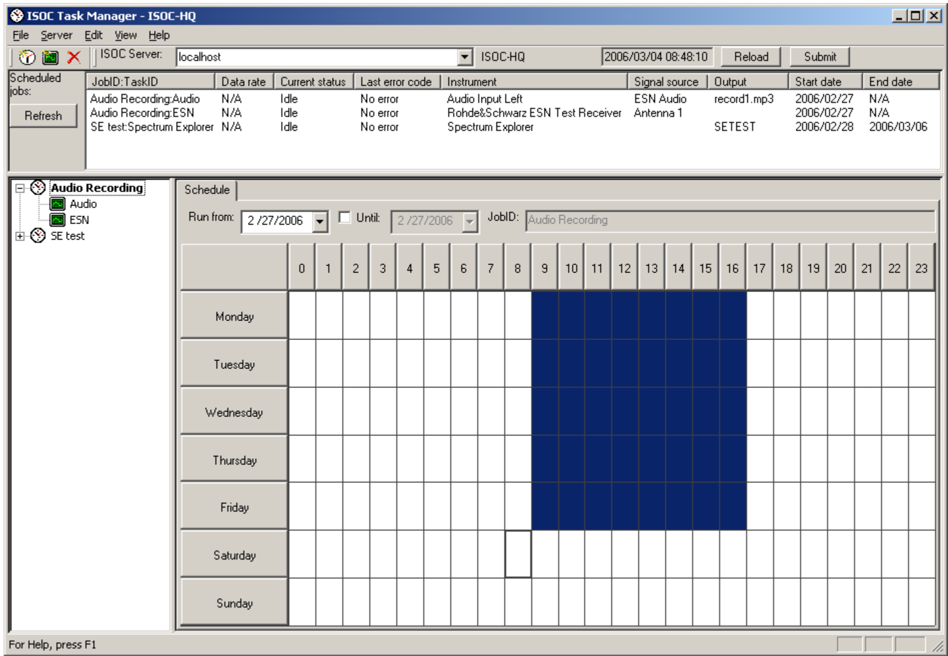
Being able to interactively operate remote instruments is but one of the two main capabilities of the ISOC: the other is its ability to execute scheduled tasks with no operator assistance. Such scheduled tasks may include scanning frequency ranges, monitoring specific frequencies, recording audio, and more. Most (albeit not all) ISOC instruments can be utilized for scheduled asks.

Setting up scheduled tasks is not difficult, but it is important to clearly understand some basic concepts.

First, the concept of *jobs*. The ISOC groups together related tasks to form a job. A job consists of one or more tasks that will be executed simultaneously. One example is a job that consists of a receiver control task (to set up a receiver to listen to a specific frequency, with specific demodulator, etc. settings) and an audio recording task (to record the digitized audio output of the receiver).

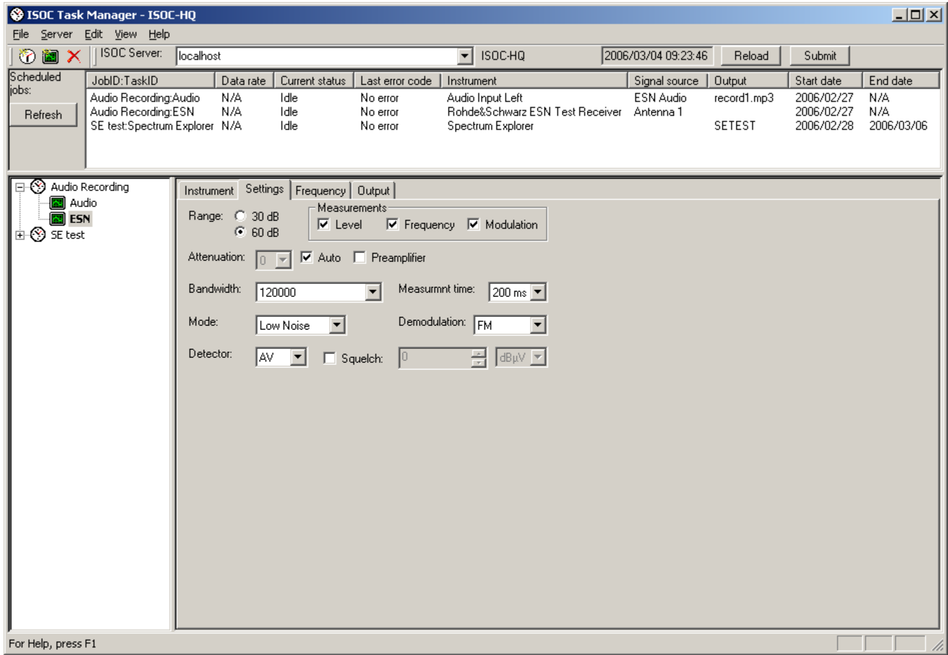
Second, *task types*. The ISOC recognizes three different task types: Instrument control, Frequency scan, and Audio recording tasks. The reason for this distinction is that the requirements of each task type are different; furthermore, not all instruments support all task types. A Frequency scan task scans a set or range of frequencies repeatedly at the highest possible rate that the instrument allows (which may be several hundred frequencies per second on some instruments, such as the Rohde & Schwarz ESN Test Receiver); the results are recorded in a binary format data file that other software tools developed by Industry Canada can process. An Instrument control task provides greater flexibility over how the instrument is configured; this type of task can also cycle through a set or range of frequencies, albeit at a much slower rate. Results of an instrument control tasks are saved optionally in a human-readable text log file. Lastly, an Audio recording task does just what its name implies: it records audio in the format of a Windows-style `.wav` or industry-standard `.mp3` file.

ISOC tasks are managed through a program called, unsurprisingly, the ISOC Task Manager:



One of the most prominent features of the ISOC Task Manager is the weekly grid, which allows you to specify when a job is to be executed. Jobs are listed on the left; the tasks of a job are shown in a hierarchical arrangement. In addition to the grid, jobs can also be restricted to run only in a specific time period, defined by a start and an end date.

Clicking on individual tasks on the left allows you to adjust their settings:



The four tabs that appear on the right allow you to control individual aspects of a task, including instrument settings, frequencies, and output file specifications.

The top area of the ISOC Task Manager window is used to list tasks that are either running at present or are scheduled to run in the future. This area allows you to interactively control running tasks. For instance, you may interrupt a running task or resume a recently interrupted task. The current status of the tasks is also displayed along with (if applicable) the current data rate; this lets you monitor running tasks and verify that they perform as expected.

> **Tip:** The ISOC Task Manager can monitor only one server at a time. However, if you wish to monitor multiple server sites, you can start up multiple copies of the ISOC Task Manager.

Frequency lists are stored in files. The result of a task is often a file, be it a binary frequency scan file, a text log file, or an audio file. These files are stored on the ISOC server where the tasks run. However, the ISOC Task Manager provides a simple file transfer service to facilitate easy transfer of files between your client computer and the ISOC server. This up/download facility is independent of any other file sharing features that may or may not be installed on the server; in other words, uploading/downloading does not require that the ISOC server be set up as a file server or FTP server using Microsoft configuration tools.

1.6. Bilingual support

The ISOC application suite is fully bilingual. All user interface components are available in both English and French. Language selection can be made either in the ISOC client application or the ISOC Task Manager. The language choice is "global", in that it applies to all ISOC components. Changes in the preferred language will take effect the next time an ISOC software component is started.

The default language of all ISOC components is the system default language; i.e., the ISOC will start in English on English versions of the operating system, and in French on French versions of Windows.

Note that some ISOC messages (notably, messages not intended for the end user, for instance log messages on the server that are of use mainly to the developer for debugging purposes) are in English only.

1.7. Logoff

The ISOC facilities are used by multiple users. It is important to free up any instruments you do not currently use, to make them available for others. To free up an instrument, simply close the corresponding virtual instrument window in the ISOC client program.

A remote ISOC site

2. *Operator's Manual*

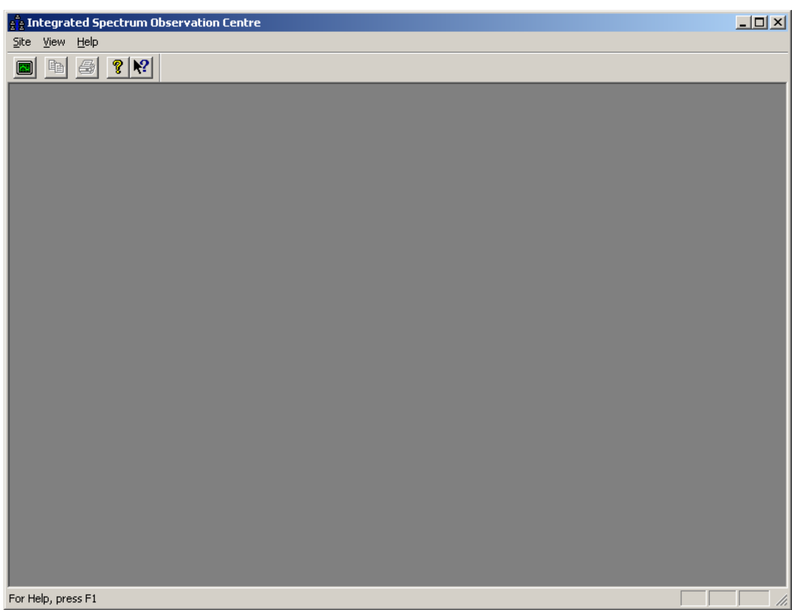
Although the ISOC system has many components, in normal daily operation only three are used: the interactive ISOC client, the direction finding (DF) client, and the ISOC Task Manager. The former is used to interactively control remote instrumentation, while the latter is used to schedule tasks that are executed automatically at the specified time and record measurements (or audio) in files for later processing.

2.1. Interactive operation

Interactive operation of the ISOC takes place using the ISOC client application. This program, called (for historical reasons) ISOCNT.EXE, can most easily be invoked by clicking the Windows *Start* menu, clicking (on Windows XP/2003) *All Programs*, *WinISOC*, and then *ISOC for Windows*. After a few seconds, the application should launch, presenting you with the interactive ISOC graphical user interface.

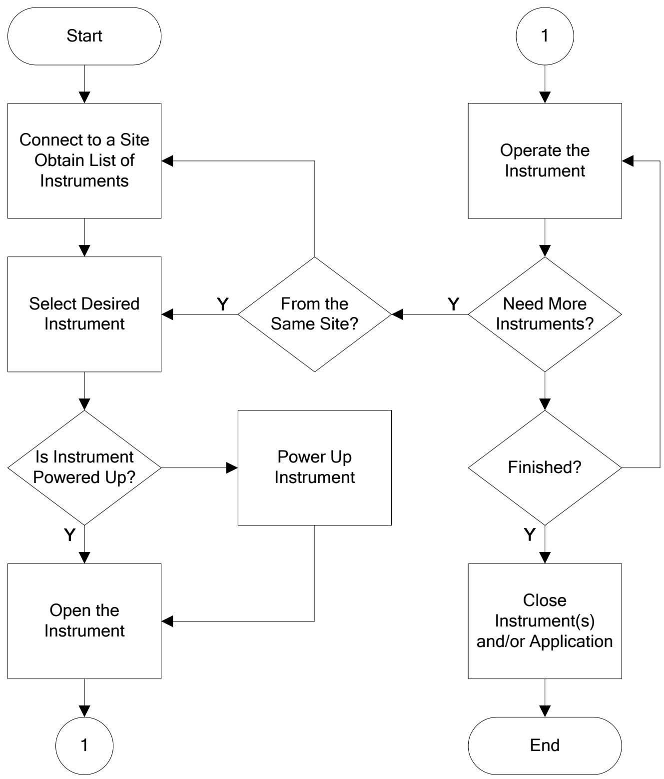
2.1.1. The ISOC graphical user interface

After the ISOC client has been started, it begins with an empty window (empty because no virtual instruments have been opened yet):

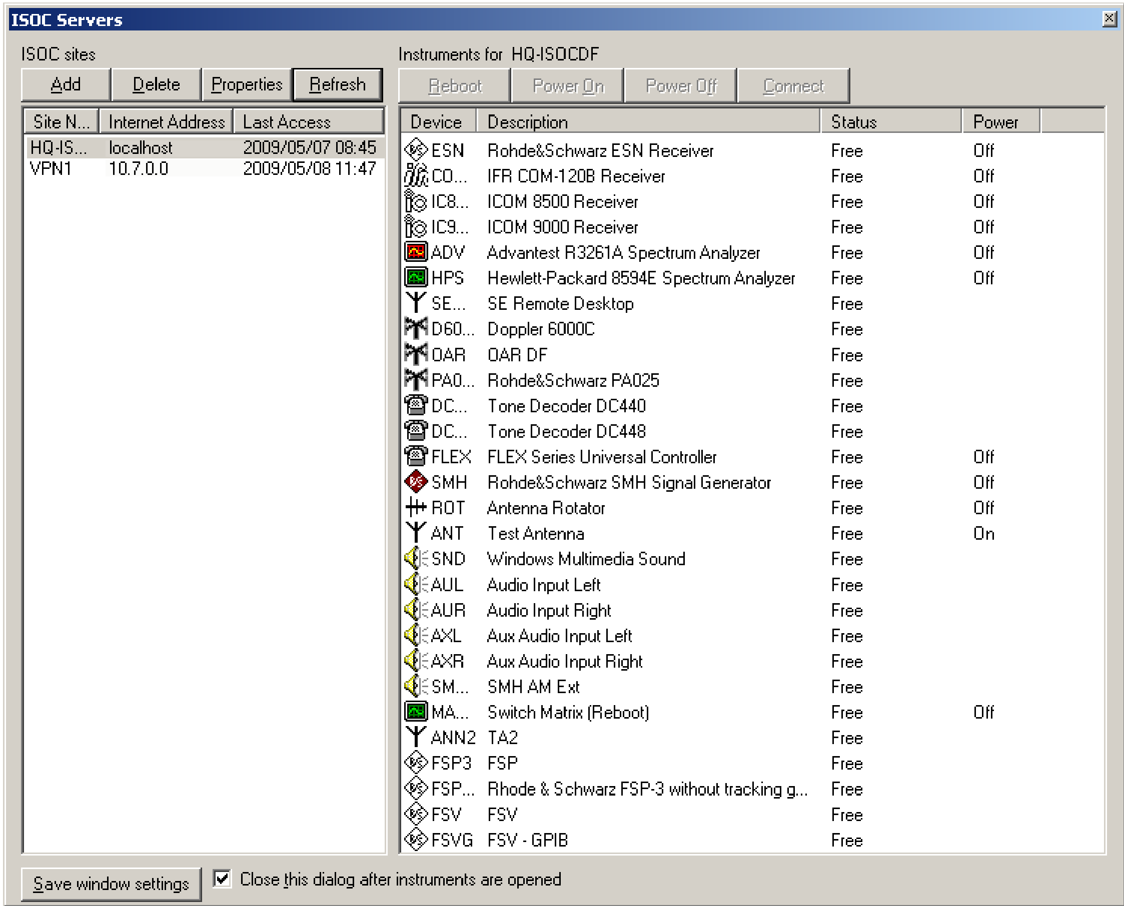


The main components of the ISOC client frame window are the menu bar, the toolbar containing some buttons, and the status bar at the bottom. The menu bar initially displays three menu options: *Site*, *View*, and *Help*. The toolbar provides quick access to some of the more common menu functions, while the status bar is used to provide occasional feedback and hints.

A typical ISOC session involves connecting to a site; obtaining a list of instruments; opening instruments; and perhaps connecting to additional sites, as the ISOC allows you to simultaneously operate instruments that are located at different sites:

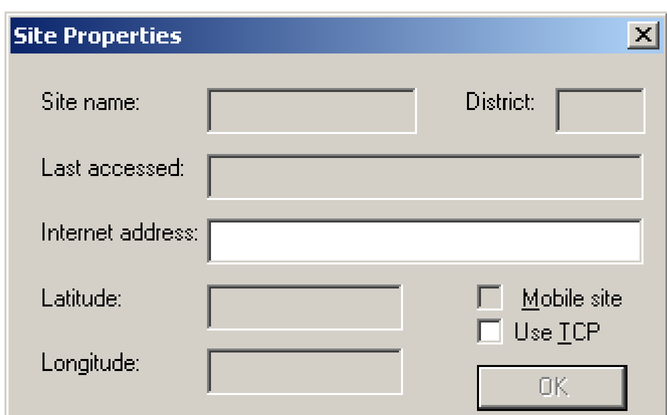


Of the activities that are depicted in this flowchart, obtaining a list of instruments, controlling power to instruments, and opening an instrument are all accomplished through the ISOC Servers window. This window opens when you select the *Connect…* command from the *Site* menu, or alternatively, click the first toolbar button:



This dialog has two parts. On the left hand side, a list of servers that were used in the past is presented. When a server is selected in this list, the instruments present on that server and their status are listed on the right.

When the ISOC is freshly installed, the list on the left hand side is empty. It can be populated by using the Add button, which opens the Site Properties dialog:



Only one of the fields in this dialog is editable, the **Internet address** field. The IP address of the desired ISOC server should be entered here. The other fields will obtain the appropriate values once a successful connection to the server is established.

> **Tip:** If the ISOC client runs on the same machine that acts as the ISOC server, use `localhost` (or the IP address `127.0.0.1`) as the **Internet address**.

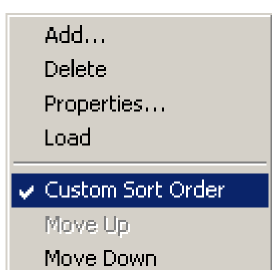
This dialog also contains a checkbox labelled **Use TCP**. Starting with version 2.8, the ISOC supports TCP-only connections to servers, in order to facilitate proper functioning of the software through restrictive Internet firewall systems.

> **Tip:** As a rule of thumb, the **Use TCP** should be checked when connectivity through firewalls is of concern, and should be unchecked when a connection is made through a low-performance network with no firewall present. Note that the Use TCP option works only with ISOC servers 2.8 and above.

The Site Properties dialog can be dismissed by clicking OK. The newly entered site will appear in the list of sites in the ISOC Servers dialog.

A previously added server can be removed by clicking the **Delete** button. The properties of a site can be viewed, and in particular, the address and Use TCP setting of a site can be changed using the **Properties** button.

If many servers are present in this list, they can be sorted by clicking the appropriate column header, or by right-clicking the list and specifying **Custom Sort Order** in the popup menu that appears:



The actual sort order can be changed using the Move Up and Move Down menu commands.

The list of sites is saved, along with the sort order, when a successful connection is made to a site. This is accomplished by clicking the Load button. Once the instruments for a particular site have been loaded, the label of the **Load** button changes to **Refresh** to indicate this fact.

Within a few seconds after clicking **Load**/**Refresh**, the list is populated with the names of available instruments on the selected server. (In case an error occurs, it may take a while longer before the application times out and an error message is displayed).

The list contains, in addition to the device identifier and description, columns indicating the current status and power state of the device.

The status column either contains the word `Free` indicating that the device is available for use, or the name (or IP address) of the computer presently utilizing that device.

The power column contains information for devices that are powered through a remote control power bar.

2.1.1.1. Connecting to instruments

To connect to an instrument (i.e., to start up a virtual instrument on your client computer and establish a connection to the physical instrument at the remote site) you need to select the desired instrument in the ISOC Servers window, and click the **Connect** button. If all goes well, the virtual instrument window will open within a few seconds, and after the physical instrument is successfully initialized at the remote end, you will be able to begin interacting with the device.

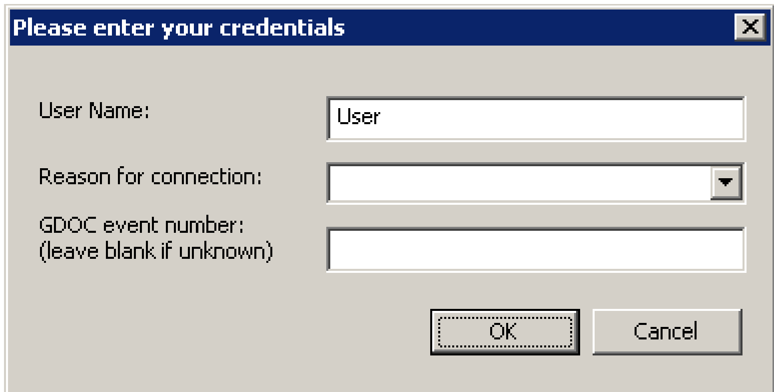
It is possible to open multiple instruments at once. To select multiple instruments, hold down the Ctrl key on your keyboard as you click the instrument name in the list. You may select as many instruments as you wish before clicking the **Connect** button.

The ISOC Servers window can be set to close automatically if the checkbox labelled **Close this dialog after instruments are opened** is set. If this checkbox is cleared, the ISOC Servers window will remain open, floating on top of the main ISOC client window and any virtual instrument windows it contains. However, you may manually close the ISOC Servers window anytime.

The current settings of the ISOC Servers window: namely, its position, size, the arrangements of columns in the instrument list, and the state of the **Close this dialog…** checkbox, can be saved by clicking the **Save window settings** button.

2.1.1.2. User credentials

When you connect to the first instrument, the ISOC client application will request that you supply user credentials. This information is used for server-side usage tracking logs. You enter this information through the following dialog:



The user name defaults to your Windows user name. However, on many (e.g., Windows XP) computers, your Windows user name may be a generic name, such as Administrator. You are requested to supply a more appropriate user name if applicable. The dialog also provides a drop-down list of reason codes for this connection; please select the appropriate reason code. Finally, please supply a GDOC event number, if applicable.

This credentials dialog will not appear on subsequent connections to virtual instruments unless you stop and restart the ISOC client application. The application will remember your last used user name and will provide that as the default (instead of the Windows user name) during these subsequent executions.

2.1.1.3. Power control

In addition to letting you connect to remote instruments, the ISOC Servers window also serves another function: it lets you control the power state of remote instruments.

Not all remote instruments can be powered up or down through the ISOC system. Those that can be are instruments connected through a *WTI RPB+ Remote Control Power Bar* or a *WTI IPS-400/IPS-800 Internet Power Switch* device. These devices are multiple-outlet power bars that can be controlled by computer. The ISOC server has the ability to control these devices, and individual instruments can be configured as appropriate.

If an instrument is configured for power control, its power state will be visible in the Power column of the ISOC Servers window. The power state of these instruments can be controlled through the **Reboot**, **Power On**, and **Power Off** buttons. The meaning of the latter two should be obvious; the **Reboot** button causes the instrument to be powered down for a few seconds and then to be powered back up.

An instrument is powered up automatically if you attempt to use it. However, if the instrument is not immediately usable after power-up, a message appears informing you of this fact and the instrument is not opened.

Many instruments are not immediately usable after their power supply has been interrupted. The ISOC software can be configured to recognize this fact: on the server, the time it takes for an instrument after power-up to become available for use can be configured. For such instruments, after you power them up you will see a countdown appear in the Power column; until the countdown reaches zero, the instrument is not considered to be usable, and attempts to connect to it will be refused.

Some instruments may also be configured to power down automatically. For these instruments, once they are not in use, a countdown appears showing the number of seconds before scheduled power-down. This countdown can be interrupted anytime by connecting to the instrument. If the countdown is not interrupted and it reaches zero, the instrument will be powered down.

> **Tip:** Use the Refresh button to obtain the current state of the instruments and their power status. The ISOC client does not automatically refresh this information; so it is possible, for instance, that an instrument showing “On” in the Power column has since been powered down by another user.

So when should you power down an instrument? This is best discussed with the administrator of the instrument site. Some instruments, such as the HP-8594E spectrum analyser, can take up to 20 minutes to stabilize after powering up. In other cases, a non-responsive instrument can be made functional again by powering it down and back up (i.e., rebooting it).

Sometimes, the power bar may be used in novel ways: for instance, it may power a relay that is used to disconnect an antenna when not in use, to provide lighting protection. Knowing how to manage the power state of instruments thus very much means knowing how a particular site is configured.

2.1.1.4. Workspaces

One particularly powerful feature of the ISOC client is its ability to save and load *workspaces*.

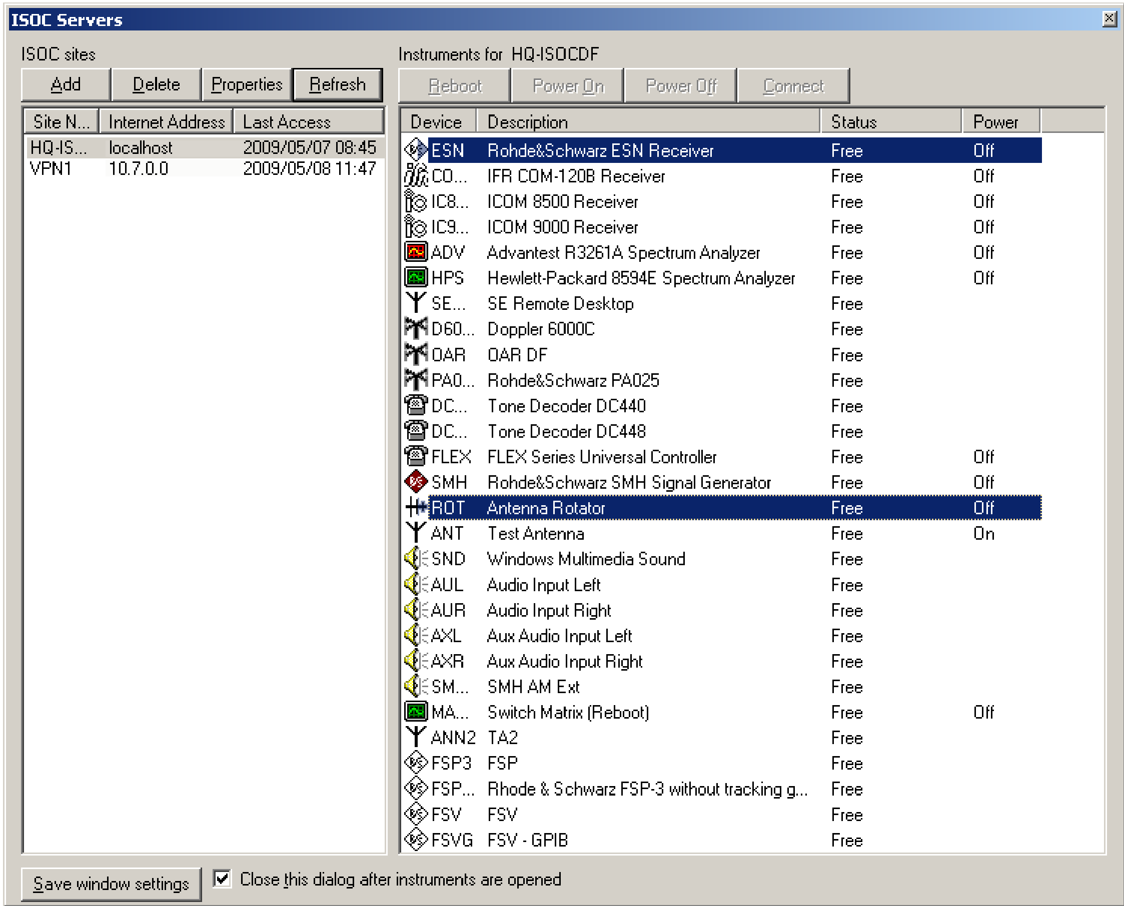
Simply put, a workspace is a collection of virtual instruments together with information about their current state.

What workspaces let you do is something quite simple: after you have established a configuration with several instruments, you can save that configuration into a file called a workspace file. Next time, if you wish to work with the same configuration, you can just reload that workspace file and, if all goes well, all virtual instruments will appear again in the same configuration in which they were at the time the workspace was saved.

Of course many things can go wrong when a workspace is loaded: most notably, the loading of the workspace may be interrupted if one or more of the instruments in the workspace are presently in use, unavailable, or powered down. Nevertheless, the use of workspaces can be a great time saver if you frequently use a collection of instruments in a particular configuration.

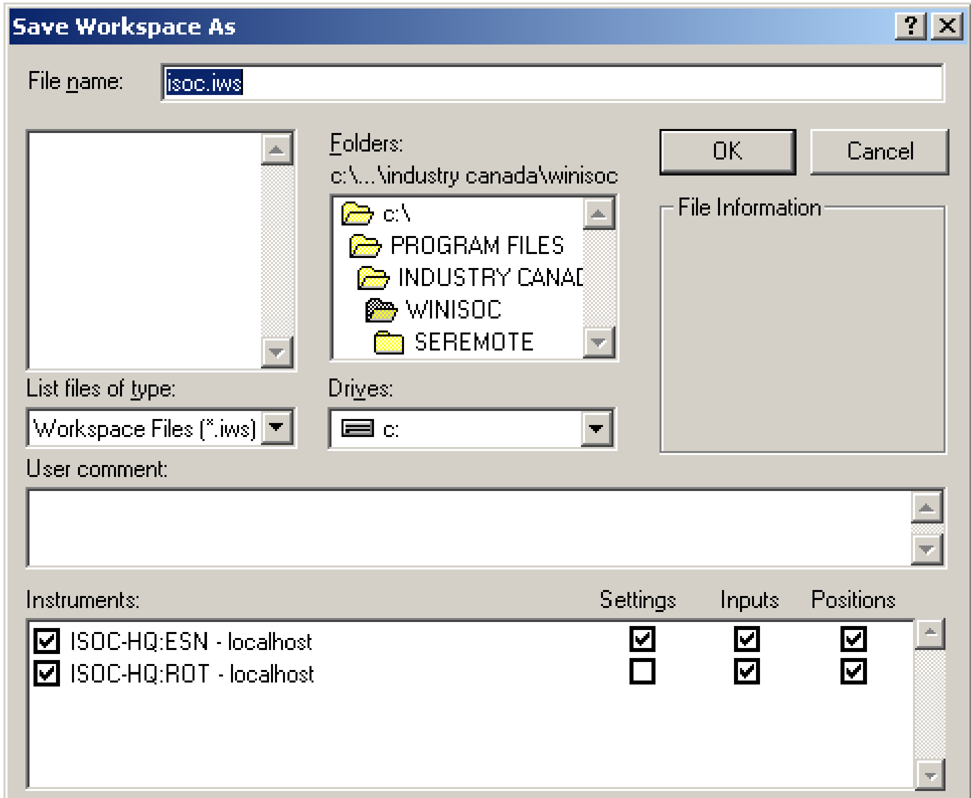
A workspace is an ordinary file stored on your computer. To save a workspace, you must first be connected to one or more instruments. As an example, let us connect to the Rohde & Schwarz ESN receiver and the Emotator EV-800D antenna rotator.

As explained earlier, you can connect to multiple instruments at once by holding down the Ctrl key on the keyboard as you are selecting them:



Once both instruments are selected, clicking the **Connect** button (or simply hitting the Enter key – notice that the **Connect** button is highlighted as the default button in this dialog) will establish connections to them.

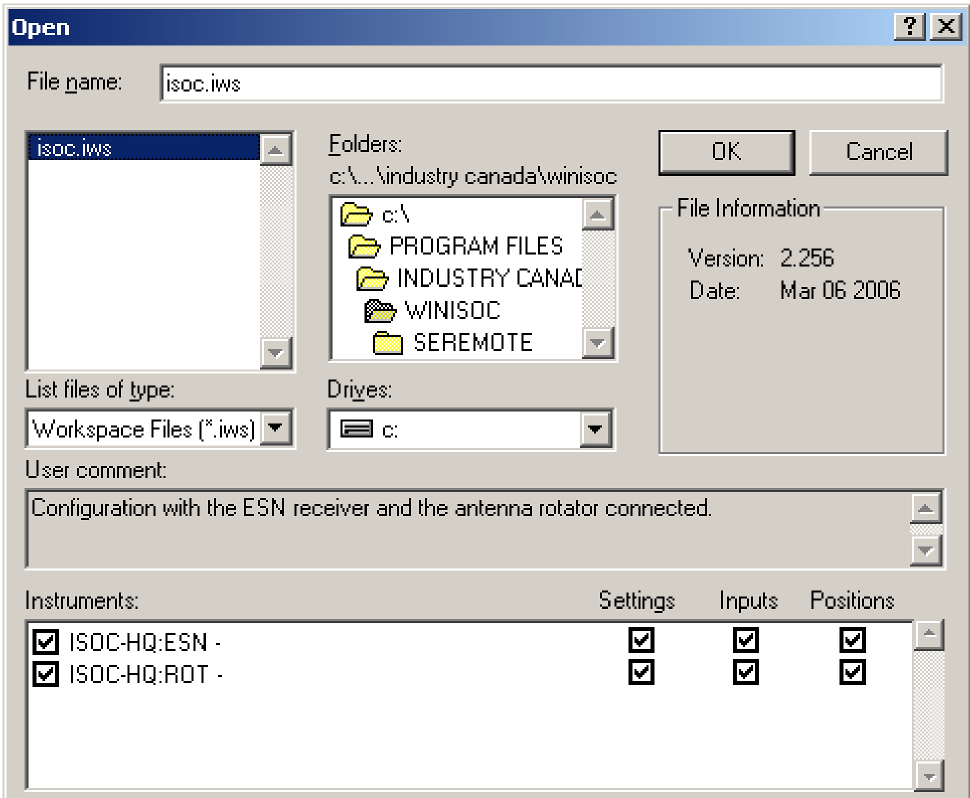
Once both instruments are opened, configure them as appropriate. When you're ready, select the *Save Workspace…* command from the *Site* menu. In response, the following dialog appears:



You may recognize this window as a modified version of the standard Windows dialog used for saving files. In addition to specifying the file name and its folder location, you can also add text comments, select which instruments are to be saved, and what information is to be saved about their current configuration.

Specifically, checkboxes in each row let you select or deselect a particular instrument, and decide whether or not the instrument's current settings, its current signal input (i.e., antenna/signal source selection) and the window position, size and arrangement for the virtual instrument are to be saved. To save the complete configuration in a workspace file, make sure that all the checkboxes are checked; select an appropriate folder; and type a file name in the **File name** field. (The default filename extension for ISOC workspace files is `.iws`, standing for, unsurprisingly, **I**SOC **w**ork**s**pace). You may also want to enter an appropriate comment in the **User comment** field, which may help you or your colleagues better identify the workspace file and its purpose later.

Workspaces can only be loaded by the ISOC client when no instruments are open. This is to avoid conflicts between what is stored in a workspace file vs. the configuration of the currently opened virtual instruments. To test the workspace that was just saved, close all virtual instruments, and select the *Load Workspace…* command from the *Site* menu. This command will display a file selection dialog similar to the one you encountered when you saved the workspace. It, too, is based on the standard file selection dialog, with some enhanced features. Most notably, you can preview a workspace file's contents and select which instruments to load, simply by clicking (not double-clicking!) on a workspace file name:



As soon as you click the file name (don't double-click, as that'd cause the workspace to be loaded immediately), the comment you entered when the workspace was saved is displayed, along with the list of instruments present in the workspace file. Once again, you see checkboxes next to each instrument, which allow you to include or exclude that instrument from the workspace; additional checkboxes organized in columns allow you to specify whether or not to load instrument settings, input signal selections, and window positions as part of the workspace.

Information about the workspace file is also displayed: the file date and the ISOC workspace file version number. Generally speaking, newer versions of the ISOC software are designed to be compatible with older workspace files, but the reverse is not true; a workspace file saved with a new version of the ISOC may contain information that older versions of the ISOC cannot interpret, so they may fail to load the workspace.

> **Tip:** To find out the ISOC version number click the *Help* menu and select the *About ISOC…* command. The version number as of the time of this writing is 2.4.0.0. If the ISOC version number is greater than the workspace file version number, the ISOC should be able to read the workspace file with no difficulty.

If you try to open a workspace that contains instruments presently in use by other users, these virtual instruments will not open. Similarly, if the workspace contains instruments that utilize signal sources that are presently in use by other users, the virtual instruments will open, but the signal sources will not be selected. (In other words, if the possibility exists that others may be using any instruments or signal sources referenced by a workspace, it's always a good idea to check all virtual instruments after you open a workspace file.)

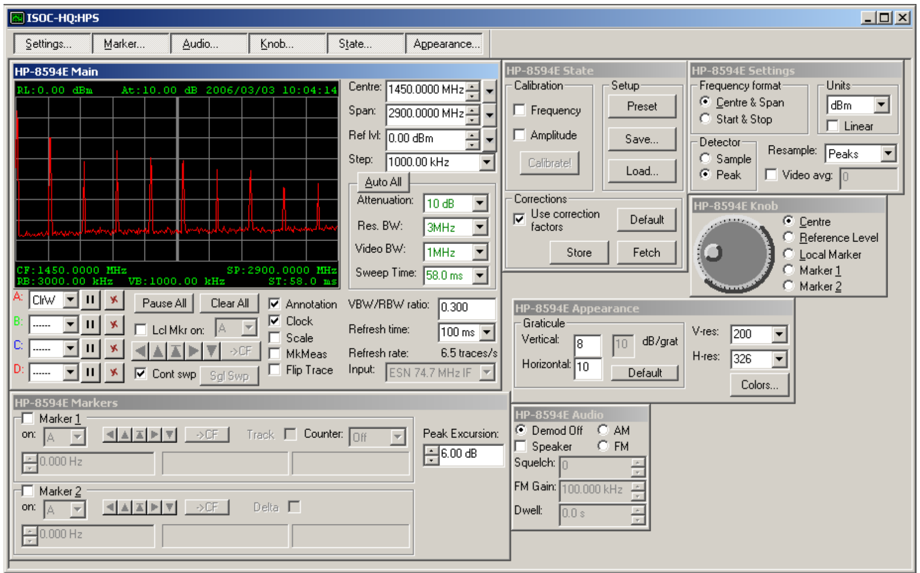
2.1.2. Using a spectrum analyser

The ISOC can utilize several different types of spectrum analysers:

- Advantest R3261A
- Hewlett-Packard HP-8594E
- Rohde & Schwarz FSP-3/FSP-7

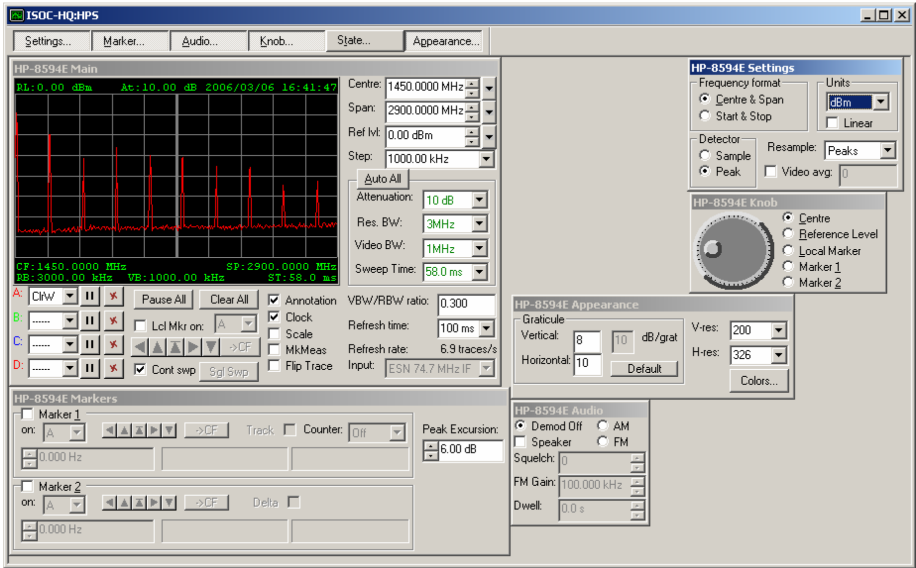
Of these, the HP-8594E is in many ways a prototype instrument for the ISOC, as this was the first instrument for which support under Windows was implemented. (Indeed, the very first ISOC program for Windows was an HP-8594E client implementation that was still designed to work in conjunction with the old ISOC server software that ran on the OS/2 operating system). The HP-8594E implementation has essentially all the features that you find in other ISOC spectrum analyser virtual instruments. In this section, operating a spectrum analyser is demonstrated using the HP-8594E as the example instrument.

To connect to the HP-8594E, open the ISOC Servers dialog (*Connect…* command from the *Site* menu in the ISOC client), click **Refresh** if the instrument list is not yet displayed, select the instrument, and click the **Connect** button. After a few seconds, the HP-8594E virtual instrument should open in a window similar to the following:



The actual arrangement of the panels within the virtual instrument window may differ; feel free to arrange the panels in any way you like and then use the **Save Settings Now!** command from the Window menu to save your arrangement. Or, if you prefer, make sure the **Save Settings on Exit** menu item (Window menu) is set in the Windows menu, ensuring that the arrangement of virtual instruments is saved every time a virtual instrument is closed.

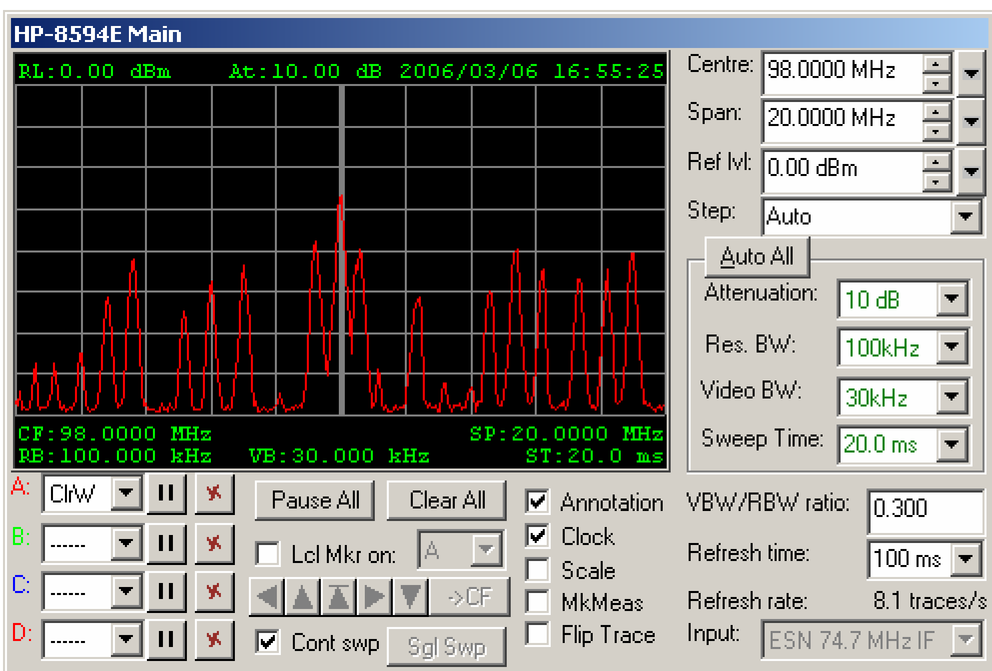
The arrangement shown here displays all available HP-8594E virtual instrument panels; if your screen space is limited, and you do not have a need for all the panels, you may opt to hide those that are not needed. To do so, observe the series of buttons in the toolbar of this window. For instance, if you do not wish to see the panel labelled HP-8594E State, click the **State…** button, and this panel will disappear:



Clicking the **State…** button a second time will cause the panel to appear again.

2.1.2.1. Basic spectrum analyser controls

Most interaction with a spectrum analyser takes place through the Main panel; indeed, this panel combines almost all the important settings of the spectrum analyser into a compact yet functional form:



The panel is dominated by the graphical trace display that closely resembles the display of the physical instrument.

Indeed, the primary function of a spectrum analyser instrument is to provide a visual representation of radio signals in the frequency domain. The extent of the domain is determined by its centre frequency and span; these two parameters can be entered in the corresponding fields in the upper-right corner of the Main panel. To enter a frequency in Megahertz, just enter the digits and use the decimal point as appropriate; when done, hit the Enter key on the keyboard to submit the value to the instrument.

> **Tip:** The ISOC client accepts units of measurements for many value types. For frequencies, the default unit of measurement is (usually) MHz; if other units are desired, their abbreviation can be appended to the unit entered. Truncated abbreviations are also accepted; the abbreviation is not case sensitive. Thus, you may enter `25k` for a value of 25 kHz or `500hz` for a value of 500 Hz.

You can interact with the virtual instrument directly through the trace display using the mouse. Clicking the mouse anywhere in the display causes a line marker to appear temporarily, and the frequency and measured level of the signal at the location of the mouse pointer is also displayed.

You can also use the mouse to change the centre frequency and span.

To change the centre frequency with the mouse, hold down the Ctrl key on the keyboard while simultaneously clicking the trace display and holding down the mouse button; then, move the mouse to the desired position. When you release the mouse button, the centre frequency is changed. If you release the Ctrl key first, however, no change will occur.

To measure a span (e.g., the width of a signal) hold down the Shift key while simultaneously holding down the mouse button and moving the mouse about in the trace area. Two vertical lines will appear corresponding with the mouse position, and the span of the area marked by the mouse will also be displayed numerically.

Last but not least, to change the span with the mouse, hold down both the Ctrl and Shift keys simultaneously while interacting with the trace display using the mouse. The span will be set to the new value when you release the mouse; if you release the Ctrl button first, no change will occur.

The default operating mode of the spectrum analyser virtual instrument is centre & span mode: in this mode, the frequency domain that appears in the display is defined by its centre frequency and span. This can be changed. Notice the small downward-pointing arrow button to the right of the Centre field. If you click on it, a drop-down menu appears that lets you switch between **Centre & Span** vs. **Start & Stop** mode. The latter is an alternate way to specify the extent of the frequency domain: if you click it, the labels of the two fields in the top right change from **Centre** and **Span** to **Start** and **Stop**, and the value in the fields change accordingly.

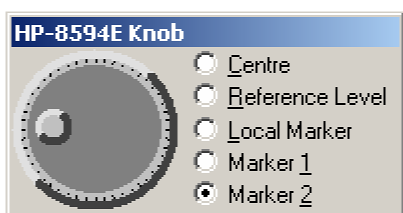
The two other downward-pointing arrow buttons activate additional menus: one allows you to control the span of the instrument, while the third lets you select units of amplitude measurement and specify whether the instrument's display is to use a linear or logarithmic (the default) scale.

You may also utilize the **Ref lvl** (reference level) setting to change the vertical position of the graphical trace.

In addition to entering values from the keyboard, you can also use the small spin control (the pair of up/down buttons) to the right of the **Centre**, **Span**, and **Ref lvl** fields to adjust their values. The amount by which the values are increased or decreased is controlled through the **Step** field. Individual step sizes for frequency, amplitude, and time values are remembered by the software, so if you set the step size to, say, 100 kHz, click on the **Ref lvl** value (causing the **Step** field to switch the amplitude step size, 1.00 dBm by default) and then back to a frequency field, the step size is reset to 100 kHz.

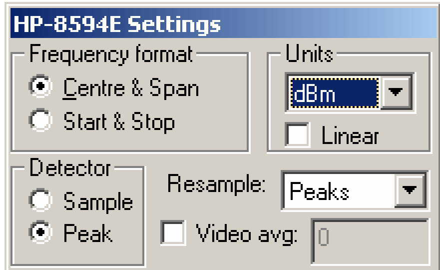
The step size for the span value can also be set to Auto. In this case, the current step size is determined programmatically as a function of the current span value. Automatic step sizes are multiples of 1, 2 and 5.

Closely related to this functionality is the Knob panel:



This panel contains a graphical representation of a tuning knob that can be manipulated by the mouse. Radio buttons next to the knob can be used to select which value the knob alters. The step size, discussed above, also controls the amount by which small movements of the knob will alter the selected value.

The spectrum analyser operating mode (Centre & Span vs. Start & Stop), level units, and linear vs. logarithmic mode can also be controlled through the Settings panel:



This panel contains additional controls that control spectrum analyser operation. First, the detector can be switched between **Sample** and **Peak** modes by clicking the appropriate radio button in the lower left of the Settings panel. Video averaging can also be configured: in this mode, the instrument transmits not individual trace readings but readings averaged over several sweeps. The number of sweeps used for this moving average is controlled by the numeric value in the lower right corner.

The Resample field controls how trace readings obtained from the instrument are converted to the resolution used by the virtual instrument. For details, please see the section titled Controlling Trace Appearance below.

2.1.2.2. Configuring the trace

Further important spectrum analyser settings are the **Attenuation**, **Res. BW** (resolution bandwidth), **Video BW** (video bandwidth) and **Sweep Time** settings. Fields for these values are presented in the middle right portion of the Main panel. By default, all these are set to Auto, indicating that their values are coupled to the current centre frequency and span settings and amplitude readings of the instrument. You may change these settings to desired values, individually switch them back to automatic (coupled) mode, or use the **Auto All** button to reset all to automatic mode.

In some cases (e.g., the sweep time setting on the HP-8594E) the instrument accepts arbitrary values within the range determined by the instrument's capabilities. In other cases, only preset values are accepted; these are presented in the form of a drop-down list, and manual values in these cases cannot be entered.

When the attenuation, resolution bandwidth, video bandwidth, and sweep time fields are set to automatic, their values are displayed in green text. When a manual override is in effect, the values are shown in red.

The automatic values are determined by the physical instrument, as a function of the current centre frequency, span, and other settings. The **VBW/RBW ratio** field does control, however, the automatic values for the video bandwidth as a function of the (automatically or manually set) resolution bandwidth.

2.1.2.3. Virtual instrument performance

So how responsive is the virtual instrument when compared to the physical instrument? It can obtain a trace from the physical instrument several times a second. The actual performance depends on several factors. Some spectrum analysers (e.g., the Advantest R3261A) respond more slowly than others. Network latency is a significant factor: you will find that an instrument sitting right next door, connected to your workstation via a local area network with a network latency of <1 ms will appear a great deal more responsive than an instrument at a remote site, accessed via a dial-up network with a network latency measured in hundreds of milliseconds.

The number of traces obtained per second can be controlled through the **Refresh Time** field. In theory, the number of traces per second will be the reciprocal of the value entered here: for instance, a setting of 100 ms would imply ten traces per second. In reality, however, due to various (instrument and network) latencies, the number will be less. The actual trace rate (i.e., the number of traces per second received by your client computer) is displayed in the **Refresh Rate** field in the lower right corner of the Main panel.

2.1.2.4. Rate fallback mechanism

The actual trace rate may also be less than expected due to another reason: the ISOC is designed to adapt to less than perfect network conditions, for instance when network congestion occurs over a slow network connection.

For instance, if you are accessing an ISOC server through a dial-up connection and utilize multiple instruments, you may quickly run out of the limited bandwidth of the connection. The ISOC detects network congestion and adjusts its behaviour in response. If you have access to the server log file, one indication is the presence of log entries such as this:

```
2006/03/03 14:42:41 Throttling down on socket 00000398
```

The mechanism works both ways. If network congestion is reduced, the server detects this:

```
2006/03/03 14:42:42 Throttling up on socket 00000398
```

Frequent “throttle-down/throttle-up” messages in the server log are not an indication of trouble, simply a sign that the ISOC continues to dynamically adapt to marginal network conditions. In some cases (for instance, if the ISOC client does not respond to the server for an extended period of time, such as during calibration) the server may throttle down several times unnecessarily; however, once the ISOC client becomes responsive again, the server will throttle back up.

2.1.2.5. Input selection

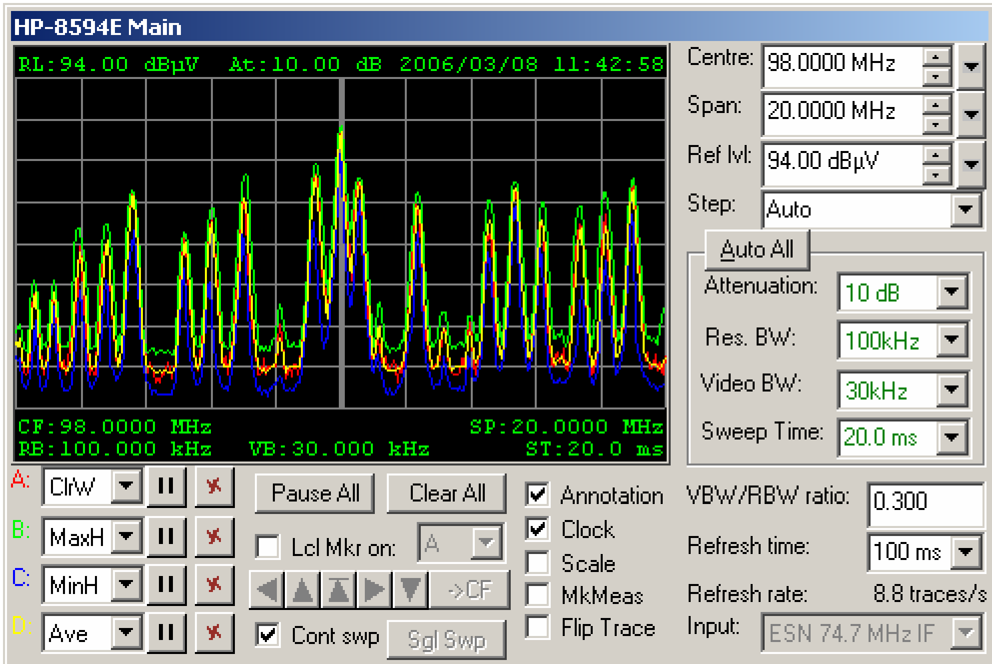
A spectrum analyser is not a very useful device unless it is connected to a signal source. In some cases, the signal source may be connected permanently (e.g., a spectrum analyser may be permanently hooked up to the IF output of a receiver). In other cases, however, you may have to manually select a signal source before an instrument can be put to use.

In the spectrum analyser virtual instrument, signal source selection is made through the **Input** field in the lower right corner of the Main panel. When selectable signal sources are available, this field contains a drop-down list of all available signals, and shows the currently selected signal. Signal sources that are presently in use are marked with an asterisk (*); an asterisk is also used to mark signal sources that cannot be selected due to a conflict at the switch matrix. To make your selection, click the drop-down list, choose the desired signal and click on it. This will cause the ISOC client software to send the appropriate commands to the ISOC server, which in turn will use the switch matrix to connect the selected signal source to the instrument.

If the Input field is grey, it may be due to one of two reasons. Either there are no selectable signal sources present for your instrument, or there is no switch matrix present at the remote site. It is possible that the switch matrix has been turned off, or for some reason it has not been detected by the ISOC server software. If you are certain that a switch matrix is present at the remote site, it may be helpful to close and then reopen the virtual instrument, as a fresh attempt is made to re-detect the switch matrix every time a virtual instrument is opened.

2.1.2.6. Using multiple traces

The graphical trace window in the spectrum analyser virtual instrument has many capabilities. Most notably, it has the ability to simultaneously display up to four different traces:



Traces can be activated by changing the selections in the lower right corner of the main panel. The four traces, labelled with the letters A through D, are each displayed in a distinct colour, and can each be set to one of the following:

---	no trace displayed
ClrW	Clear Write: the trace follows the instrument's signal level readings
MinH	Minimum Hold: the trace displays calculated minimum levels
MaxH	Maximum Hold: the trace displays calculated maximum levels
Ave	Average: the trace displays a calculated moving average

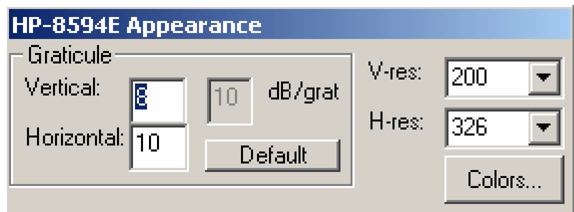
Next to each trace label is a dropdown list box where the trace type can be selected. Next to each dropdown list box is a pair of buttons for each trace containing symbols for pause ( ) and clear ( ). These buttons allow you to individually control each trace. You can also pause and clear all traces at once using the **Pause All** and **Clear All** buttons.

2.1.2.7. Controlling trace appearance

Four simultaneously appearing traces in a small trace display can be rather confusing. This is just one of the reasons why the ISOC client offers numerous features through which you can customize the appearance of the trace.

The most important controls are available through the Main panel. The **Annotation** and **Clock** checkboxes, for instance, turn on and off the text labels and the running clock on the trace display. The **Scale** checkbox, off by default, causes vertical scale labels to appear to the left of the trace. The **Flip Trace** checkbox causes the trace to be flipped; this is useful, for instance, when the spectrum analyser is used on the IF output of a receiver, which is often flipped in frequency.

Additional controls that affect the appearance of a trace are accessible through the Appearance panel:



First, you can change the number of horizontal and vertical graticules that are used to subdivide the trace display. The default is 8 graticules vertically, 10 horizontally. (Just to clarify, a vertical graticule consists of horizontal lines, which is how it subdivides the display in the vertical direction). The default of 8 vertical graticules is suitable for most spectrum analyser trace configurations, as the full vertical height of the trace display corresponds with 80 dB of amplitude. You may find it useful to use a different number of graticules, however, when the spectrum analyser is in linear mode, for instance.

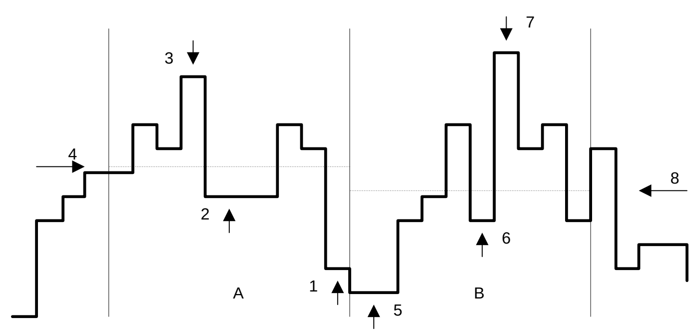
The Appearance panel can also be used to change the horizontal and vertical resolution of the trace. Why bother, you ask? Well, the higher the resolution, the more data needs to be transferred from the ISOC server to the client workstation; this can create problems over slow communication lines, for instance when the server is at a remote site accessible only through a dial-up connection. It also does not make much sense to use a resolution higher than the instrument's native resolution (you cannot create data where there is none) or even a resolution higher than the size of the trace display window. To help you choose the right resolution, the **V-res** and **H-res** fields include drop-down options to change to values specific to the instrument or to your current screen settings (i.e., the current horizontal and vertical size of the trace display).

A change in resolution necessarily means that the signal has to be resampled, leading to a potential loss of information. It is important to understand how the ISOC deals with that loss of information by applying the most appropriate resampling algorithm.

The resampling algorithm is selected through the **Resample** field of the Settings panel, shown earlier in the subsection titled Basic Spectrum Analyser Controls. The following choices are available:

- Peaks
- Sample
- Average
- Min Peak
- Max Peak

To understand the meaning of these choices, it is necessary to first understand why resampling is necessary and what the algorithmic choices are. Traces come from physical instruments in the form of a series of level readings. The width of the trace window is subdivided into a large number of sample points (typical number are 400, 500, 700, or 1000 samples), and a level reading for each is provided. For a simple example, let us take the case of an instrument that provides 1000 samples across the width of the trace, which we wish to downsample to 100 samples. In other words, we need to process each sampling interval, consisting of 10 samples each, with a single value. The following figure depicts a signal with two such sampling intervals shown, marked with the letters A and B:



Numbered arrows in this diagram are used to mark the signal levels that will be picked when the various resampling algorithms are employed:

Sample: A representative value is chosen for both sampling intervals: this will be value #2 for sampling interval A, and value #6 for sampling interval B. For a noisy, rapidly varying signal these values may not be very representative at all; the result may be dominated by the noise.

Average: For both sampling intervals, the arithmetic mean of the level values is calculated. These are marked by arrows #4 and #8 in the diagram above. While mathematically correct, this method tends to “dull” a signal, making it appear less noisy than it is in reality.

Min Peak: For each sampling interval, the lowest value is used (values #1 and #5 in the diagram above). This resampling method is likely to underestimate the signal level, especially if the signal is noisy.

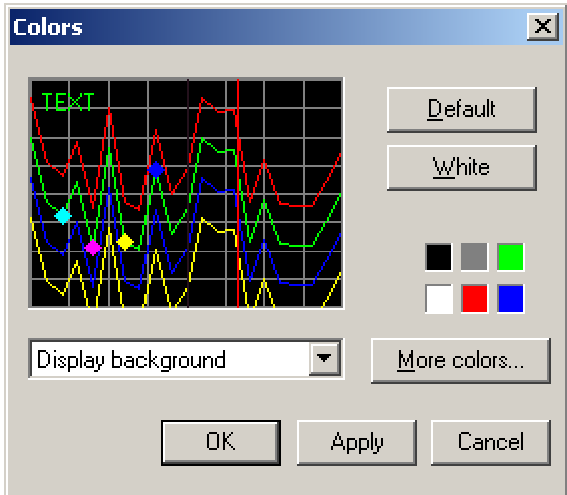
Max Peak: The opposite of Min Peak (picking values #3 and #7 in the diagram above), this resampling method tends to overestimate the signal level of a noisy signal.

The last remaining resampling method, ***Peaks*** (also known as the minimax method) is the most sophisticated of the lot and deserves a more detailed discussion. This method is intended to preserve the characteristics of the signal to the greatest extent possible, while dealing with the inevitable loss of information inherent in any downsampling method. In this mode, two adjacent sampling intervals are processed simultaneously, and the highest and lowest signal levels are located (values #5 and #7 in the example above). These signal levels will be used, in the order in which they appear, as the levels for the two sampling intervals. Since value #5 in the current example precedes (is to the left of) value #7, value #5 will be used as the reading for sampling interval A, and value #7 will be used as the reading for sampling interval B.

This resampling method tends to be the most successful preserving the characteristics of the original signal, even when very aggressive downsampling rates are employed. For this reason, the Peaks algorithm is the default downsampling algorithm used by the ISOC.

> **Tip:** It is recommended that you use the Peaks resampling algorithm and set the **V-res** and **H-res** fields both to the Screen value for optimal results. However, if you intend to export or print traces often (see next section) and bandwidth is of no concern, you may want to use the Sample algorithm and set the **V-res** and **H-res** fields to the Instrument preset.

You may also change the colour of the visual elements that appear in the trace window. This is not just an idle game with cosmetics: you may be spending hours looking at the trace display of various ISOC virtual instruments, so being able to find a visually pleasing combination of colours can be important. To change colour settings, click the **Colors…** button in the Appearance panel. This invokes the Colors dialog:



This dialog contains a simulated picture of a trace display with four traces, four markers, graticules and text shown. The colour of all these display elements, as well as the trace background, can be adjusted by selecting the element from the dropdown list box underneath the simulated trace, and then clicking one of the colour buttons to the right. Alternatively, you can use the **More colors…** button to invoke a colour palette through which arbitrary colours can be selected.

The ISOC has two built-in colour schemes that can be activated by clicking the corresponding button: the **Default** scheme uses a black background, while the **White** scheme uses a white background with dark colours for the text, graticules, markers and traces.

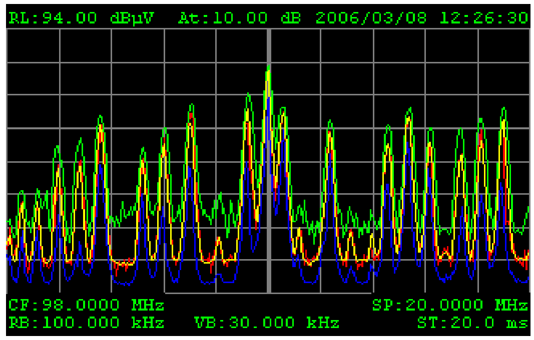
When you're done changing colours, and you are satisfied with the result, click the **OK** button to return to the spectrum analyser virtual instrument. Or, you may try to the **Apply** button to apply the currently selected colour scheme to the spectrum analyser without closing the Colors dialog. The Cancel button closes the Colors dialog without changing the current colour settings of the virtual instrument.

2.1.2.8. Exporting and printing traces

An important and, in some cases, particularly useful feature of the trace display used in ISOC virtual instruments is the ability to export or print a snapshot of the trace.

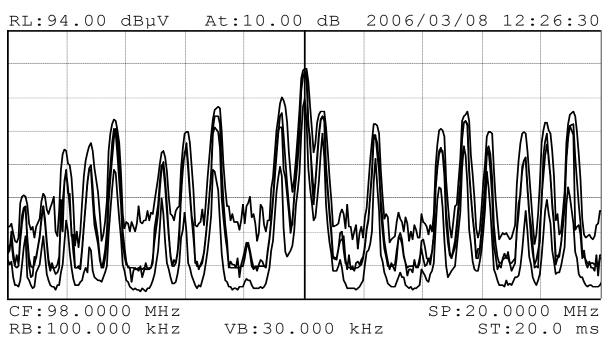
Exporting a trace takes place through the Windows clipboard. The ISOC can export a trace in two different formats: either as a bitmap, or as a Windows metafile.

When exported as a bitmap, the trace display is an exact, pixel-by-pixel representation of the display that you see on-screen:



While a bitmap can be used “as is” in many applications, it has certain drawbacks: most notably, a bitmap does not scale very well to different resolutions. If you enlarge a bitmap, details become blurred, pixelated. For this reason, you may prefer the alternative of exporting the trace in the form of a metafile. The metafile format is essentially a series of drawing instructions to the computer: commands to draw a line here, draw a character or a string of text there, etc. The drawing consists of primitives such as lines, circles, ellipses, or characters of text. When a metafile is enlarged, the drawing instructions remain the same, only the coordinates change; the result will automatically appear in good quality at the new resolution, with no pixelation artefacts.

When exported in the metafile format, the trace may appear in black-and-white:



This is suitable for inclusion in print documents, for instance. However, you can also export color metafiles, by choosing the *Print/Export Traces in Color* setting under the *View* menu.

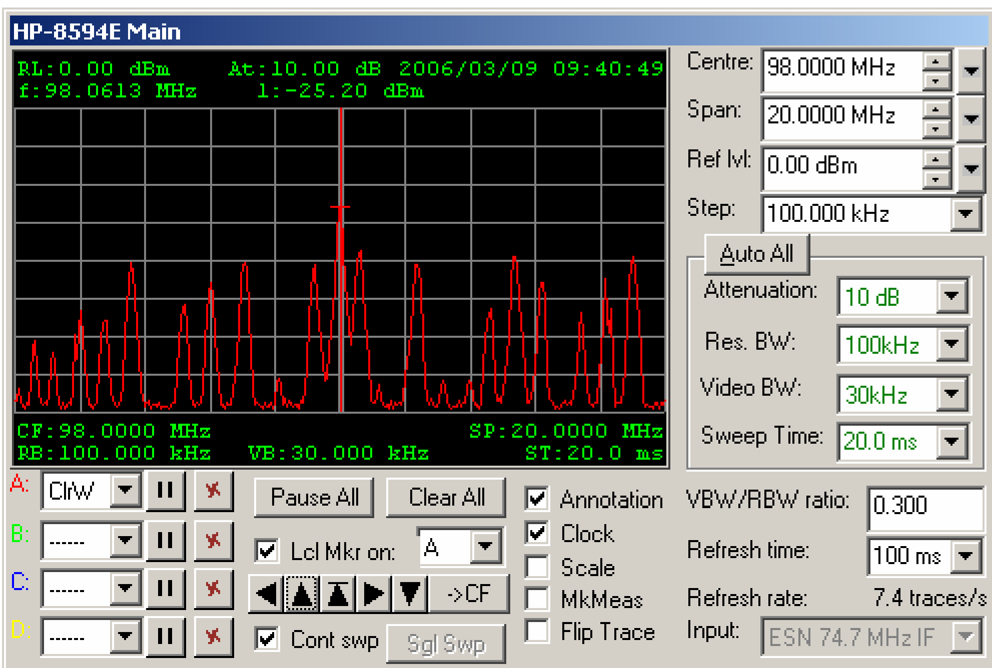
Speaking of printing, the ISOC is capable of sending a trace directly to the printer. To send the trace to the printer, select the *Print* command from the *Site* menu. (If you have multiple instruments open, the command will print the trace of the virtual instrument whose window is currently on top).

2.1.2.9. Markers

A particularly useful feature of the spectrum analyser instrument is the ability to place a marker on the trace. The software offers one "line marker" and two additional markers for your use.

The distinction between line markers and regular markers is primarily a matter of appearance; whereas the line marker appears as a thin vertical line, regular markers appear as coloured diamonds. On some instruments (such as the HP-8594E) the implementation of the two types of markers is different: whereas the line marker is implemented in software (for this reason, it was also called a "local marker"), regular markers are provided by the physical instrument. This distinction, however, has very little effect on how these markers function in the virtual instrument.

The line marker is turned on by clicking the **Lcl Mkr on** checkbox in the Main panel, and selecting a trace on which to position the marker using the drop-down box provided next to the checkbox:



The line marker looks the same as the marker that appears when you click the mouse in the trace area; indeed, it is the very same line marker, and it can be positioned with the mouse. The difference is that when the **LclMkr on** checkbox is checked, the line marker does not disappear when you release the mouse.

You can also position the line marker using one of the five arrow buttons that appear right beneath the **Lcl Mkr on** checkbox. The buttons are graphical representations for Next Left, Maximum, Next Maximum, Next Right, and Minimum; however, if you find the button symbols cryptic, notice that if you let the mouse hover over the buttons for a few moments, a tooltip appears containing the corresponding description. The function of these buttons can be described as follows:

Next Left (◀): move the line marker to the next peak found left of the marker's current position. If no more peaks appear to the left of the marker, the marker will not be moved. A peak is defined as a local maximum that is separated from nearby peaks by troughs of sufficient depth (the requisite depth being determined internally by the peak search algorithm).

Maximum (▲): move the line marker to the highest signal level that appears anywhere in the trace.

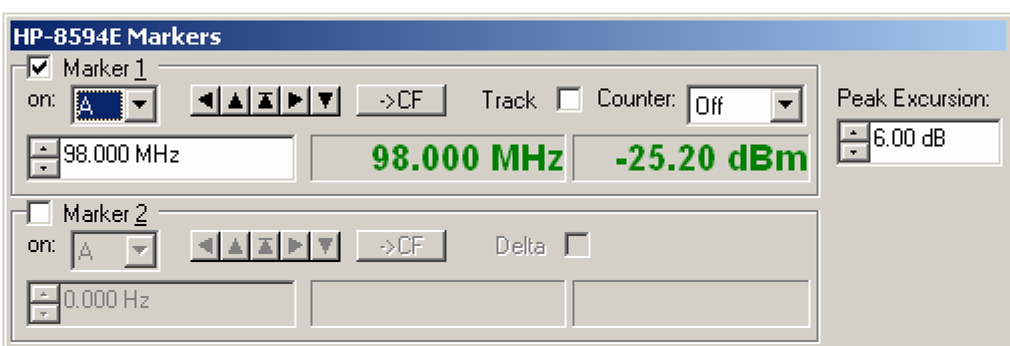
Next Maximum (▲): move the line marker to the highest peak (as defined above under Next Left) whose level is below the signal level at the current line marker position.

Next Right (▶): move the line marker to the next peak (as defined above under Next Left) to the right of the marker's current position. If no further peaks are found to the right of the marker, the marker is not moved.

Minimum (▼): move the line marker to the lowest signal level that appears anywhere in the trace.

One very useful and practical feature associated with the local trace is the **->CF** button. This causes the centre frequency to change to the current line marker frequency, helping you to quickly tune in on a signal of interest, for instance.

In addition to the line marker, the spectrum analyser virtual instrument offers two regular markers. These markers can be controlled through the Markers panel:



> **Tip:** If you never use two markers either individually or in delta marker mode (see below), you can reduce the size of the Marker panel and hide the region reserved for Marker 2. On computers with small displays, e.g., laptops, this may save valuable display space.

To activate either one of these markers, select the **Marker 1** or **Marker 2** checkbox, and optionally use the dropdown list box labelled **on** to select which trace the marker is attached to. You can position the marker in one of two ways: either enter the marker frequency, or use one of the Next Left, Maximum, Next Maximum, or Minimum buttons (marked with the same graphical symbols that were used for the line marker above).

For these markers, the **Peak Excursion** field defines what constitutes an adjacent peak. Given one peak, so long as the signal level remains within the vicinity of that peak as defined by the peak excursion, these adjacent data points are considered part of the same peak; a trough deeper than the peak excursion value must occur first before an adjacent signal is considered a separate peak.

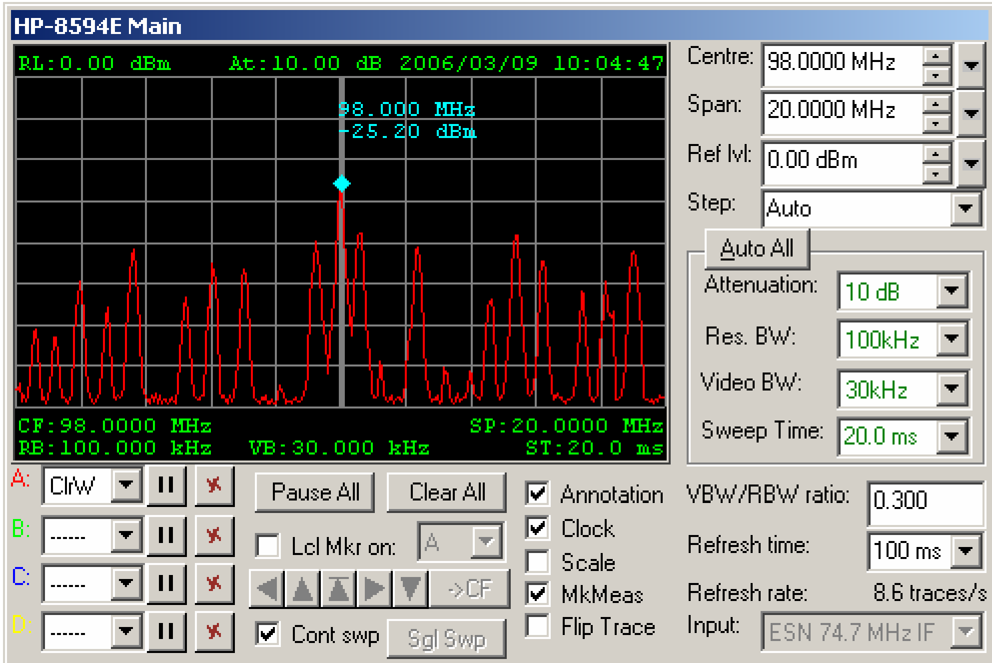
As soon as the marker appears on the display, the marker frequency and the signal level at the marker appear in the Markers panel. The marker frequency is usually identical to the frequency to which the marker has been set, unless the **Counter** field is changed from its default value (Off) to something else.

When marker counting is on, the sweep is paused at the marker position and the signal at the marker (characterized by the resolution bandwidth) is sent to a frequency counter, for a period corresponding with the counter resolution. The result is displayed as the marker frequency.

Be careful not to specify a very low marker counter value unnecessarily; to perform accurate marker frequency measurements, the physical instrument will execute a lengthy pause during each sweep, which may be undesirable.

The marker track function is activated when the **Track** checkbox is checked. In this mode, the spectrum analyser’s centre frequency will follow the marker. This is very useful when you are following a signal of changing frequency and wish to apply a narrow span.

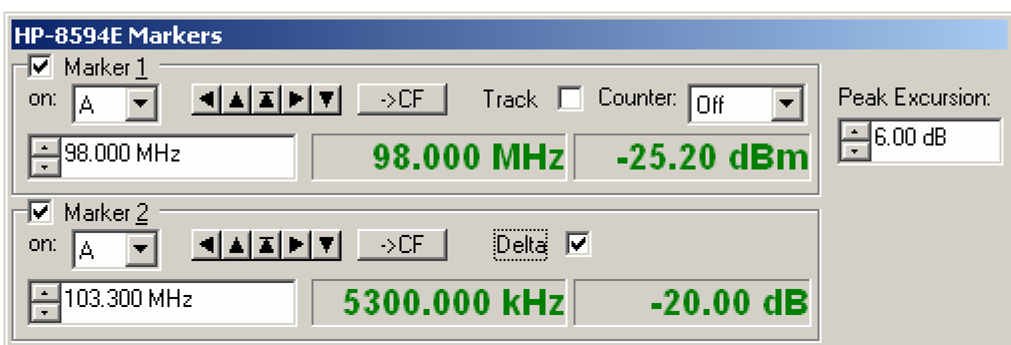
Whenever a marker is active, it is displayed as a diamond-shaped graphical symbol in the trace display. Optionally, if the **MkMeas** checkbox is checked, the marker frequency and signal level are also displayed alongside the marker symbol:



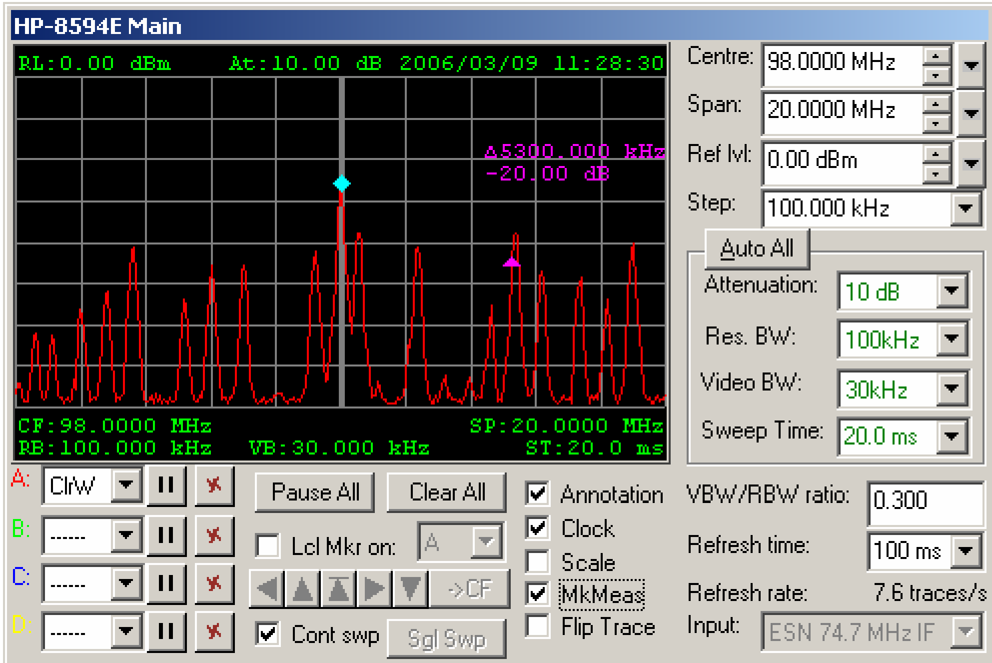
The marker symbol and optional text are also printed or exported when the trace display is copied to the clipboard.

The two markers can be used either individually or in delta marker mode. In delta marker mode, the second (delta) marker's values are displayed relative to the first marker.

To activate delta marker mode, make sure both markers are active and the **Delta** checkbox is set. In delta marker mode, the second marker's frequency and amplitude are relative to the first:



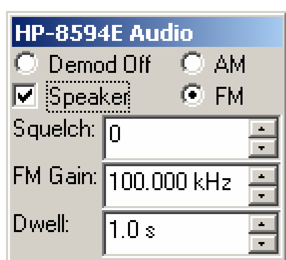
When in delta marker mode, the second marker is displayed with a triangular symbol resembling the Greek letter delta, to visually distinguish it from a regular marker:



The delta symbol is also used in the on-screen marker measurement display if the **MkMeas** checkbox is set.

2.1.2.10. Audio settings and zero span mode

The HP-8594E spectrum analyser is capable of producing an audio signal. The built-in demodulator can demodulate AM and FM radio signals. You can control the demodulator settings through the Audio panel:



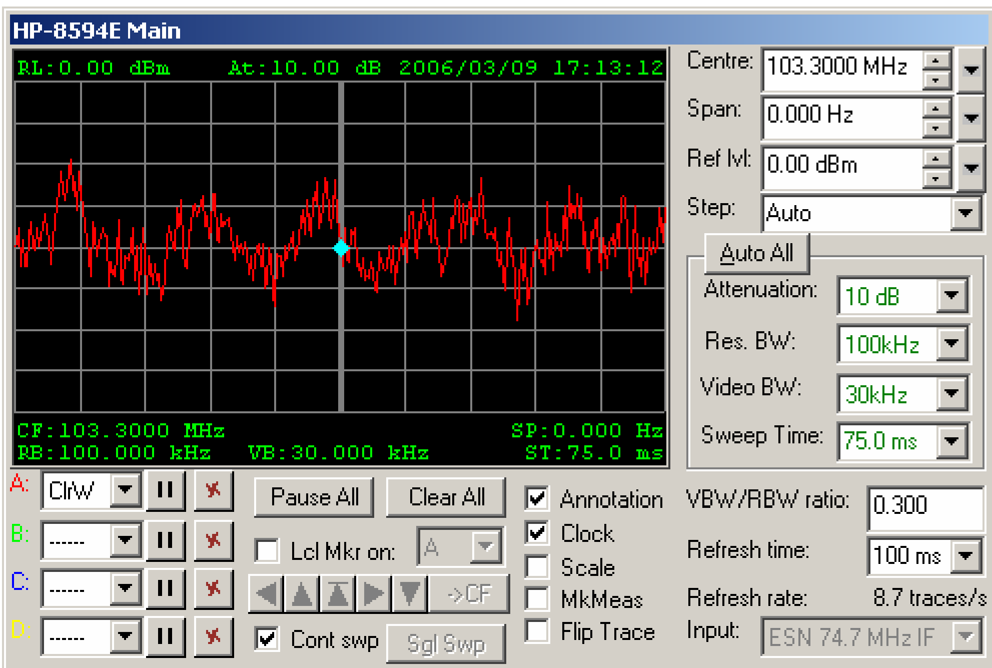
To actually receive audio from the spectrum analyser, the following must be true:

- The demodulator must be set to **AM** or **FM**
- The **Speaker** must be on
- The first marker (**Marker 1**) must be positioned to the desired signal
- The **Dwell** time must be set to a non-zero value.

When all these conditions are true, the spectrum analyser will momentarily pause during each sweep when it reaches the marker. During the pause, the demodulator is turned on and audio is heard. Expect to hear a regular clicking noise as, after pausing for the period of time specified in the Dwell field, the sweep resumes and the demodulator is turned off.

> **Tip:** You will of course not hear any audio unless you are standing next to the physical instrument, or the instrument's audio output is routed to the ISOC server and you have configured your ISOC client software to receive remote audio from the server. Using remote audio is described in section 2.1.4 below.

There is another way to use the spectrum analyser that, among other things, provides for uninterrupted audio. You can set the analyser into zero span mode. In this mode, the analyser is continuously tuned to a single frequency. The trace display changes: the horizontal axis no longer represents the frequency domain but the display effectively becomes an oscilloscope screen; the vertical axis measures FM Gain. The width of the screen will correspond with the time value set for the **Sweep Time**:



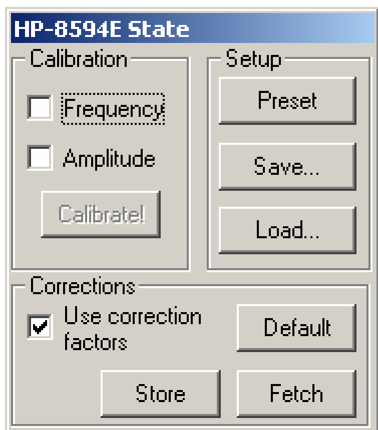
The vertical axis also changes: its functionality becomes dependent on the setting of the demodulator. If the demodulator is set to **Demod Off** or **AM**, the vertical axis continues to represent the signal level. However, if the demodulator is set to **FM**, the vertical axis measures the deviation in frequency from the centre frequency, and is measured in units of Hz or (more typically) kHz.

Several other features of the spectrum analyser virtual instrument work differently when in zero span mode. For instance, the horizontal marker position is no longer a frequency value; it is rather a time value, indicating the distance from the left edge of the trace display.

2.1.2.11. Spectrum analyser state and calibration

The current state of the spectrum analyser—its frequency and span, setup, demodulator, etc. configuration—can be saved to a file. You have already seen in a previous section how to save your current workspace into a workspace file. The settings of an individual instrument can also be saved, using a file format that is specific to that instrument type. For HP spectrum analysers, settings files have the extension `.HPS`.

To save the current settings of the instrument, use the **Save…** button available in the State panel:



When you click this button, the standard Windows file selection dialog appears that lets you specify the file name. To load a previously saved instrument configuration, use the **Load…** button; once again, the standard Windows file selection dialog appears where you can pick the file to load.

The State panel also lets you reset the instrument to its factory default state through the **Preset** button, and lets you perform self-calibration. In order for the latter to work, the instrument's CAL OUT signal must be connected to its input, either by a piece of cable or through a switch matrix. To perform a calibration, click either the **Frequency** or the **Amplitude** checkboxes (or both) and click the **Calibrate!** button. Once started, the calibration process cannot be interrupted. During calibration, the instrument remains unresponsive for several minutes; however, you will be able to interact with other instruments in the meantime. (That said, it is probably a good idea not to operate other instruments on the same server while you are calibrating a spectrum analyser).

The result of a calibration is stored in the physical instrument's operative memory. If the instrument is powered down, the calibration results are lost unless they are saved in permanent memory using the **Store** button. Alternatively, if you are not satisfied with the results of a calibration run, you may use the **Fetch** button to reload from permanent memory into operative memory the results of the previous calibration. Lastly, the **Default** button can be used to load factory default calibration values into operative memory.

2.1.3. Using a receiver

The first receiver for which support in the ISOC was implemented is the Rohde & Schwarz ESN Test Receiver. Since this receiver remains one of the most feature-rich receivers in the ISOC suite, it will be used as the prototype receiver through which the receiver-specific features and capabilities of the ISOC are demonstrated.

Other receivers that the ISOC can use are the

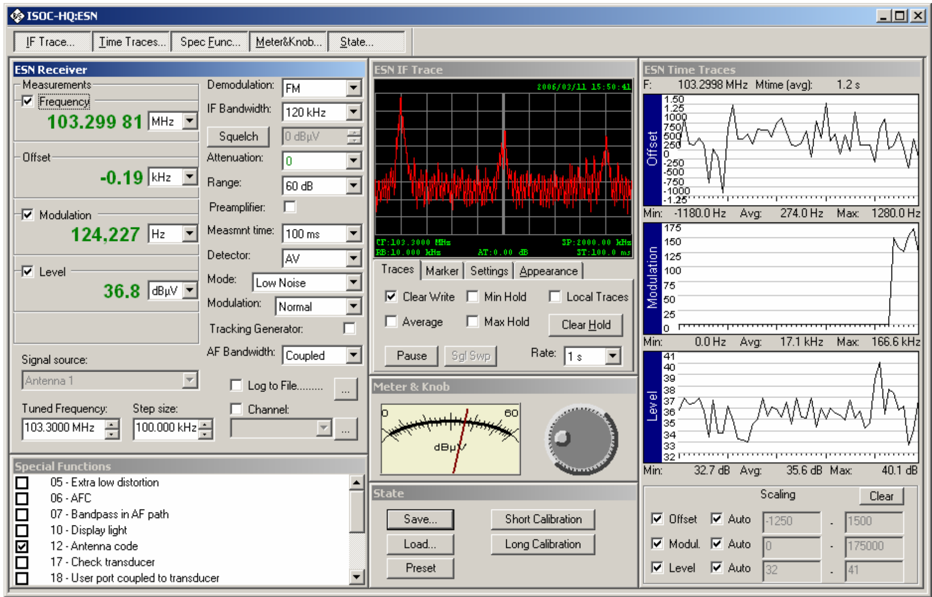
- ICOM R-8500[3]
- ICOM R-9000
- Rohde & Schwarz EB-200
- Rohde & Schwarz ESMB

Of these, the ICOM receivers are the most limited, lacking all except level measurement capability, lacking the ability to provide a graphical trace, and also lacking a fast frequency scan function.

> **Tip:** Even though you are operating a radio receiver, do not expect to hear any audio unless you are either sitting next to the physical device, or the device's audio output is connected to the ISOC server and you are receiving audio from the server. To receive remote audio from an ISOC server, please consult section 2.1.4.

A receiver like the ESN has many functions. The virtual instrument interface is correspondingly complex:

[3] Tentative support exists for the ICOM R-7100 receiver. Other ICOM receivers may also provide at least limited functionality through the ISOC.

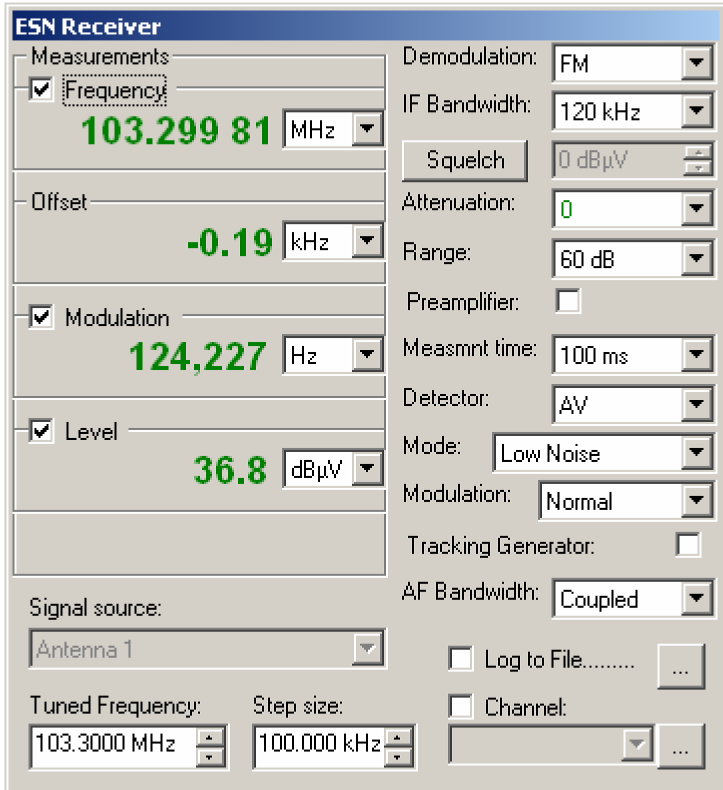


When you first power up the virtual instruments, the panels may not be arranged to your liking. You can arrange the panels as you prefer, turning specific panels on and off by pressing the corresponding button in the toolbar near the top. For instance, if you have no use for the IF Trace panel, click the first button in the toolbar and the panel will disappear. When you are done arranging the panels, you may use the *Save Settings Now!* command from the ISOC client application's *Window* menu to save your current settings; whenever you open the same instrument later, your settings will be remembered.

Some of the panels and controls that appear in the receiver virtual instrument may already be familiar if you already used a spectrum analyser virtual instrument, described in the previous section. Panels unique to receivers include the Receiver and Time Traces panels. The Trace panel, available for receivers like the ESN that have graphical trace functionality, delivers a subset of the functionality available in a spectrum analyser.

2.1.3.1. Basic receiver controls

The primary interaction with a receiver takes place through the Receiver panel. The basic functionality of a receiver in the context of the ISOC suite is to deliver a continuous stream of signal level, frequency (offset), and modulation measurements at a given carrier frequency and with given receiver, detector, and demodulator settings. These readings are displayed and can also be recorded in a log file that can be read by a human operator or processed by automated tools.



The most prominent feature of the Receiver panel is a set of large display regions in the upper left portion. For the ESN receiver, four display areas are provided, for the frequency, offset, modulation, and level measurements. For other receivers, not all these areas may be present, only those that the receiver actually supports.

Some of these measurements are optional. Turning them on may alter the reception characteristics of the receiver, and/or may slow down the receiver.

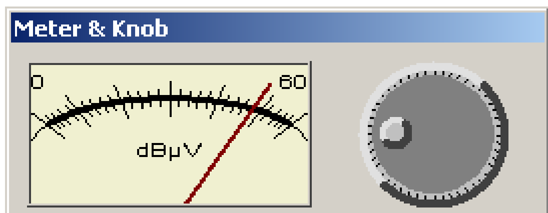
Not all measurements are performed by the physical instrument. As an example, the measured frequency and offset readings are not independent; they are related to the tuned frequency by the following equation:

$$f_{\text{tuned}} + f_{\text{offset}} = f_{\text{measured}}$$

To change the tuned frequency of the receiver, enter the desired frequency in the **Tuned Frequency** field near the lower left corner of the Receiver panel.

Tip: Don't be surprised if the **Tuned Frequency** field behaves a little oddly at times. The tuned frequency may change if the receiver is in AFC mode; therefore, the software must be able to update the value in this field in response. This may interfere with your attempts to enter a new frequency value. Although the software does attempt to avoid interference by not updating the value once you began editing it, as a practical matter, it is easier simply to erase whatever value is in this field by selecting it with the mouse and hitting the Backspace key, and then enter the new value.

Alternatively, you can use the up/down control to the right of the Tuned Frequency field to change the field's value; you can also use the tuning knob in the (separate) Meter & Knob panel:



As this panel's functionality is largely cosmetic, if you are short on real estate, you may hide it by deselecting the **Meter&Knob** button in the virtual instrument's toolbar at the top.

A high-end receiver such as the ESN has many controls that affect the operation of the different receiver stages: RF/preamplifier stages, IF stages, the demodulator, etc. These controls are arranged on the right of the Receiver panel. A few of these deserve special mention here as their effect in the virtual instrument may not be instantly evident.

The **Squelch** button enables squelch in the physical instrument. When the RF signal level is below the squelch value, the instrument's audio output is muted. In the ISOC, you would notice this if you were receiving audio from this instrument through a separate (audio) virtual instrument, described in a later section. When squelch is enabled, you can enter an amplitude value in the squelch field using the keyboard, or use the mouse to manipulate the up-down control at the right of this field. If you are entering a value from the keyboard, make sure to hit the Enter key in order for the new value to take effect.

This arrangement with a separate Squelch button and field mimics the physical instrument: when squelch is off, this is a state distinct from when squelch is merely set to a very low value.

The **Attenuation** control can be set to a value in decibels, or to Auto. In Auto mode, attenuation is controlled by the physical instrument; the current state of the attenuator is queried along with the signal level, so that this field always correctly reports the current automatic attenuator setting. When a manual attenuation level is chosen, care must be taken to ensure that the receiver is not damaged by overload.

The **Range** control affects the sensitivity of the physical instrument's level meter. The simulated meter in the Meter & Knob panel mimics this behaviour: its range changes from 60 to 30 dB and vice versa as you manipulate the Range control. Numerical signal readings are not affected, although the behaviour of the physical instrument's automatic attenuation control may change when the 30 dB range is used.

The **Measmnt Time** control changes the signal level measurement time. The longer the measurement time, the more accurate are the level and frequency readings. However, a long measurement time can interfere with your ability to control the receiver. Though most such occurrences are prevented by the software, it is possible that when a receiver is set to a measurement time of several seconds, it will remain unresponsive for a while as you manipulate its settings. In particular, you may have to be patient as you attempt to change the measurement time back to a more manageable, lower value.

By default, the receiver's AF bandwidth setting is coupled to its IF bandwidth. If you wish to explicitly set the AF bandwidth to a different value, you can use the **AF Bandwidth** field to select the desired value.

2.1.3.2. Channel tuning

Receiver virtual instruments offer a convenience feature called *channel tuning*. Channel tuning lets you tune the receiver to frequencies that come from a pre-existing list, stored in a frequency list file. Two file formats are recognized: `.LST` files contain frequency values separated by the newline character, while `.SST` files use a more complicated format (containing, in addition to frequency values, attenuation and bandwidth settings) that is used primarily for ISOC background scanning (described in a later section below). When a `.SST` file is used, the attenuation and bandwidth values are ignored.

When you click the **Channel** checkbox, channel tuning is enabled. If no channel file was previously selected, a file selection dialog automatically appears; you can always have this dialog redisplayed by clicking the ... button next to the channel frequency dropdown list.

When a file is selected, the channel frequency dropdown list is enabled and it is populated with frequencies read from the channel file. Afterwards, you can quickly tune the receiver to any frequency from this list by simply selecting it in the dropdown list.

2.1.3.3. Logging measurements

The interactive virtual receiver instrument can log its measurements in the form of a human-readable text file. (The format of this file is the same as that used in background “instrument control” tasks, described later in this manual). These files can also be processed by other software tools (external to the ISOC suite) available at Industry Canada.

To enable logging, click the **Log to file…** checkbox. If no logging file has been selected yet (i.e., if logging was not previously enabled), a file selection dialog appears. (You can always select another log file by clicking the ... button next to the **Log to file…** label). Once a log file is selected, logging begins, and it continues until you clear the **Log to file…** checkbox.

The log file format is illustrated in the following brief example:

```
"Version 2.0"
"Log File / Fichier journal","ESN",ESN,2006-03-12,12:45:41.00
"ISOC-HQ","00","Mobile",,
2006-03-12,12:45:41.00,"New Instrument Settings Header / ►
Nouvelle entête des réglages d'instrument"
"Input/Entrée                       : ","LONG-WIRE"
"Demodulation/Démodulation          : ","FM"
"Range/Plage (dB)                   : ",60
"Meas. time/Temps de mesure (ms)    : ",100
"IF Bandwidth/Largeur FI (kHz)      : ",120
"IF Level/Sortie FI                 : ","Fixed"
"Detector/Détecteur                 : ","AVE"
"Mode/Mode                          : ","Low Noise"
"Level Unit/Unité de mesure du niv : ","dBµV"
"Squelch/Silencieux                 : ","OFF"
"Attenuation/Atténuation            : ","Auto"
"Generator/Générateur               : ","OFF"
"Preamp/Préamp                      : ","OFF"
"yyyymmdd","hhmmss.ss","Latitude","Longitude","Level","Attenuator","Tuned ►
Frq(MHz)","Offset(kHz)","Deviation(kHz)","Modul Depth (%)"
"aaaammjj","hhmmss.ss","Latitude","Longitude","Niveau","Atténuateur","Fréq ►
synt(MHz)","Écart(kHz)","Déviation(kHz)","Taux de modul(%)"
2006-03-12,12:45:41.00,0,0,50.7,0,103.300000,0.200,23.356,
2006-03-12,12:45:41.00,0,0,51.4,0,103.300000,0.240,34.465,
2006-03-12,12:45:41.00,0,0,51.8,0,103.300000,-0.120,20.508,
2006-03-12,12:45:42.00,0,0,51.5,0,103.300000,0.320,21.444,
2006-03-12,12:45:43.00,0,0,51.4,0,103.300000,0.300,23.682,
2006-03-12,12:45:45.00,0,0,50.7,0,103.300000,-0.090,59.001,
2006-03-12,12:45:46.00,0,0,50.5,0,103.300000,0.050,36.621,
2006-03-12,12:45:47.00,0,0,50.9,0,103.300000,0.350,68.644,
2006-03-12,12:45:48.00,0,0,50.9,0,103.300000,0.120,45.695,
```

As can be seen, the log file consists of three distinct parts:

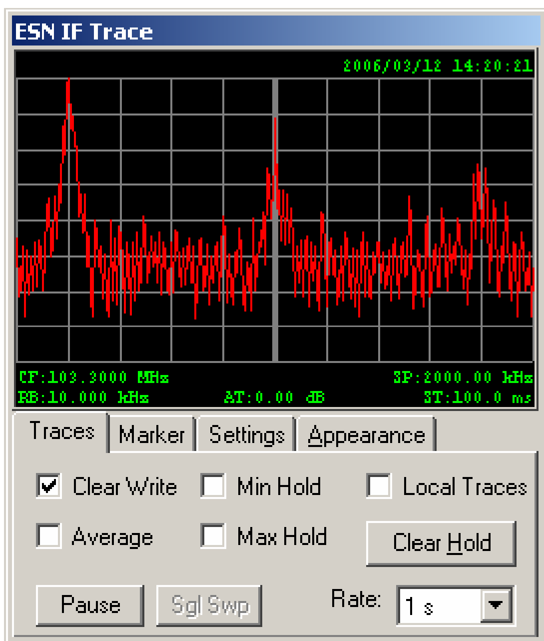
- a file header containing file version information;
- a session header containing receiver settings;
- one or more lines of receiver readings.

The file header appears only once per file; the session header appears every time receiver settings change.

Log files are always appended to, never overwritten. That is, if you select an already existing log file, its contents will not be erased; new readings will be added to the file.

2.1.3.4. The trace display

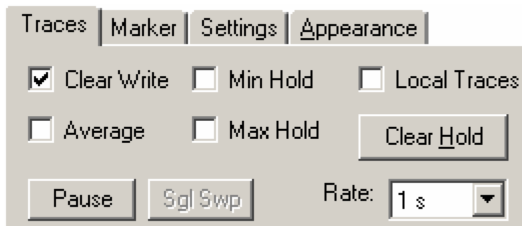
While receivers are not full-featured spectrum analysers, some receivers offer a spectrum analyser type display with limited functionality. The ESN is one such receiver. Its spectrum display functionality is also available in the virtual instrument in the Trace panel:



As with spectrum analysers, you can interact with the trace display using the mouse. Clicking and dragging the mouse inside the trace display momentarily shows a line marker along with the signal frequency at the position of the marker. Holding down the Ctrl key while releasing the mouse button tunes the receiver to the frequency at the position of the line marker. Holding down the Shift key while moving the mouse displays two lines measuring a span. (You cannot change the span setting of the receiver using the mouse).

As the IF trace capability is of less central significance for a receiver than for a spectrum analyser, the IF Trace panel in the virtual instrument is designed to occupy less screen space. For this reason, the controls of the trace display are organized into overlapping tabs, situated just below the trace display area.

The first of these tabs lets you select up to four traces, pause and resume traces, and change the rate at which traces are obtained:



The 1 second minimum value for the **Rate** field is not a mistake. The ESN receiver is not capable of delivering traces at a faster rate. Even at this rate, you will notice that obtaining a trace causes the instrument to momentarily pause, effectively slowing the rate at which other measurements are obtained. For this reason, you may find it beneficial to use a higher value in the **Rate** field, to slow down the rate at which traces are obtained.

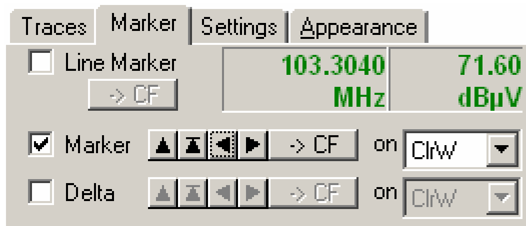
The Local Traces field requires a bit of an explanation. The ESN instrument can draw two traces simultaneously; these can be set to clear write, minimum hold, maximum hold, or averaging modes. When **Local Traces** is disabled, these two traces are used and trace information is obtained directly from the instrument. Therefore, when **Local Traces** is disabled, the virtual instrument cannot display more than two simultaneous traces.

In contrast, when **Local Traces** is enabled, the physical instrument is configured to generate only one trace, in clear write mode. Values for minimum hold, maximum hold, and averaged traces are calculated by the virtual instrument software. All four of these traces can be displayed simultaneously.

So why would you *not* use **Local Traces** when it obviously offers richer functionality? That is because when the instrument generates minimum hold, maximum hold, and averaging values internally, it does so by appropriately configuring its hardware detector and digital signal processor circuits. The result, in some cases, is a more accurate trace: for instance, the instrument's built in maximum hold feature can detect transient signals that appear only momentarily and disappear before the virtual instrument obtains the next clear write trace.

In other words, it is a trade-off: Local Traces offers richer functionality, but at the expense of reduced measurement accuracy.

As with spectrum analysers, the trace display for virtual receiver instruments offers marker capabilities:



Though the interface is simplified, the basic idea is the same: a line marker is available that can mark the mouse cursor's position, and up to two regular markers, which can be used in conjunction for delta marker functionality, are also offered. Buttons to position the markers on the trace are as follows:

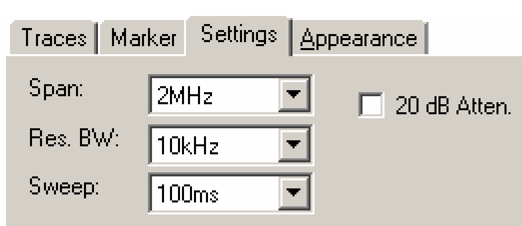
Next Left (): move the marker to the next peak found left of the marker's current position. If no more peaks appear to the left of the marker, the marker will not be moved. A peak is defined as a local maximum that is separated from nearby peaks by troughs of sufficient depth (the requisite depth being determined internally by the peak search algorithm).

Maximum (): move the marker to the highest signal level that appears anywhere in the trace.

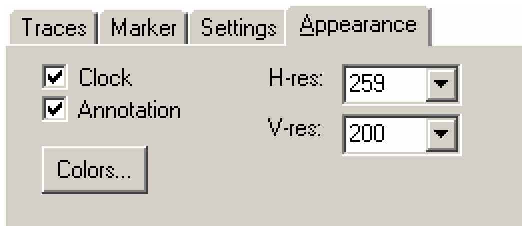
Next Maximum (): move the marker to the highest peak (as defined above under Next Left) whose level is below the signal level at the current marker position.

Next Right (): move the marker to the next peak (as defined above under Next Left) to the right of the marker's current position. If no further peaks are found to the right of the marker, the marker is not moved.

The settings of the IF trace can be controlled through the **Trace** tab: settings include the trace's span, resolution bandwidth, and sweep time. In addition, on the ESN receiver a 20 dB attenuator is available that is specific to the trace (i.e., it does not otherwise affect the measured signal level).



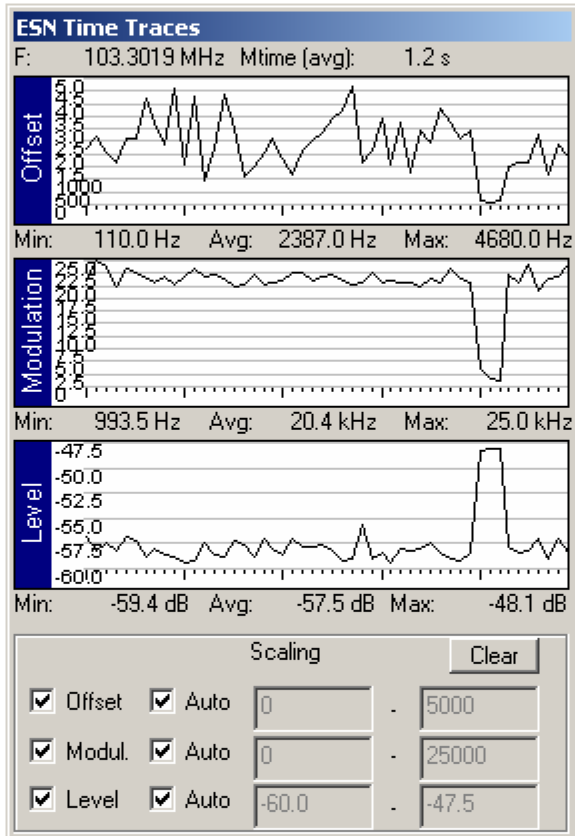
The appearance of the trace can also be controlled. This is important as, just like for spectrum analysers, the trace of a receiver can be exported or printed. The **Appearance** tab lets you select whether or not to display the clock and annotations on the trace, and the horizontal and vertical resolution of the trace:



The resampling algorithm used to change the horizontal resolution is the “minimax” method: as explained in the chapter on spectrum analysers (see the section entitled Controlling Trace Appearance), this method can reduce the horizontal resolution of the trace while preserving most of the trace’s visual characteristics.

2.1.3.5. Time traces

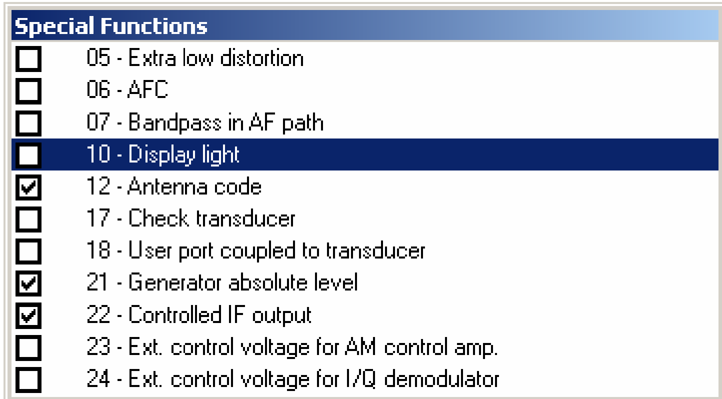
A unique feature of receiver virtual instruments is the Time Traces window. For repetitive measurements (offset, modulation, and signal level for the ESN receiver) the 50 most recent data points are remembered and are displayed in the form of simple graphs:



The Time Traces panel lets you select which measurement you wish to see displayed, and allows you to either select automatic ranging, or manually set the vertical scale for these measurements. The **Clear** button, as its name suggests, clears the existing time traces and starts a new sequence of measurements.

2.1.3.6. Miscellaneous settings

The ESN receiver has many ancillary functions, accessible as "Special Functions" through the physical instrument's front panel. Some of these special functions are controlled internally by the ISOC software, while other functions can be invoked manually. All available special functions are listed in the Special Functions panel:

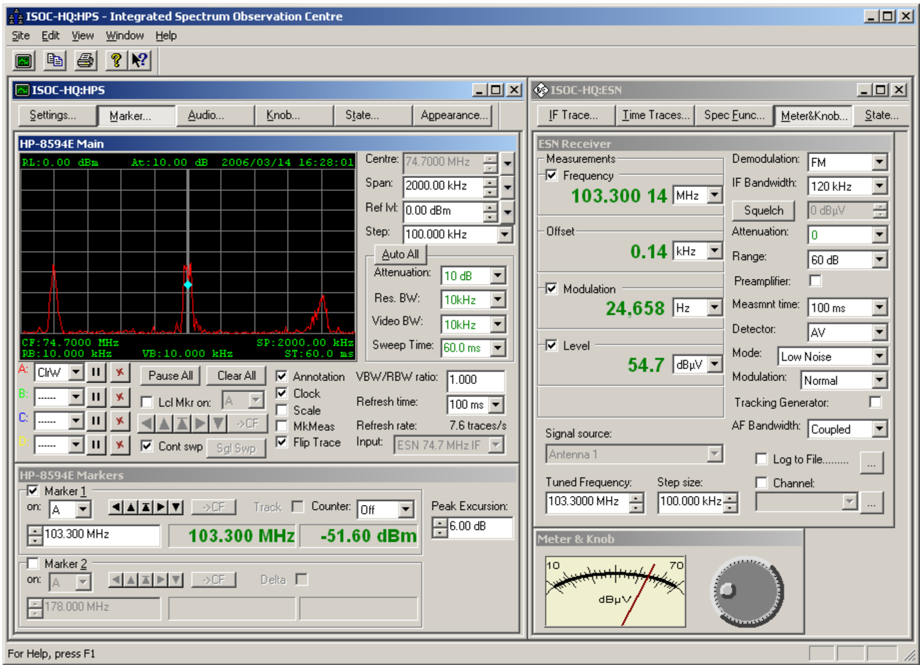


If necessary, consult the ESN receiver's manual and/or the administrator of a server site to find out if any of these special functions are applicable to your measurements.

> **Tip:** As ISOC instruments are expected to be operated primarily remotely, the backlighting of the ESN receiver front panel is turned off automatically when the virtual instrument takes control of the receiver. To turn the backlighting back on, select special function 10 from the Special Functions panel.

2.1.3.7. Using the receiver with a spectrum analyser

A particularly powerful capability of the ISOC is its ability to control multiple instruments together. One such case is when a spectrum analyser and a receiver are used in conjunction. This mode of operation is useful with receivers that have an intermediate frequency (IF) output that can be connected as input to the spectrum analyser:



When the receiver and spectrum analyser are coupled in this way (also known as "tune with" association or "intertuning") the operation of the spectrum analyser changes somewhat. The most notable difference is that the centre frequency of the spectrum analyser becomes fixed: the actual intermediate frequency of the receiver is known in advance, and it is entered when the ISOC server is configured.

The spectrum analyser display can still be used to tune to a new frequency; but the tuning affects not the spectrum analyser, but the receiver instead. (Hence the phrase, "intertuning"). Similarly, frequency values displayed in the trace display, or for the line marker and regular markers, are the frequencies of the receiver, not the frequencies of the spectrum analyser.

Additionally, the spectrum analyser trace is automatically flipped horizontally if the receiver requires it (i.e., if the receiver's IF output is "mirrored" in the frequency domain, as is the case for the ESN receiver).

So how do you use a spectrum analyser and a receiver together? A "tune with" association is automatically established whenever the input for the spectrum analyser is an input signal associated with a receiver's IF output, and the virtual instrument that corresponds with the receiver is already active. In practice, this means either one of the following two scenarios:

1. You have a system with a switch matrix, and both the receiver and the spectrum analyser have been opened. You use the Input field in the spectrum analyser to select a signal that corresponds with the receiver's

IF output. The spectrum analyser is set to “tune with” mode, it is automatically tuned to the IF frequency, the trace is flipped if necessary, and the centre frequency field becomes disabled;

2. You have a system without a switch matrix, and the default (hardwired) input for the spectrum analyser is the receiver’s IF output. You open the receiver, and then open the spectrum analyser virtual instrument. The spectrum analyser automatically opens in “tune with” mode.

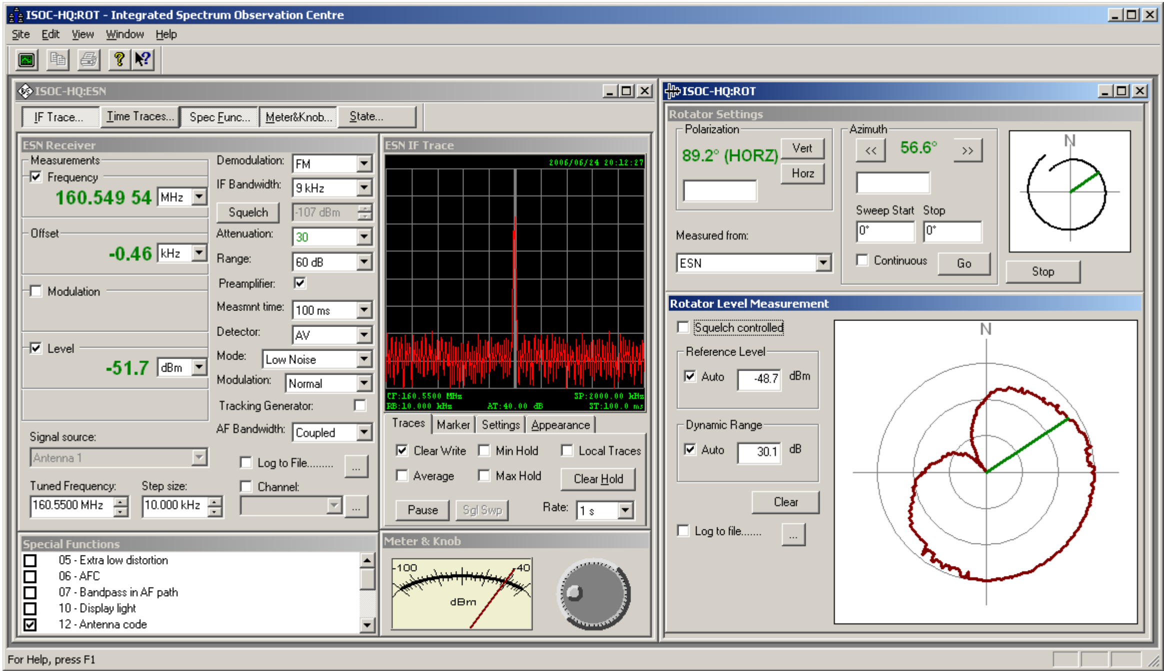
The “tune with” mode for the spectrum analyser is automatically terminated if the receiver virtual instrument is closed, or if the signal corresponding with the receiver’s IF output is deselected in the spectrum analyser’s Main panel.

You can use the ISOC client program’s Workspace feature to save an instrument configuration containing a receiver and a spectrum analyser. When the workspace is reloaded, the software ensures that instruments are loaded in the correct order, so that any “tune with” associations are automatically re-established.

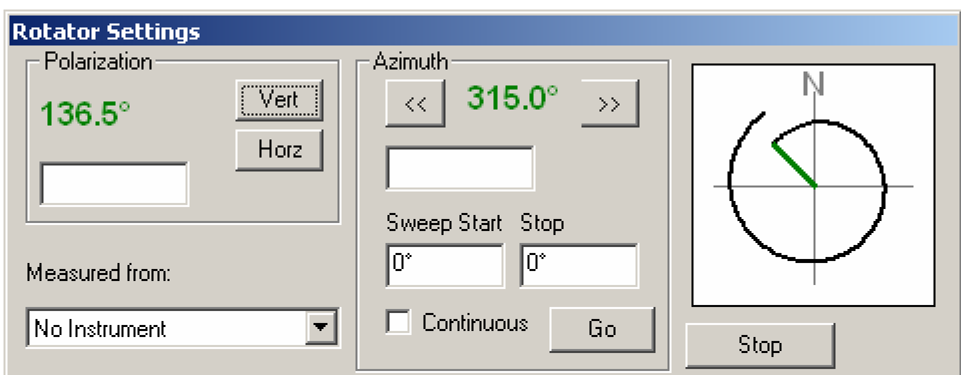
2.1.3.8. Using the receiver with an antenna rotator

Another instrument with which a receiver can be used in coupled operation is the antenna rotator.

The Emotator EV-800D antenna rotator is a simple device that can control the azimuth and polarization of an antenna, and provide a readback of the antenna position. While this instrument can be used by itself through a corresponding ISOC virtual instrument, its real utility becomes apparent when it is used in conjunction with a receiver:



The antenna rotator virtual instrument consists of two panels; initially, however, only the Settings panel is visible. This panel contains controls that can be used to manually position an antenna to the desired azimuth and polarization:



The antenna polarization can be set in two ways: either by pressing the **Vert** or **Horz** buttons, or by entering the desired polarization angle in the text field inside the **Polarization** box, and hitting the Enter key.

Similarly, the antenna azimuth can be adjusted either by clicking the **<<** or **>>** buttons, or by entering the desired azimuth angle. If you click the **<<** or **>>** buttons, the antenna begins moving and the buttons remain depressed; the antenna stops moving when it reaches an extremal position, or when you again press the **<<** or **>>** buttons.

The azimuth can also be adjusted through the azimuth indicator to the right; by clicking and dragging the mouse inside the indicator, you can select a new azimuth position. If you do not wish the antenna to move, just make sure you move the mouse outside the white area of the indicator, cancelling the command.

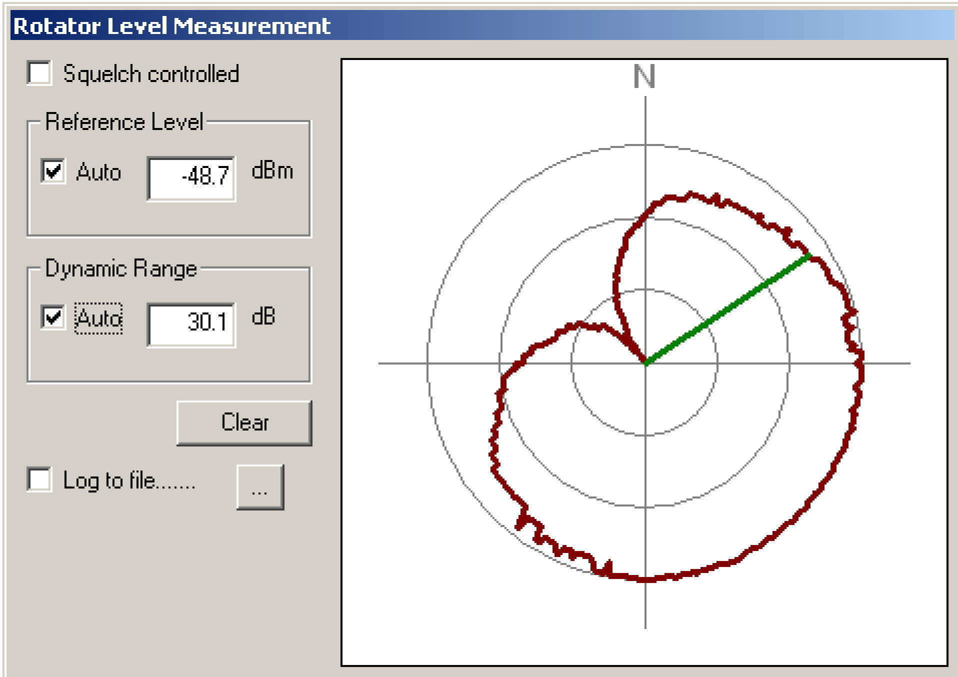
The rotator can also be instructed to sweep through a range of angles. To do so, enter the desired start and stop angles in the **Sweep Start** and **Stop** fields, and click **Go**. By default, the sweep stops as soon as either the start or the stop angle is reached; however, if the **Continuous** checkbox is set, the antenna will continue sweeping back and forth within the desired range until stopped. Notice that while you are sweeping, the label of the **Go** button changes to **Pause**; pausing the sweep does not cancel it (i.e., when it is resumed, it will continue at the same position and in the same direction as it was moving previously).

The Stop button stops all antenna movement instantaneously. Among other uses, the Stop button can be seen as an “emergency stop” feature, in case the rotator is inadvertently moved to a dangerous position.

All this functionality is of course useful, but the rotator virtual instrument’s true capabilities come to life when it is used with a receiver. To use the rotator with a receiver, a compatible receiver virtual instrument must be open.

> **Tip:** The ISOC suite does not actually check if the receiver’s signal source is an antenna physically mounted on the antenna rotator. Make sure you select the correct signal source for the receiver before starting measurements with a rotator.

As soon as such a receiver or receivers are opened in the ISOC client, the **Measured from** checkbox in the antenna rotator is populated with a list of compatible virtual instruments. When you select a receiver from this list, the **Level Measurement** panel appears in the rotator window:



This panel contains an enlarged view of the rotator azimuth position, along with a thick red line indicating the most recent level measurement at each position that the rotator reached during the current session. As the rotator makes a full 360° turn, it will show changes in signal level as a function of direction. The display can be reset (previous readings cleared) by clicking the **Clear** button.

The reference level (signal level corresponding with the outermost concentric circle in the level measurement display) and dynamic range of the display can be changed manually or left at automatic.

The rotator can also be configured to perform squelch controlled sweeps. Set a start and stop sweep angle, make sure the **Continuous** checkbox is set, and click **Go** to start a sweep. Make sure also that the **Squelch controlled** checkbox is set. Now as the rotator is sweeping back and forth, change the receiver's squelch level so that the current signal is below that level; observe that the rotator stops sweeping. As soon as a signal of sufficient strength appears, the sweep resumes.

Rotator azimuth and level measurements can also be logged. If you set the **Log to file** checkbox, if no log file was selected previously, a file selection dialog appears, where you can specify the name and location of a log file. Logging can be stopped by clearing the **Log to file** checkbox; the name of the file can be changed by clicking the ... button to invoke the file selection dialog again. Log files are always appended to, never overwritten by subsequent readings.

The log file format is simple. A header line indicates when logging began; subsequent lines show the azimuth angle and measured signal level:

```
2006-03-15,11:11:50.39 *** BEGIN Rotator data logging for ISOC-HQ:IC8500
2006-03-15,11:11:50.85 -1.5°: -54.9
2006-03-15,11:11:51.24 0.1°: -52.9
2006-03-15,11:11:51.63 1.2°: -51.7
2006-03-15,11:11:52.04 3.4°: -48.3
2006-03-15,11:11:52.24 4.4°: -46.9
2006-03-15,11:11:52.54 5.0°: -44.5
```

Although timestamps are indicated with a precision of one hundredth of a second, it should be emphasized that these are timestamps on the client computer, representing the time when a reading was received from an ISOC server; the amount of time it took for the measurement to be taken and to be communicated to the client (network latency) is not taken into account, and in any case, the client and the server computer's clocks may not be synchronized.

2.1.4. Remote audio

One of the distinguishing capabilities of the ISOC suite is its ability to deliver multiple streams of digitized audio simultaneously from server sites to clients.

Indeed, not only can the ISOC deliver audio to users, it delivers shared audio: the same audio stream can be listened to by multiple users simultaneously.

This explains one of the less self-evident features of the ISOC: the presence of separate "Windows Multimedia Sound" and "Audio Input" virtual instruments. The reason? When you use the sound instrument, you are not actually controlling anything on the server: you are merely listening to audio that the server provides. Other users may be listening to the same audio as you do; it is also possible that a scheduled background task is recording audio as you are listening to it.

The one thing you cannot do with a sound device is change its input(s). Even if the ISOC server is equipped with an audio switch matrix, you cannot choose which audio signal to listen to… at least not through the sound device. This is why a separate device type exists in the ISOC, the Audio Input device. This is a so-called "dummy device": a virtual instrument that has no real functionality, it merely serves as a placeholder, a means to select an input signal through the switch matrix.

The complete picture, then, is as follows:

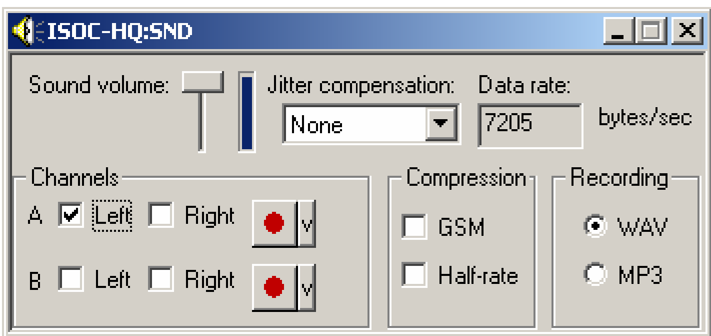
- A server may have one or more audio cards installed. The ISOC recognizes an audio card as a device with two input channels (most audio channels support the capture of one stereo signal, which is the same as two monaural audio signals).

- Associated with each audio *card* is a “Windows Multimedia Sound” virtual instrument. This is a “passive” instrument that can be shared by multiple users: users do not control the instrument, they merely receive the captured audio streams.

- Associated with each audio *input* is an “Audio Input” instrument. This is a dummy instrument that allows users to select, through an audio switch matrix, the signal to connect to the given input of the audio card. Of course on servers with no audio switch matrix installed, no audio input instrument needs be installed.

2.1.4.1. Sound options

When you connect to the Windows Multimedia Sound virtual instrument, a simple user interface is presented:



The **Sound volume** slider and indicator need no explanation. The **Jitter compensation** setting may be of use if audio becomes choppy; by waiting a little longer for audio packets to arrive, the program compensates for variable network delay[4].

In the bottom left area, you can select which of the two audio channels to listen to, and individually decide which speaker they should be heard on. The **A** and **B** channels correspond with the left and right channels on the server, but since we are using these conceptually as two separate monaural channels, we are not labelling them so.

If you are utilizing the sound device over a low-speed connection, the **Data rate** field becomes rather important. It tells you the number of bytes per second that is

[4] For compatibility reasons, the current version of the ISOC uses an external sound server program, `MULTISND.EXE`, for audio playback. This external program provides audio mixing capabilities even on operating systems, such as Windows NT, that have no native support for the simultaneous playback of multiple audio streams. `MULTISND.EXE` may not always respond to the jitter compensation value as expected.

needed for audio using your current settings. A single, uncompressed monaural audio channel requires, on average, 8,000 bytes per second at the quality that the ISOC uses for audio capture. This does not sound like a lot until you consider: the highest speed ordinary modem connection is 33,600 bits per second, or 4,200 bytes per second, much too slow for uncompressed audio; and even a semi-digital “56K” modem delivers only 7,000 bytes per second under ideal conditions. For this reason, it is highly recommended that you use the **GSM** compression option for audio over a low-speed connection. This compression significantly reduces the amount of data required to deliver the audio, at only a moderate loss of audio quality. A further, much greater decrease in the amount of data can be accomplished if you turn on the **Half-rate** option, but the loss of audio quality may be unacceptable. Having said that, if you are only waiting for the presence of a signal, and it does not necessarily have to be comprehensible, the **Half-rate** option may be meaningful over a low-speed, unreliable connection: in experiments, we have had success with continuous audio even over a cellular data modem connection when both the **GSM** and **Half-rate** options were selected.

2.1.4.2. Automatic rate fallback mechanism

The full bandwidth required to deliver two uncompressed audio streams is 16,000 bytes per second, which is the maximum bandwidth of a dual-channel ISDN connection. Obviously, this bandwidth is unsustainable in many real-life situations. For this reason, the sound device is designed to adaptively fall back to lower transmission rates when network congestion is detected.

The fallback algorithm implements a data rate reduction in stages, as a function of measured network latency between the server and the client.

- First, GSM compression is turned on automatically. This dramatically reduces the data rate with only a minor impact on audio quality. In most cases, turning on GSM compression is sufficient to reduce the data rate to a level compatible with the network bandwidth.

- Second, half-rate compression is also turned on: this results in a further significant reduction in the data rate.

- Third, audio is turned off altogether, first in the A, next in the B channel. Why such a drastic step, you ask? The philosophy is that it is more important to be able to maintain control of the ISOC than to listen to audio; a (very) low-quality connection may not be compatible with streaming audio at all, but this fallback mechanism ensures that you will still be able to control ISOC instruments.

If network conditions improve, the settings are gradually restored to values previously established by the user. The mechanism has a built-in hysteresis to ensure that compression options or the audio channels are continuously turned on and off in rapid succession.

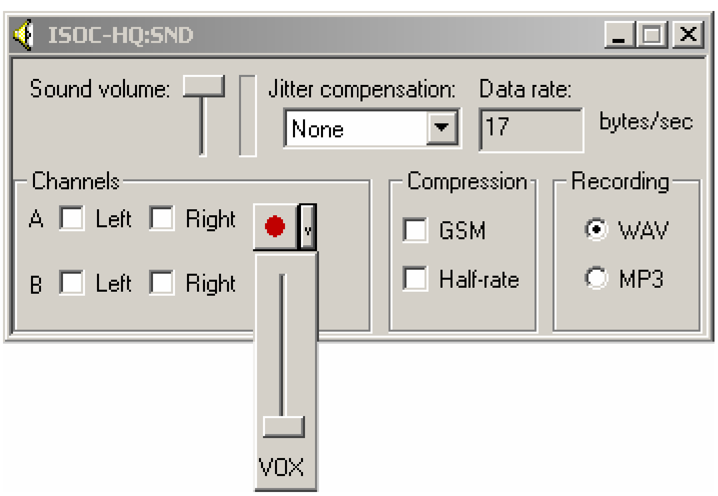
2.1.4.3. Recording audio

The ISOC can also record audio. Or, to clarify: the ISOC *server* can also record audio. Why the server? Because it is at the server that an uninterrupted, good quality audio stream is available; whether or not it was successfully delivered to a streaming client in real-time is far from certain.

To record audio, press the record button () next to the channel that you wish to record. The two channels can be recorded separately; the recordings that are created are monaural.

Before you begin recording audio, you may also wish to change the file type used for the recording. You can select either the uncompressed **WAV** file format, or **MP3** audio. The latter delivers a highly compressed audio file at only a minimal loss of audio quality.

The down-arrow button right next to the record button allows you to change VOX squelch. When VOX squelch is used, audio recording is paused whenever no audio is detected above the VOX squelch level for some period of time. As soon as a signal appears at or above the VOX squelch level, the recording instantly resumes:



You can also pause audio recording manually. As soon as you begin recording, the pause button () appears next to the record button. Clicking this button causes the recording to pause (the button remains depressed); clicking it again (the button is released) resumes the recording.

One question that remains, not an unimportant one, is this: What happens to the recorded audio? There was no file selection option, where is it saved?

The server has folders reserved for various file types, used mainly for unattended background tasks (see the chapter below about the ISOC Task Manager). Specifically, folders exist for WAV and MP3 files. This is where the recorded audio will be stored, using files named as follows:

`client-devid-ch-datetime.ext`

where

`client` is the name of your (the client) computer from which the recording was initiated;
`devid` is the ISOC name of the audio device, as configured by the server administrator (e.g., SND3 for sound card #3 on the server);
`ch` is the audio channel being recorded (A or B);
`datetime` is the date and time in numeric format: `yyyymmddHHMMSS`
`ext` is the filename extension, WAV or MP3 depending on the file type.

To transfer a file containing recorded audio from the server to the client, you may use Windows file sharing, standard file transfer tools such as FTP, or the built-in file transfer capability of the ISOC Task Manager, described in a later chapter.

2.1.4.4. Input selection

As indicated in the previous selection, the Windows Multimedia Sound virtual instrument is a passive device: you do not control what happens on the server, you are only a recipient (perhaps one of several) of the server's captured audio stream(s).

On some servers, an audio switch matrix is present, which lets you select which audio signals are routed to the physical audio input connector(s) of the server. One audio card typically has one stereo "Line In" connector with two monaural channels; a server may have more than one audio card installed, however. Associated with each audio channel is an Audio Input device: a dummy device whose sole function is to provide a means to select an audio input signal:

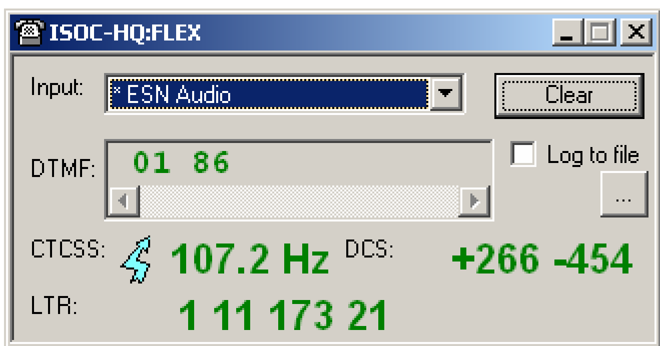
When a switch matrix is present and the signal sources are correctly configured on the server, you can select a signal source in the **Input** field. If no switch matrix is present and/or the audio input is hardwired, you may still use the Audio Input device to display the hardwired input setting; it has no other uses, however.

2.1.4.5. Other audio devices: The tone decoder

With the ISOC, you can not only listen to audio: you can also decode audio signals using a tone decoder device. The ISOC supports three different types of tone decoders:

The Optotrakker (aka. DC-440) tone decoder with a serial interface
The Optotrakker DC-448 code decoder with an ICOM-compatible CI-V interface
The Flex Series Universal Controller

Of these, the Flex Series Universal Controller is the most feature-rich device. It is capable of simultaneously decoding DTMF dial codes, and subaudible CTCSS, DCS, and LTR codes:



Other than selecting a signal source, you cannot control a tone decoder device interactively. It is a passive device: it sends codes representing the signals that it detects, but it does not accept commands from the ISOC server.

The visual interface of the tone decoder device is self explanatory. Fields show the recent **DTMF**, **CTCSS**, **DCS**, and **LTR** values that the device detected. (The LTR field is absent from the virtual instrument in the case of the two Optotrakker devices). A little lightning bolt symbol appears every time the instrument is detecting a new reading. The display can be cleared using the **Clear** button; all prior readings are removed, and the virtual instrument begins to collect new readings.

The tone decoder virtual instrument can also log readings. If you click the **Log to file** checkbox, logging begins; if you have not previously selected a log file, a file selection dialog appears where you can specify the log file name. Log files are always appended to, never overwritten.

The following excerpt contains some entries from a log created by the Flex Series Universal Controller:

```
2006-03-16,15:03:50.44 CTCSS: 146.2
2006-03-16,15:04:18.25 CTCSS: 131.8
2006-03-16,15:07:17.24 LTR: 1 11 173 21
2006-03-16,16:04:58.86 CTCSS: 146.2
2006-03-16,16:05:30.38 CTCSS: 131.8
2006-03-16,16:10:14.74 LTR: 1 11 173 21
2006-03-16,16:10:15.18 LTR: 1 21 141 17
2006-03-16,16:10:16.19 LTR: 1 28 094 17
2006-03-16,15:59:38.18 DTMF: 5
```

Slight differences exist in the case of the Optotrakker devices, as these devices also separately report when a CTCSS or DCS signal appears and vanishes. Correspondingly, these times are indicated in the log file:

```
2006-03-16,15:03:41.11 CTCSS ON
2006-03-16,15:03:41.13 CTCSS: 186.2 Hz
2006-03-16,15:03:41.86 CTCSS OFF
2006-03-16,15:54:41.87 DCS ON
2006-03-16,15:54:41.91 DCS: +036 -172
2006-03-16,15:54:42.63 DCS OFF
```

2.1.5. Using a signal generator

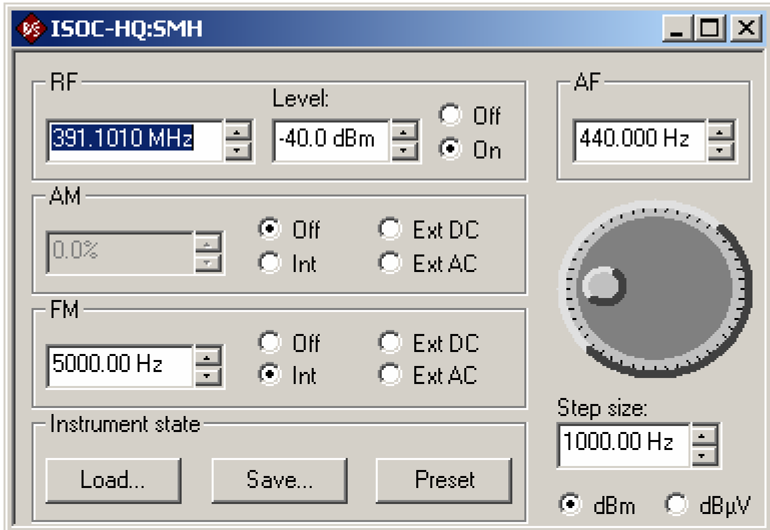
The main purpose of a signal generator is to provide a known reference signal against which, for instance, unknown signals can be compared. The signal generator can also be used to calibrate instruments and to verify their correct operation.

A signal generator can be used interactively through the ISOC suite, or during scheduled scanning operations (e.g., during occupancy testing, it can be used to produce a reference signal with 100% occupancy). The signal generator is also used in some configuration tools, most notably the calibration tools provided for ICOM receivers.

In this section, interactive use of the signal generator is described.

The ISOC suite can operate a Rohde & Schwarz SMH signal generator. Limited support for signal generator functionality also exists for the IFR COM-120B instrument.

The signal generator virtual instrument interface is very simple. The virtual instrument appears as a dialog window with a limited number of controls:

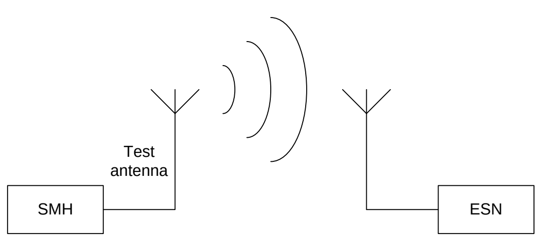


The labels of the various sections are self-explanatory. Controls in the **RF** box operate the signal generator's RF oscillator; controls in the **AM** and **FM** boxes control signal modulation. Needless to say, the Ext DC and Ext AC radio buttons are only useful when the equipment configuration at the ISOC site actually provides an external modulating signal for the signal generator, either connected permanently or connected through a switch matrix.

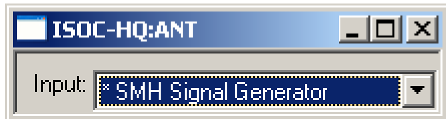
Lastly, the **AF** box controls the modulating audio frequency signal. A continuously tuneable AF oscillator is an installable option on SMH signal generators. If it is absent, the control in the **AF** box changes to a drop-down list box containing a selectable list of audio frequencies.

The state of the signal generator can be saved to a file by clicking the **Save…** button, and saved configurations can be loaded again using the **Load…** button. The signal generator's state can also be saved as part of an ISOC workspace file.

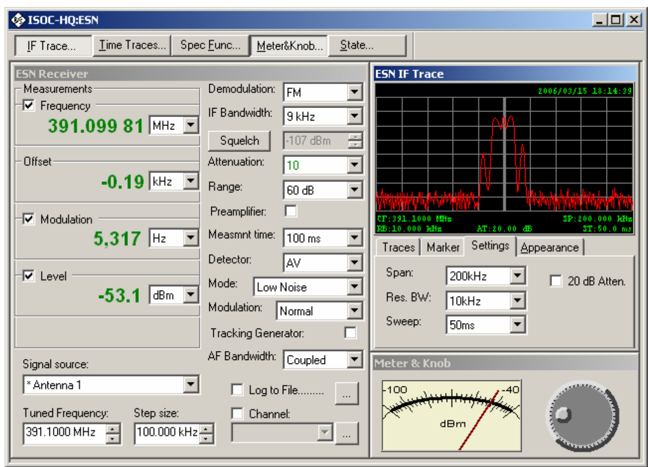
So how would you use a signal generator? In one possible configuration, the input of the signal generator is routed to a test antenna that transmits the signal; the signal is then received by a receiver that is being tested:



Indeed, the ISOC actually has a "test antenna" instrument! It is another example of a "dummy instrument": an instrument with no real functionality that exists mainly as a placeholder. Placeholder for what, you ask? It is a placeholder that allows an input signal to be selected. In an ISOC configuration where a switch matrix is present, the test antenna dummy instrument makes it possible to route the signal of, for instance, a signal generator to the transmission antenna through the switch matrix:



The signal would then be received by a receiver being tested. For instance, if an ESN receiver was tuned to the correct frequency, its display may look similar to the following as it receives the signal generated by an SMH generator with the settings shown on the previous page:



Other configurations are also possible; for instance, when you use the signal generator for testing or calibration, it is probably preferable to connect it directly to the equipment being tested, as opposed to transmitting its signal over the air through a test antenna.

> **Tip:** The signal generator can produce an output signal that may be strong enough to damage a receiver. Be careful before connecting the signal generator to a sensitive instrument. To avoid accidental damage, the signal generator virtual instrument always turns off the signal generator's output when the virtual instrument is closed.

2.1.6. Example: Detecting the SCMO of an FM or TV station

One particularly interesting (and potentially useful) complex example that combines the use of several instruments described in the previous sections is a technique that can be used to detect the SCMO (subcarrier) audio present in some FM or TV broadcast signals. (This subcarrier is often used to broadcast secondary audio or data).

To detect and listen to the SCMO, three instruments are required[5]: an ESN test receiver, an SMH signal generator, and an HP-8594E spectrum analyser. (Other equivalent instruments can be substituted; in particular, an ordinary receiver, such as the ICOM R-8500, can be used in place of the spectrum analyser).

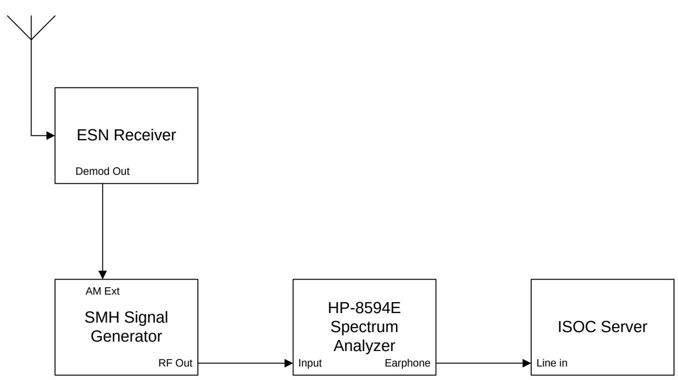
The setup requires that the demodulator output of the ESN receiver be connected to the AM Ext input of the signal generator. This can be accomplished by hand (if you are at the physical location of the instruments) or through the use of an Audio Input dummy instrument that is configured to represent the AM Ext connector of the SMH signal generator.

The signal generator's output, in turn, is connected to the spectrum analyser (or a secondary receiver). The audio output of the spectrum analyser can be listened to through the ISOC server.

The combined setup involves as many as six virtual instruments:

1. The ESN receiver that receives the off-air signal
2. The SMH signal generator that remodulates that ESN output
3. A dummy instrument representing the SMH AM Ext connector
4. The HP-8594E spectrum analyser
5. The Windows Multimedia Sound virtual instrument
6. A dummy instrument representing a line in connector on the ISOC server.

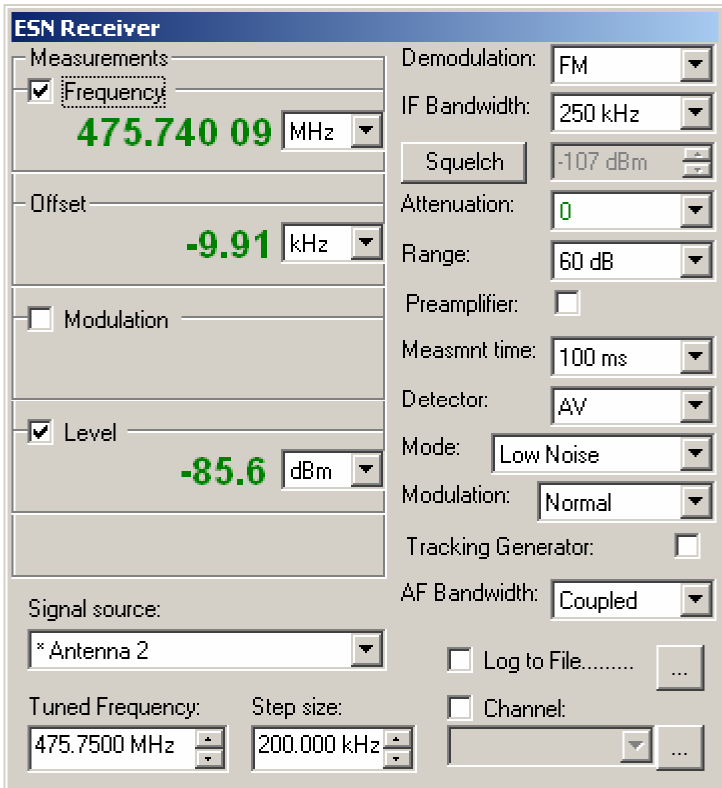
Graphically, the instrument configuration will be similar to the following:



[5] The example presented here does not necessarily represent the simplest method to perform this measurement. An alternative is to connect the demodulator output of the ESN receiver to the RF input of a receiver or spectrum analyser. Tune the receiver to 67 or 92 kHz with the FM demodulator to demodulate the SCMO, or tune the analyser to 50 kHz with a span of 100 kHz to see the entire baseband signal.

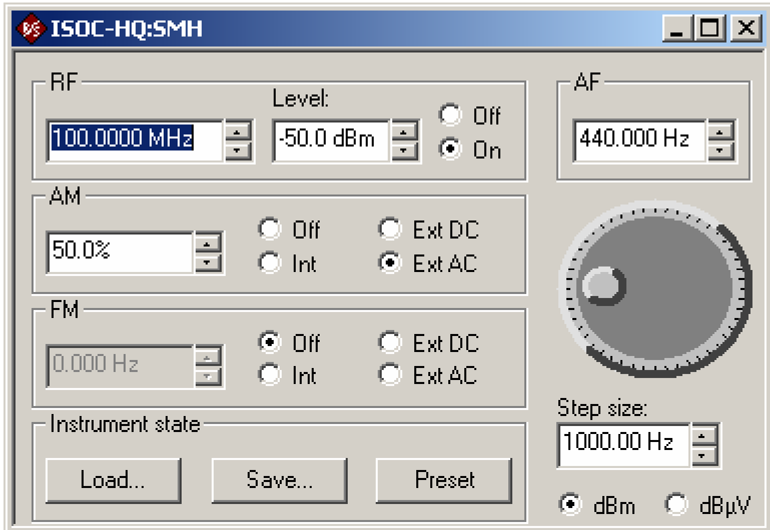
The steps required to set up this configuration are as follows:

First, connect to the ESN instrument. Tune the instrument to the frequency of the desired (FM or TV) station. For instance, you may be tuning to the main sound carrier of terrestrial TV channel 14, at 475.75 MHz:

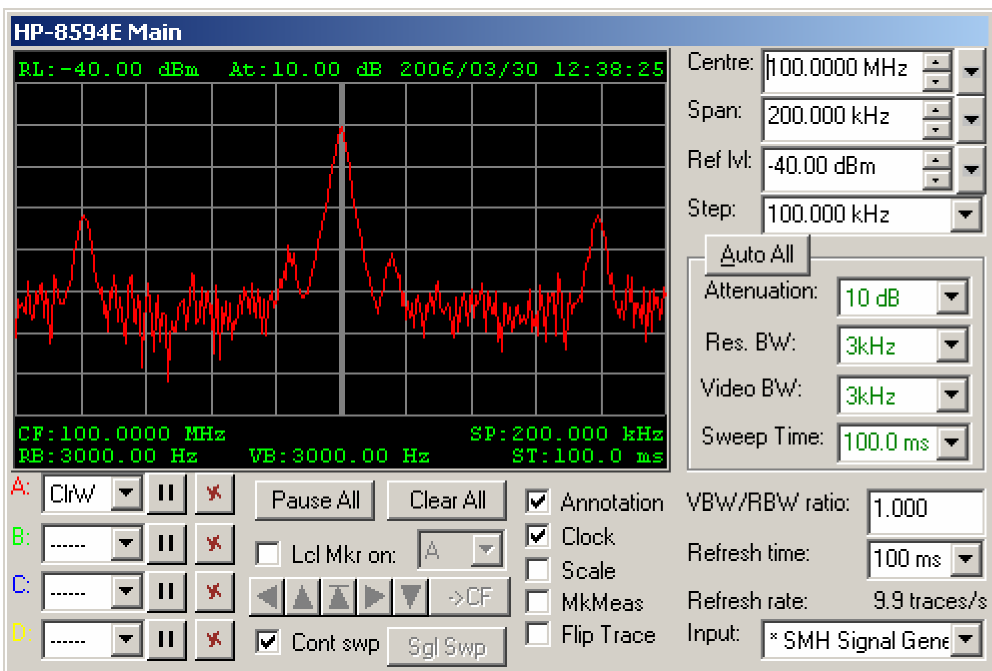


Make sure that the ESN's demodulator output is actually connected to the SMH signal generator. If it is not hardwired, you may have a dummy instrument called SMH AM Ext or something similar. Connect to this dummy instrument and select the ESN Demodulator as the signal source:

Next, connect to the SMH signal generator. Tune the generator to 100 MHz (or any other frequency that is free of interference). Set the **RF Level** to -50 dBm, make sure the FM modulation is **Off**, and the AM modulation is switched to **Ext AC**. Set the AM modulation level to 50%:

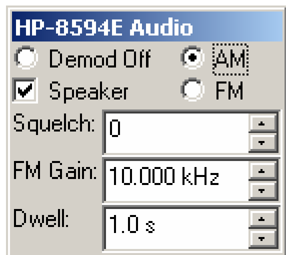


Next, connect to the HP-8594E spectrum analyser. Select the SMH as the spectrum analyser's signal source, Tune the spectrum analyser to the SMH frequency (100 MHz). Set the Span to 200 kHz:

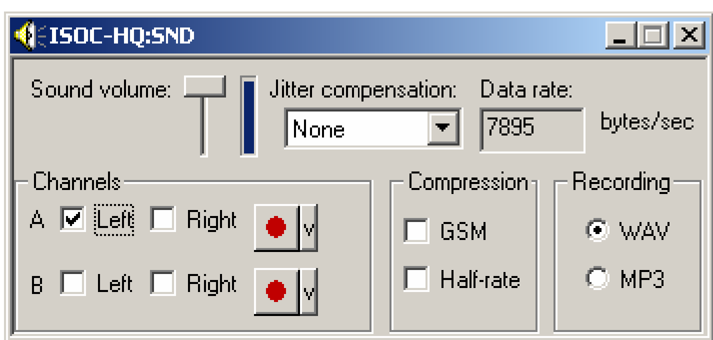


Tip: In this example, you will use the spectrum analyser's audio. If this is not available, you may use an additional receiver, connected to the signal generator's output, and connect the spectrum analyser to that receiver's IF output. In such configurations, you may tune to spectrum analyser to 100.05 MHz, with a span of 100 kHz, placing the centre of the SMH signal on the left edge of the spectrum analyser's trace display.

In the spectrum analyser’s Audio panel, make sure the Speaker checkbox is checked, select AM demodulation, and set the dwell time to 1 s:



At this point, you should be able to listen to the spectrum analyser’s audio, and hear the sound of the selected TV channel. If you are not physically collocated with the spectrum analyser, you need to connect to the Windows Multimedia Sound virtual instrument and, optionally, to an audio input dummy instrument through which to select the signal source.



Before you attempt to detect the SCMO signal, make sure you can actually listen to the main sound carrier. This is to verify that up to this point, the instruments are correctly configured. This may also be a good time to save your workspace, so that you need not redo this setup again later.

Now to actually detect the SCMO subcarrier (if present) you need to tune the spectrum analyser to its frequency. If the SCMO frequency is 67 kHz, you need to tune the spectrum analyser to a frequency that is offset by 67 kHz relative to the SMH output frequency; i.e., to 100.067 MHz. You can accomplish this either by manually entering the new frequency, or by using the mouse in conjunction with the Ctrl-key in the spectrum analyser's graphical display window.

The final step is to switch the spectrum analyser to FM demodulation in the Audio panel, and select a suitable value for **FM Gain** (bandwidth), e.g., 10 kHz. If an audio subcarrier is present, you should be able to hear it at this point.

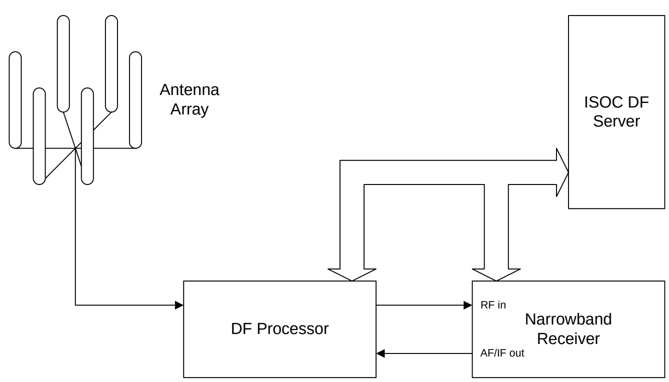
You may also wish to switch the spectrum analyser to zero span mode now, in order to eliminate the "clickety-click" sound that is heard as the spectrum analyser sweeps.

2.1.7. Using a Direction Finder

The ISOC direction finding capabilities can utilize the following types of DF processors:

- Doppler Systems DDF6000D, 6100 and 7000 series
- Rohde & Schwarz PA025
- OAR 3001
- OAR 4*xxx* (including the OAR 4006 and OAR 4400)

The DF processor works together with a narrowband receiver (built-in or separate) to obtain the bearing of a signal. The DF processor includes an antenna array; the signal from this antenna array is the input to the narrowband receiver. The receiver is tuned to the frequency of the monitored signal.



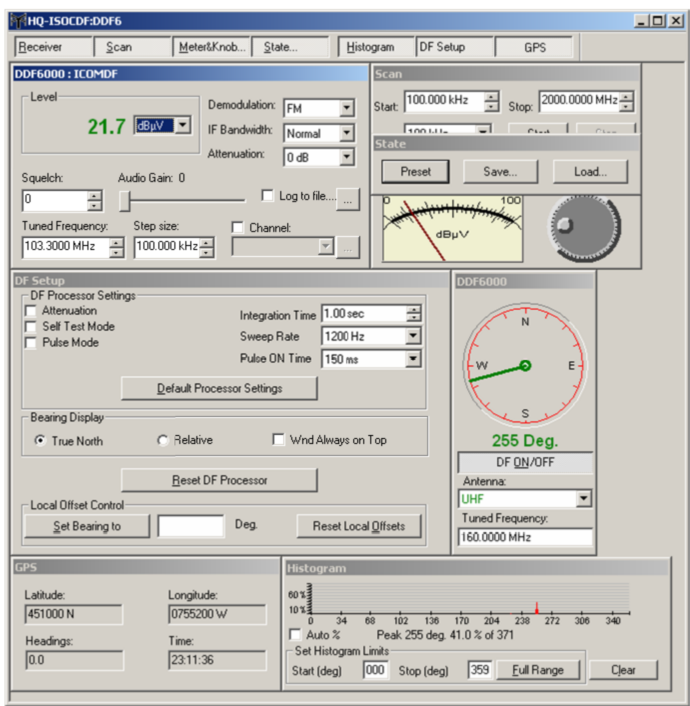
DF processors based on the Doppler principle, like the DDF6000D, utilize a rapidly rotating antenna array that modulates the received signal by an audio frequency that corresponds with the rotational velocity. Other DF processors utilize the Watson-Watt technique in which the relative signal strength on perpendicularly mounted dipoles is measured and the bearing of the transmitter is computed.

Some DF processors are integrated with a receiver; other DF processors require an external receiver. The ISOC can use a series of selected receivers together with a DF processor. These include the following:

- ICOM R-7100
- ICOM R-8500
- ICOM R-9000

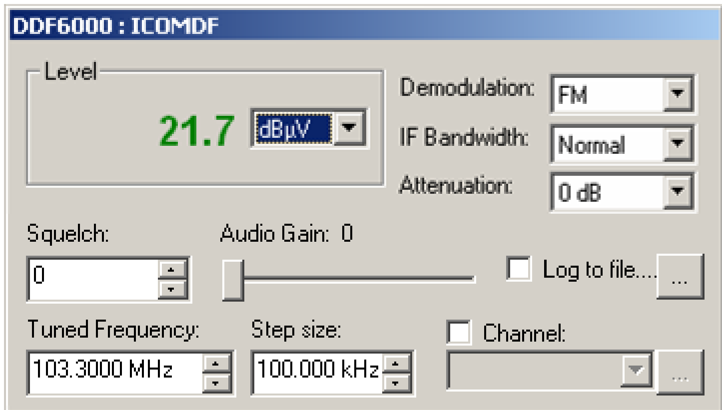
To obtain a fix on the location of a transmitter, it is necessary to utilize two or more DF sites. This is accomplished by a separate program, the ISOC DF application, which is described below in section 2.2.

It is, however, also possible to use DF equipment from within the main ISOC for Windows application, if all that is required is to obtain a bearing, for instance. The Doppler DDF-6000D, in conjunction with an ICOM receiver, appears in the form of a virtual instrument with eight panels:

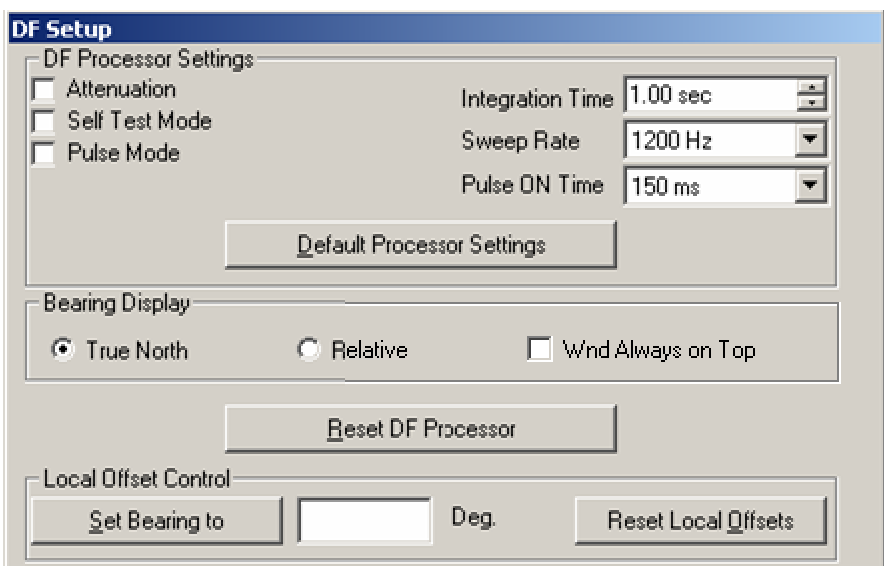


While it is the same virtual instrument that you are familiar with from the ISOC client, it is also different. The virtual instrument now combines data from two physical instruments: the receiver and the DF processor. These may be two separate physical instruments, or the same physical instrument; doesn't matter, insofar as the virtual instrument is concerned the DF processor remains one logical unit.

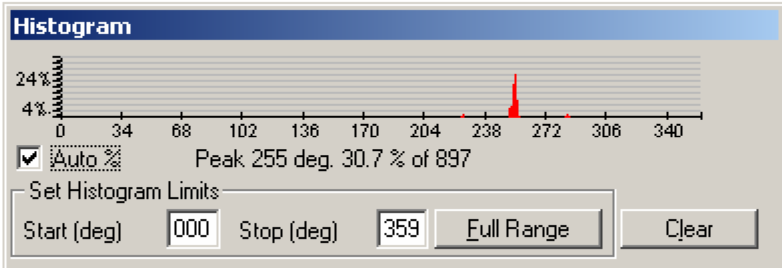
The receiver panels are similar to those used for the standalone ICOM receiver virtual instrument. There are some subtle changes in functionality when the receiver is used for DF purposes. For instance, the main receiver panel lacks controls for signal source selection:



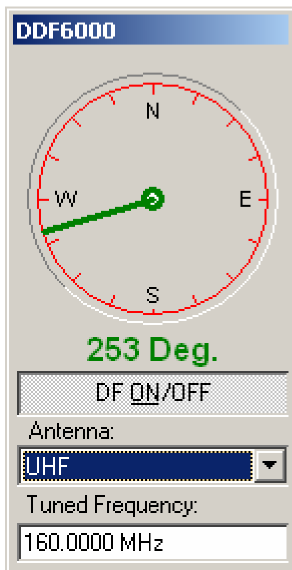
The virtual instrument also contains several panels that control the DF processor. The configuration of the DF processor can be modified through the DF Setup panel:



The actual readings of the DF processor can be viewed through two panels. The Histogram panel shows the 360 degrees of the DF antenna's view in the form of a “flattened” graph, with a relative count of bearings in each direction indicated by the graph:



The last DF panel shows the actual direction as a compass direction, and also provides a means to select a DF antenna and specify a frequency:

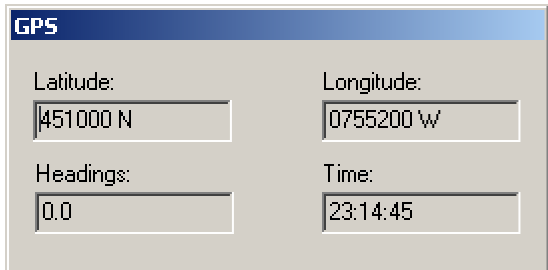


When the contour around the compass is black, the frequency is tuned to the frequency range of the selected antenna. A red contour means that it is not in the antenna range. You must then select another antenna from the **Antenna** field. Selecting **Auto** ensures that the antenna is always selected according to the frequency, thereby eliminating this problem.

A green needle indicates recent readings. There is a blinking white dot in the centre that indicates that new bearings are being received. A yellow needle means that the processor has not provided any readings in over six seconds, and a red needle means that the processor has not provided any readings in over 10 seconds.

In mobile configurations, the bearings can be displayed as True North, or relative to the front of the vehicle. In the latter case, the display is changed from NESW to FRBL (Front, Right, Back, Left.)

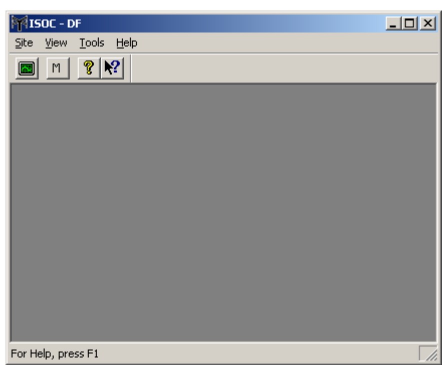
Another panel provides GPS information for the DF site. In addition to providing station location for mobile sites, the GPS information is also used for time synchronization, which is essential for calculating a fix:



2.2. The ISOC DF application

When a site has DF equipment installed, the equipment can be accessed through the main ISOC client program and can be used to obtain bearings. The main ISOC client program does not, however, have the capability to obtain a location fix on a transmitter.

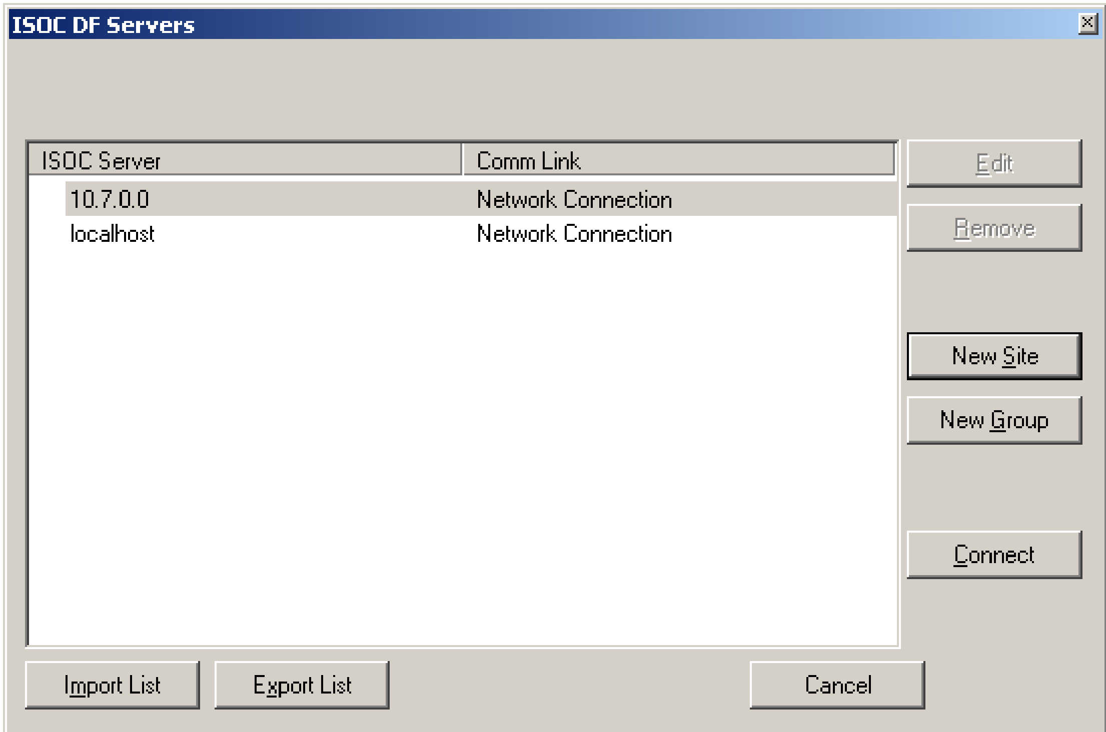
Instead, a separate program, ISOC DF, is provided for this purpose. Although it bears many similarities to the main ISOC client, there are also important differences, both conceptually and in terms of operating details. When ISOC DF is started, it shows a blank window, just like the main ISOC client:



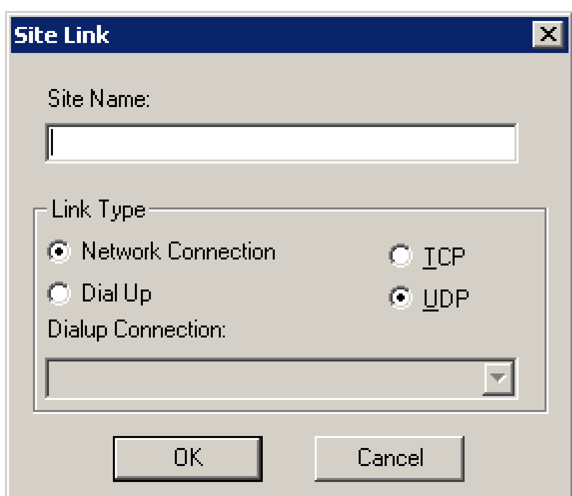
The buttons in the toolbar are slightly different, and that already provides a hint that these two programs “see” ISOC servers in a different way.

With ISOC DF, you do not so much connect to individual pieces of equipment but connect to a DF network of one or more DF sites. Connecting to more than one DF site is a prerequisite to obtaining a fix on a station. For this reason, the ISOC

DF presents a different interface for selecting sites, in the form of the ISOC DF Servers window:

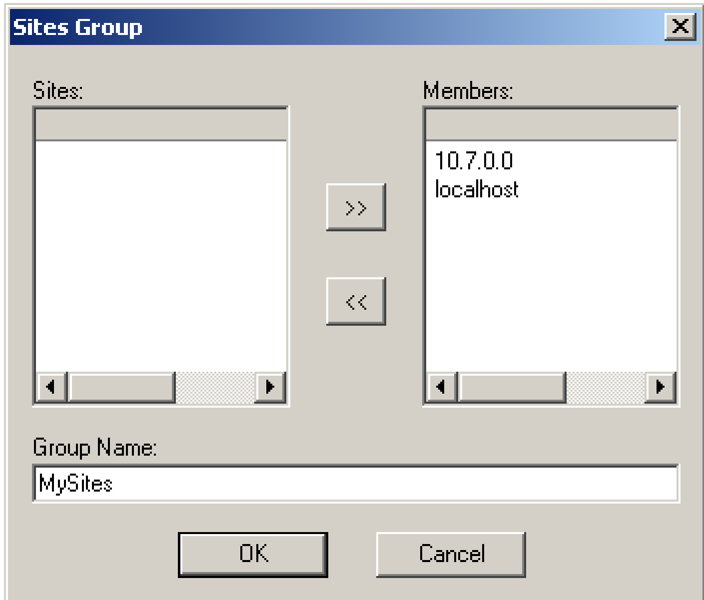


This window shows ISOC sites that were previously defined. If you have no sites appearing in this window, it could be that none have been defined yet; to define an ISOC site, click the **New Site** button:

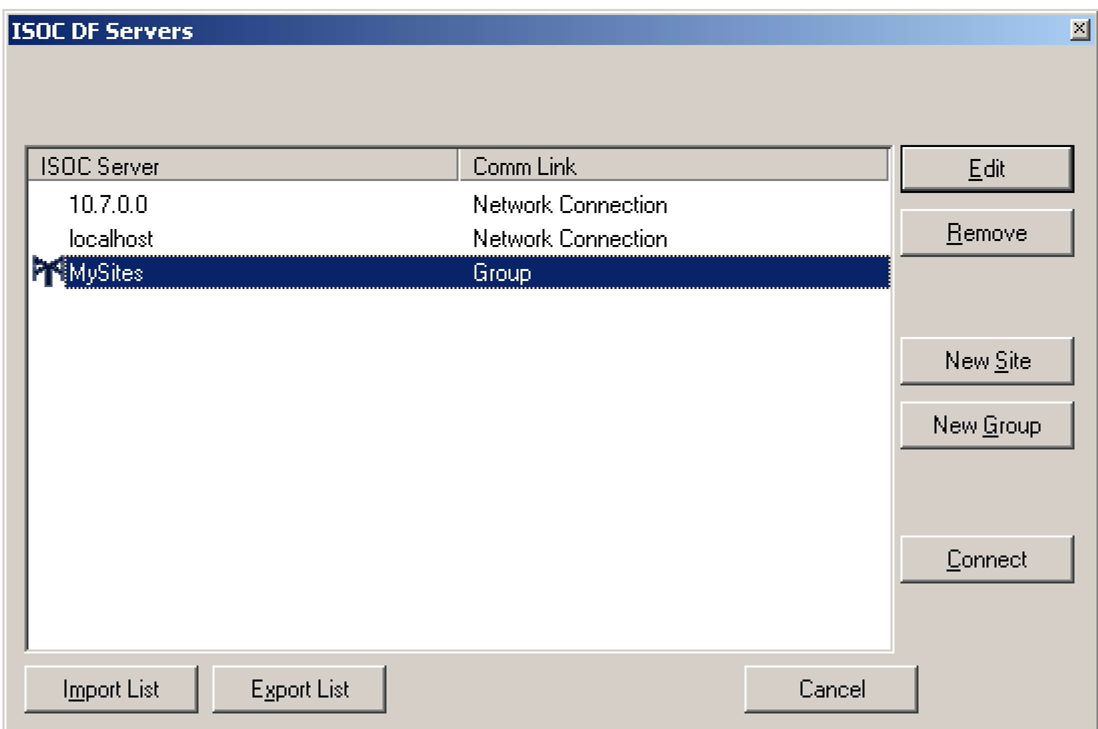


The site's Internet name or IP address should be entered in the **Site Name** field.

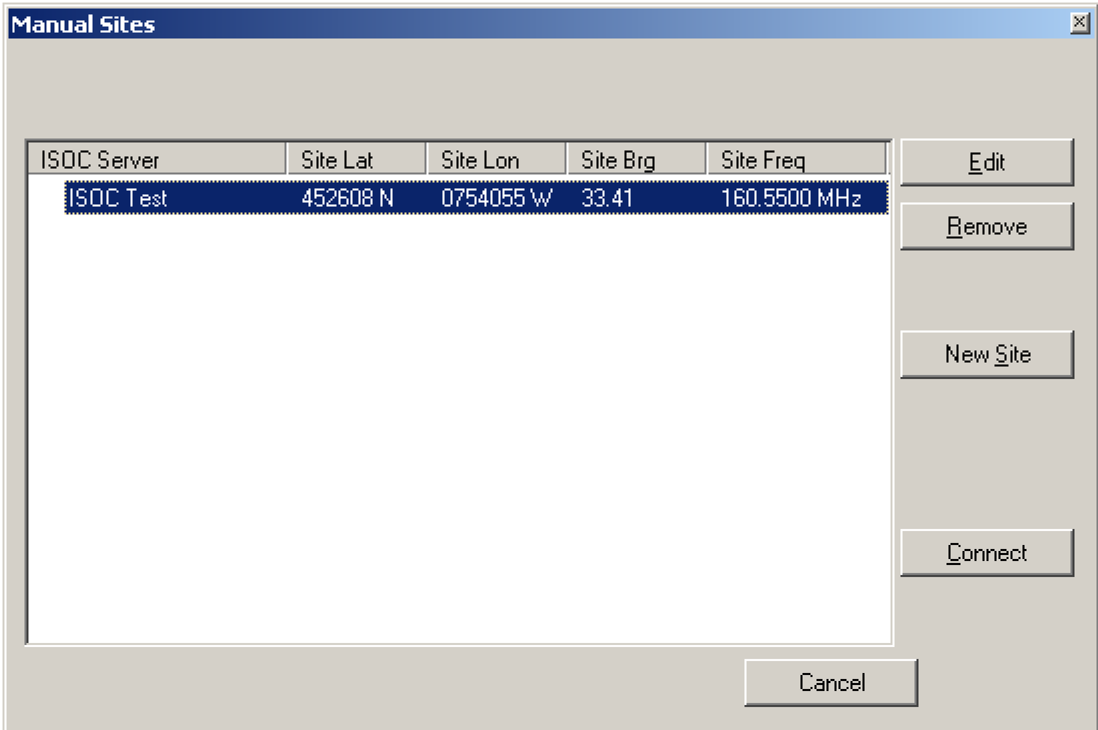
Sites can also be organized into groups, i.e., DF networks. To define a group, click the **New Group** button:



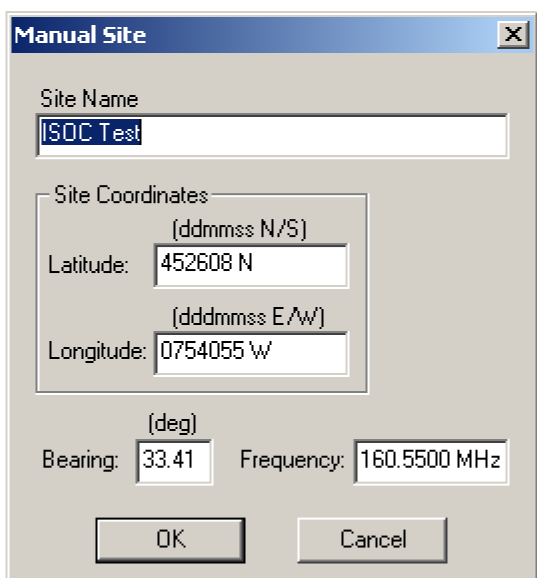
By organizing sites into groups, you can simplify the connect process. Groups appear as a single entity in the ISOC DF Servers dialog:



You can also define a site “manually”, through the Manual Sites dialog:

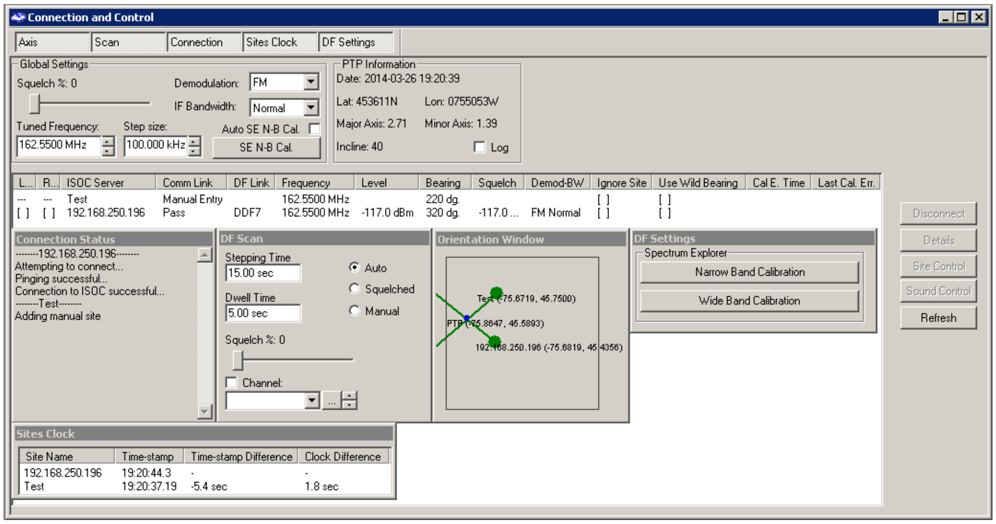


To include a manual site in the position determination, select it and click the **Connect** button. To add a new site, click the **New Site** button and complete the Manual Site dialog:



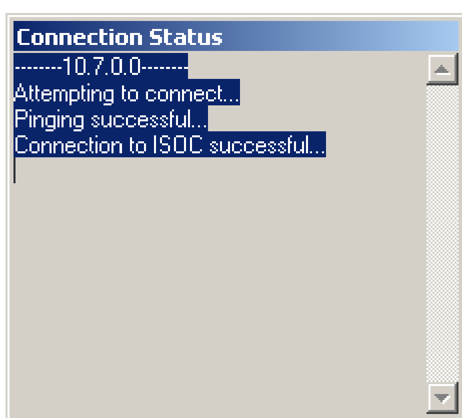
When you define a site this way, the site's coordinates, the antenna bearing, and receiver frequency are entered by hand for each site. In other words, a manual site is not part of a DF network, but its bearing is used in the calculation of a fix. Bearing information is not obtained automatically by the ISOC software, but instead entered by hand (e.g., received through the telephone).

However the sites are defined, when you connect to a site or set of sites, the ISOC DF presents its main interface, the Connection and Control window:



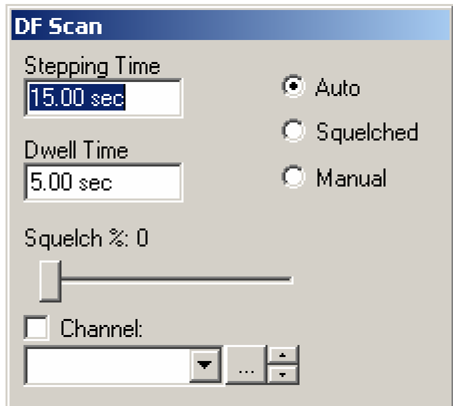
This interface provides an overview of the DF network, i.e., all the sites to which the ISOC DF program is presently connected. The top part of this window provides areas for settings that apply to all sites (global settings) whereas the bottom part lists individual sites. Five small panels are also displayed that provide information on connection status, DF scan settings, an orientation window that provides a graphical representation of the DF network and its bearings of the measured signal, a panel comparing clock settings and DF configuration panel.

The Connection Status panel provides feedback on the ISOC DF program's attempts to connect to a site. What is displayed in this panel may be used to troubleshoot connection problems, for example:

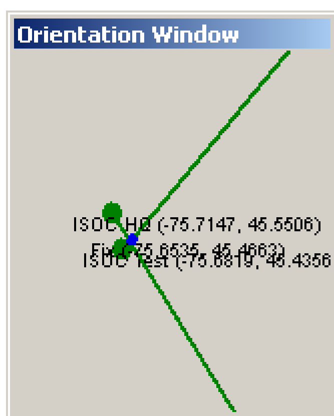


Once all required connections have been established, the Connection Status window can be closed, as it contains no further useful information.

The DF Scan panel provides a means to perform a frequency scan with the DF processor(s):



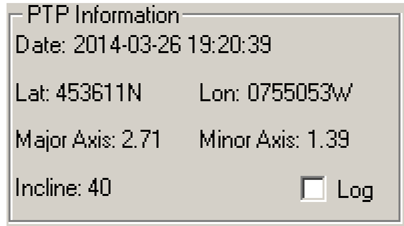
Lastly, the Orientation Window panel provides graphical feedback on the fix[6]. If the location of the transmitter has been identified using bearing information from two or more DF sites, valid bearings (i.e., bearings that are consistent with the fix) are displayed in a colour that distinguishes them from wild bearings, i.e., bearings that are inconsistent with a fix (or all bearings if no fix has been obtained, either because of too few DF sites, or no consistent bearing information):



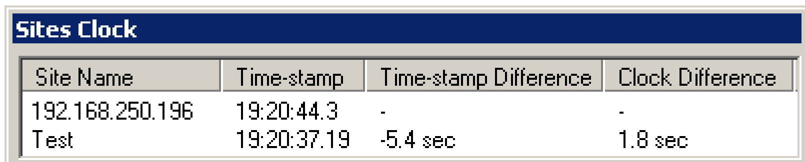
These five panels can be selectively turned on and off using the buttons in the toolbar.

[6] It is important to note that the Orientation Window will display bearings at a rate based on the integration time as defined in the Settings dialog (Tools menu), while the DF Compass window of a particular site (available under the Site Control button) will display the bearing at its own integration time, which is defined separately.

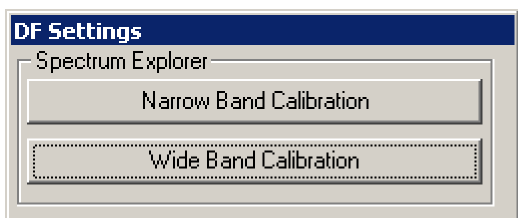
When a fix is obtained, it is also displayed in the top right part of the Connection and Control window:



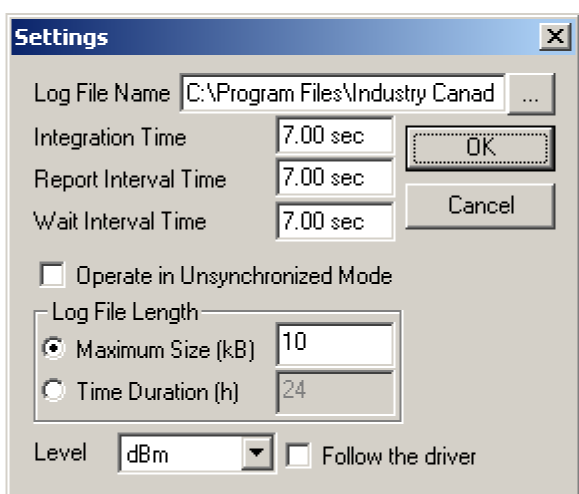
The Sites Clock panel provides an easy means to compare the running (GPS) clocks at each DF site as well as the time-stamp difference between the last directional fixes:



The DF Settings panel, applicable when a CRC Spectrum Explorer instrument is used as a DF source, can be utilized to effect a wideband/narrowband calibration of the SE instrument:



DF measurements can also be logged. The name of the log file is but one of the settings that are controlled through the Settings dialog. To invoke this dialog, select the **Settings** command from the Tools menu:



For information about the additional fields in this dialog, please consult the Reference section (section 3.1.2).

There are several buttons on the right-hand side of the Connection and Control window. Of these, the **Disconnect** button can be used to disconnect a specific site, while keeping the connection to other sites open.

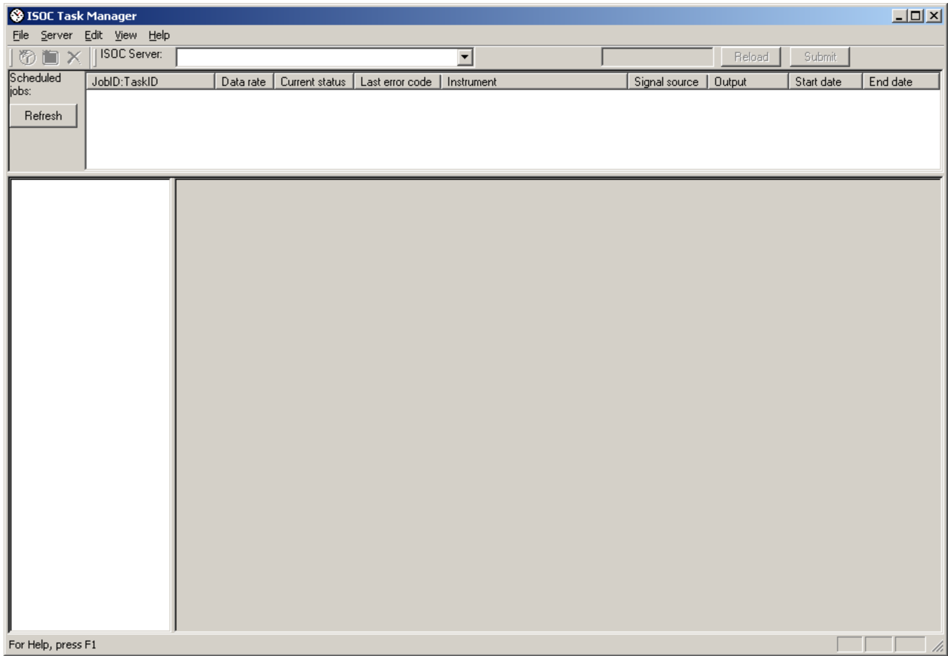
The **Site Control** button in the Connection and Control window provides a means to control the individual instruments at a site. For manual sites, it invokes the Manual Site dialog, described earlier in this section. For a non-manual site, when you click the Site Control button, lo-and-behold, a virtual instrument interface appears just like in the main ISOC client program (see section 2.1.7).

The **Sound Control** button becomes active when audio is selected, by clicking the checkboxes in either the Left or the Right columns in the Connection and Control window. (There may be some lag time after clicking these checkboxes and before the **Sound Control** button is activated.) The software automatically finds an available audio channel through which the DF audio is connected. Once the connection has been made, the Sound Control button can be used to invoke the Remote Audio virtual instrument (see section 2.1.4), through which sound can be controlled.

2.3. The ISOC Task Manager

While the interactive features of the ISOC are powerful, they do not provide a solution to all problems. Sometimes, it is important to be able to monitor a frequency or a set of frequencies for extended periods of time, or perform other measurements at scheduled times. The third main program of the ISOC, the ISOC Task Manager, and the associated server-side service, provide a solution in these cases.

The ISOC Task Manager can be launched from the Windows *Start* menu, or from the *Site* menu of the main ISOC client program. When started, the Task Manager displays an interface divided into several areas:

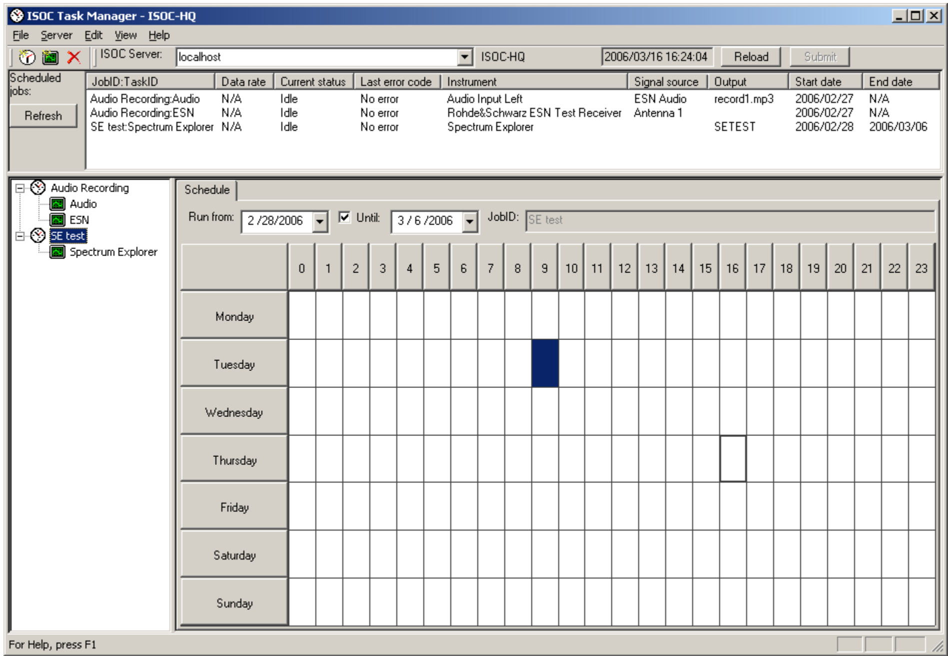


Most user interface elements in this window are inactive until you establish a connection to an ISOC server. To do so, enter the name of the desired server in the **ISOC Server** field just under the menu bar, and hit enter, or press the **Reload** button on the right.

You may also use the name of a previously used ISOC server, up to ten of which may appear in the dropdown list of the **ISOC Server** field. The ISOC Task Manager and the main ISOC client program share the list of servers; so for instance, if you used a server previously for interactive operations with the main ISOC client, its name will appear here in the ISOC Task Manager's dropdown list.

2.3.1. The Task Manager interface

Once you entered a server name and hit the **Reload** button, the Task Manager window is populated with data. (Be patient; it may take a few seconds, especially on a slow network connection). The user interface now shows all jobs and tasks that exist on the server:



The left side of the main area of the Task Manager window provides an overview of all tasks and jobs presently on the server. In the terminology used in the ISOC Task Manager, a *job* is a collection of (usually, but not necessarily) related tasks that are scheduled to be executed at the same time. Therefore, you can think of a job as an entity that consists of a schedule (i.e., at what time is the job to run) and a set of tasks.

A *task*, on the other hand, is a specific collection of settings that apply to a particular instrument. When the task is activated (i.e., when the job that it is a part of begins execution) the settings are applied, the instrument is controlled, and measurements are made. The measurements may be recorded to a file.

2.3.2. Task Manager operations

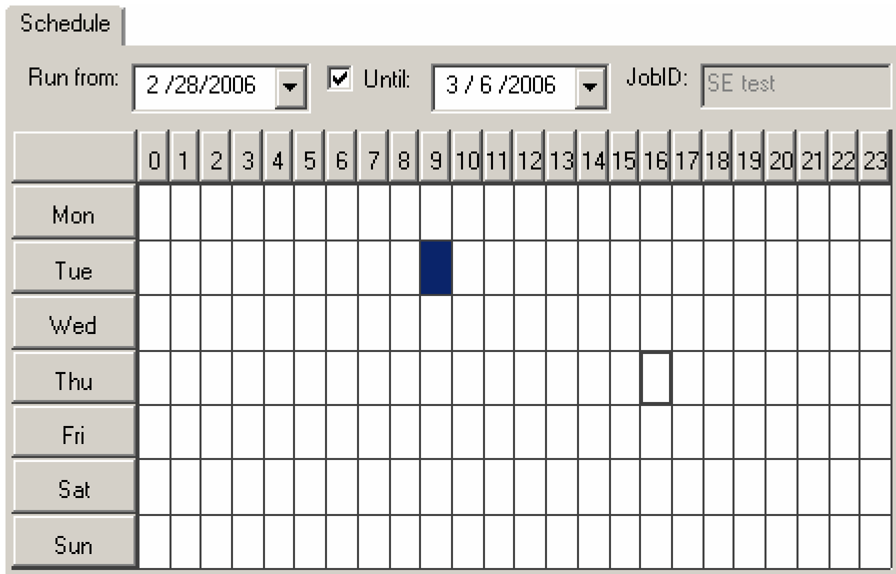
All the above is reflected by the user interface. Jobs and tasks are shown in a hierarchical arrangement in the left side of the main area of the ISOC Task Manager window. Whenever you click a particular job or task, settings that correspond with it appear in the form of a tabbed display in the right side of the main area.

2.3.2.1. Adding jobs

You can create a new job by selecting the *Create a New Job* command from the *Edit* menu or by clicking the first button in the toolbar: .

2.3.2.2. Editing jobs

For a job, there is only a single tab on the right-hand side: the **Schedule** tab that shows the **Run from** date, the optional **Until** date, the **Job ID**, and a grid with cells corresponding with each of the 168 hours in a calendar week:



When a job is created, it is given a default identifier (**JobID**). This field is the unique identifier of a job. Therefore, it cannot be changed once a job has been submitted to the server; it is only editable for a newly created job.

The remaining controls in this user interface are self-explanatory. The **Run from** and **Until** fields define when the job is allowed to run; blue shaded areas in the weekly grid specify at which hours the job is to be run. The weekly grid is easy to manipulate; you can select and deselect individual cells, you can click and drag the mouse to select a range of cells, or you can select entire rows and columns. The current day and hour is indicated by a thickened rectangle.

2.3.2.3. Adding tasks

To add a task to a job, make sure first that the desired job is selected in the left side of the Task Manager window, and then either use the *Add a Task* command from the *Edit* menu, or click the second button in the toolbar: .

Individual tasks have many settings, and this is reflected in the user interface: when a task is selected, the right side of the Task Manager window contains four tabs. For a new job, these tabs should probably be selected in order, as they are arranged in a logical progression.

2.3.2.4. Task types

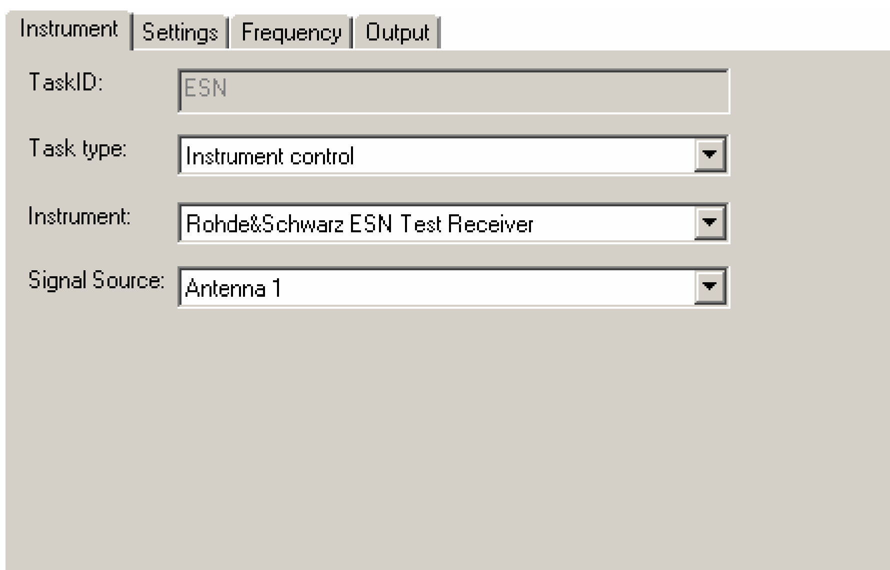
Like a job, a task also has a name (**TaskID**) that can only be edited when the task is being created; once it has been saved on the server, the task's name is immutable.

The most fundamental piece of information about a Task Manager task is its type. There are three task types available:

Audio Recording, as the name suggests, is a task that records audio. An audio recording task uses, as its "instrument", the computer's sound card, and it produces a `.wav` or `.mp3` file as its output.

Instrument Control is somewhat of a misnomer: originally designed to merely provide basic control of an instrument (e.g., setting up a receiver for audio recording), instrument control tasks are much more capable today and can perform programmed scans, record measurements, and more.

Frequency Scan tasks are designed for receivers that have a fast frequency scan capability. On some receivers (e.g., the Rohde & Schwarz ESN) in certain configurations more than a thousand frequencies per second can be scanned.



Depending on which task type to select, the **Instruments** field is populated with a choice of instruments that support the selected task type. (For instance, receivers would be listed for Instrument Control and Frequency Scan tasks, while the server's sound hardware will be listed for Audio Recording tasks).

Selecting an instrument causes the Signal Source field to be populated with all the signal sources that are available for that instrument. This field is intended for server configurations that are equipped with a switch matrix, which makes signal source selection under computer control possible; if no switch matrix is present at the server, the Signal Source field will serve simply as an informational field, reporting whatever signal source is specified as a hardwired, or default, signal source for the selected instrument. (It is up to the ISOC server administrator to ensure that meaningful information is reported for hardwired connections).

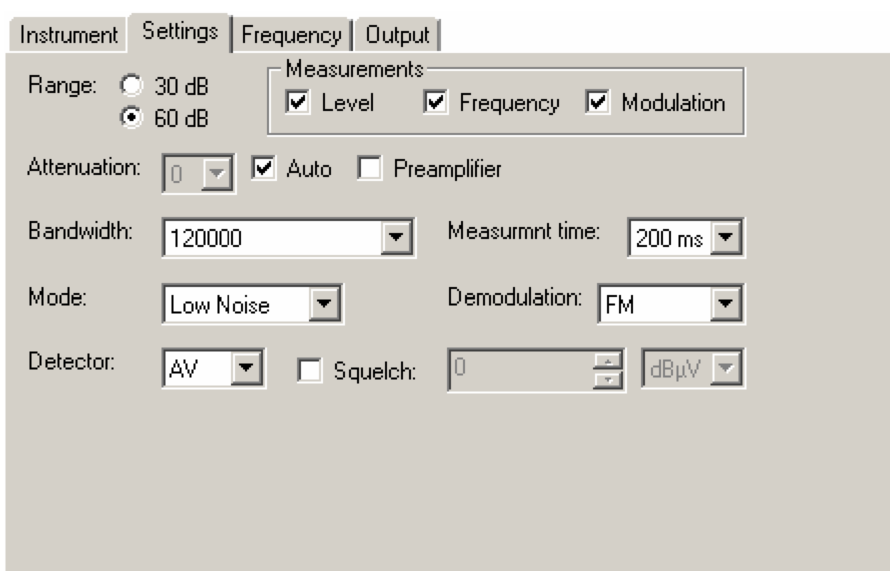
When you are done selecting the Task Type, Instrument, and Signal Source, it is time to move on and configure the instrument, by clicking the Settings button.

2.3.2.5. Task settings

Under the **Settings** tab, dialog fields appear that are instrument specific. Furthermore, the actual content of the page for a specific instrument type may differ depending on the type of task selected; for instance, for a receiver, many more options are available for an Instrument Control task than for a Frequency Scan task.

These differences notwithstanding, the basic idea behind the **Settings** tab remains the same; you configure an instrument for the scheduled task here.

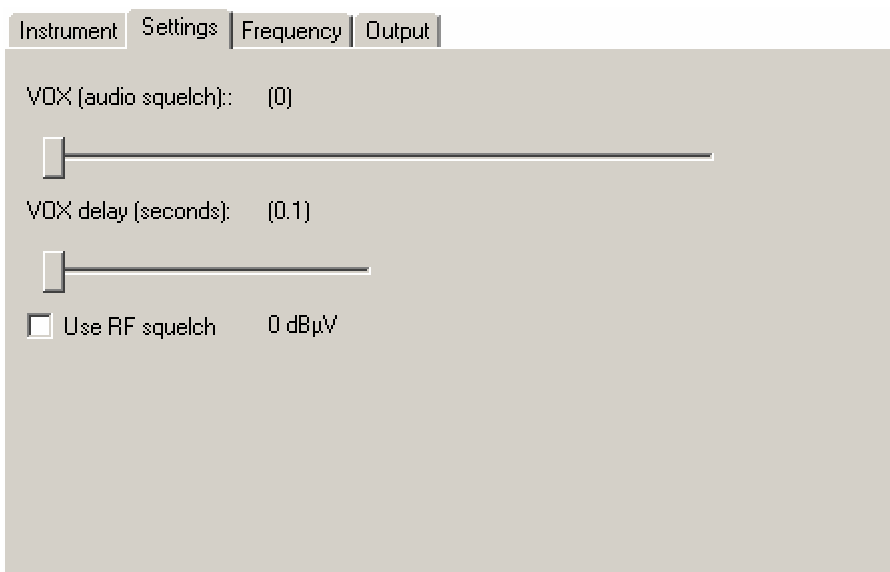
For instance, take the **Settings** tab for a Rohde & Schwarz ESN Receiver, being used in an Instrument Control task:



The parameters that can be configured here should be familiar from the interactive virtual instrument interface. The basic idea is simple: you configure the receiver’s RF and IF stages, and determine what values should be recorded as measurements.

One parameter that you might expect to see under the **Settings** tab yet it is not present is the receiver frequency. Why? Because the frequency of the receiver is controlled separately, under the **Frequency** tab, as you will see shortly.

A very different example for an instrument configuration is the **Settings** tab for an audio recording task. There are not too many parameters that can affect an audio recording: what we see here are settings for VOX squelch and RF squelch.



The operation of VOX squelch is self-explanatory. The scale of the VOX slider is relative to the maximum audio input level of the server computer’s sound card.

The VOX delay setting determines how long a period of silence must last before recording is suspended. Audio recording is resumed instantly when an audio signal exceeding the VOX squelch level is detected.

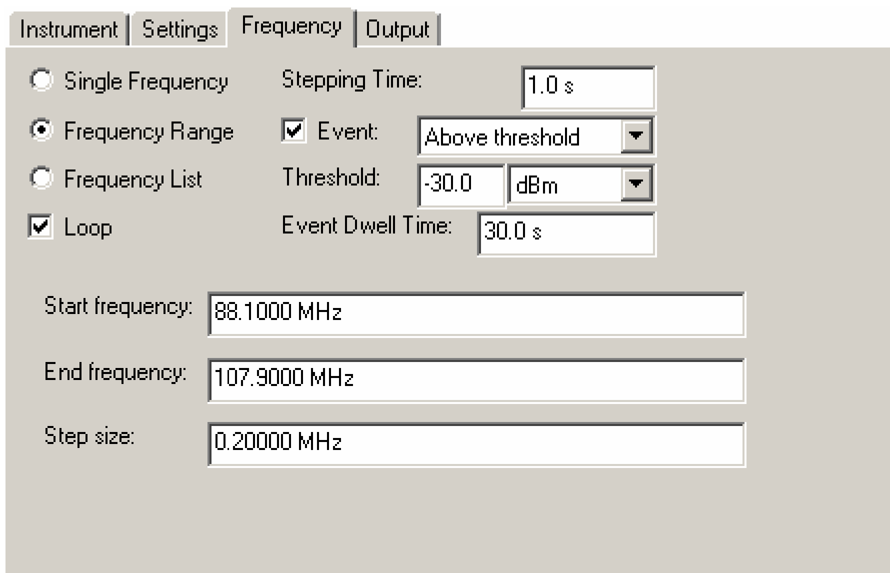
The RF squelch option is used in conjunction with a receiver. Please see the example in section 2.3.3.3 about recording audio with a receiver.

2.3.2.6. Frequency control

When you operate a receiver, it is normally configured to receive a signal on a fixed frequency or a range of frequencies. The ISOC Task Manager provides options for both in a variety of configurations.

(Needless to say, frequency controls are only available for tasks where the idea makes sense. For tasks such as audio recording tasks, or tasks using an instrument such as an antenna rotator, the **Frequency** tab remains blank).

To set up the frequency of a receiver, you need to click the **Frequency** tab:



As indicated in the upper left area of this tab, you have three basic options: you can tune the receiver to a single frequency, you can select a frequency range (defined by a start frequency, stop frequency, and step size), or you can tune the receiver to a frequency list that is read from a file. For frequency ranges and frequency lists, you can also use the **Loop** checkbox to ensure that once the receiver gets to the end of the list or range, it starts over from the beginning.

When a frequency range or frequency list is selected for an instrument control task, additional fields become visible. These fields control how rapidly the receiver is to step from one frequency to the next in the list or range. The value specified in the **Stepping Time** field is used unless the **Event** checkbox is checked and the condition specified is satisfied by the signal:

- **Above threshold** means that the RF signal level must exceed the value specified in the Threshold field
- **Below threshold** means that the RF signal must *not* exceed the value specified in the Threshold field

When the specified event condition applies, the receiver will stay on the current frequency for the duration that is entered in the **Event Dwell Time** field.

If the **Single Frequency** mode is selected, a single field labelled **Frequency** appears in the bottom part of this tab, where you can specify the desired receiver frequency.

If the **Frequency Range** mode is selected, three fields appear: the use of the **Start frequency**, **End frequency**, and **Step size** fields should be self-evident.

For the Frequency list mode, the tab presents many additional options. These options are aimed at allowing you to select one or more frequency list files on the server that will be used for this task.

The ISOC server recognizes four frequency list file types.

`.LST` files are simple lists containing one frequency value (in MHz) per line. As an example, the following file contains the list of GRS band radio frequencies in .LST format:

```
26.965
26.975
26.985
27.005

...

27.375
27.385
27.395
27.405
```

`.SST` files serve the same purpose as `.LST` files but using a slightly different syntax. These files also contain a header line and columns in addition to the frequency column, that are intended to specify additional receiver settings. The additional columns are for bandwidth, filter, and antenna settings; however, these columns are not used by the ISOC system, as these settings are specified separately through the ISOC graphical interface.

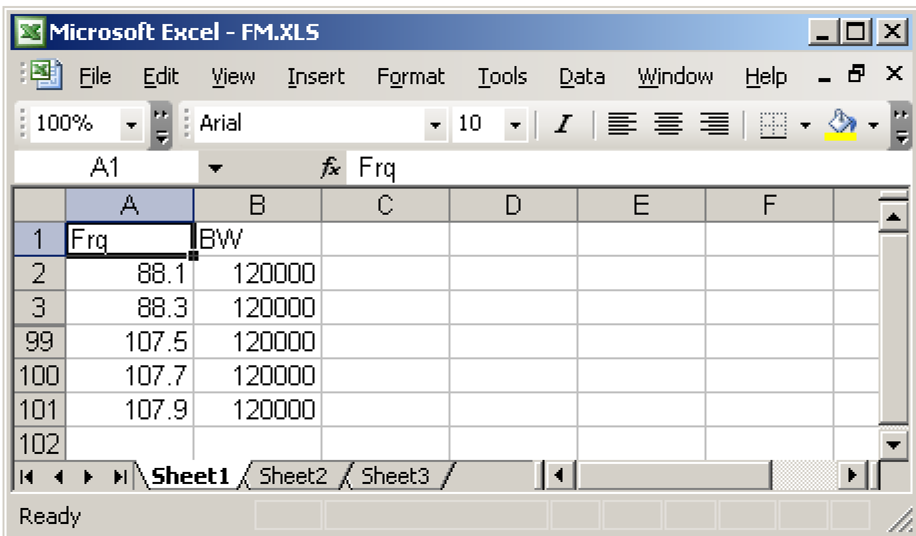
The following example demonstrates how GRS frequencies would be stored in an `.SST` format file:

```
GRSFREQS 0120060321Test file for GRS     ISOC-HQ
  26.965 0 1 0
  26.975 0 1 0
  26.985 0 1 0
  27.005 0 1 0

...

  27.375 0 1 0
  27.385 0 1 0
  27.395 0 1 0
```

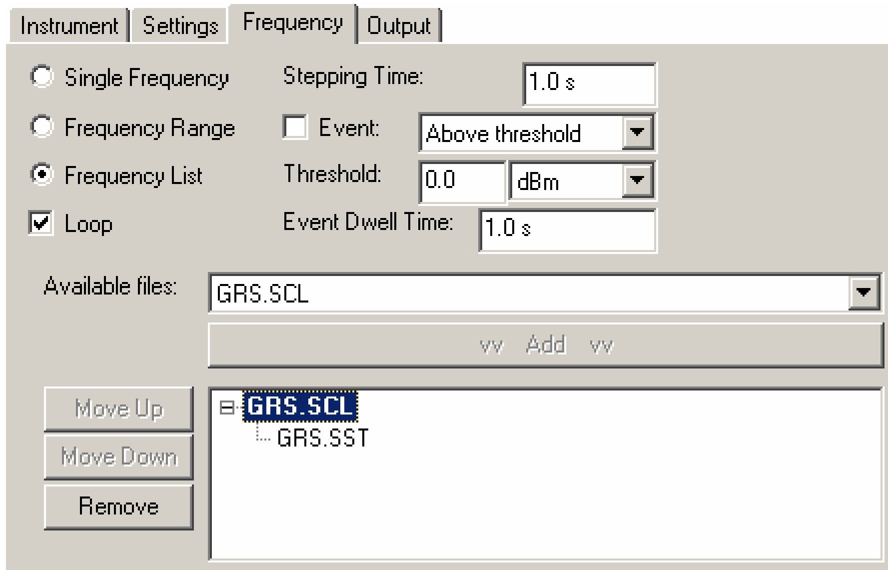
```
27.405 0 1 0
E
```

The third file type that can be used in scheduled tasks is the `.SCL` format. An `.SCL` format file contains a list of (`.LST` or `.SST`) files. The actual frequencies will be read from the files referenced by the `.SCL` file.

Lastly, the ISOC server can also use Microsoft Excel format spreadsheet files. In order to be recognized, an Excel format file must contain, in its first worksheet, a list of frequencies and bandwidths in columns A and B. The first row is reserved for a header; subsequent rows must contain decimal values, with frequencies measured in units of MHz, and bandwidths measured in units of Hz, as in the following example:



To select files for use in a task, click the **Available files** dropdown box. In this field, you will see a list of all frequency files that are presently available on the ISOC server. Select the desired file and then click the **vv ADD vv** button to move the file to the list area below:



As this screenshot demonstrates, when a `.SCL` file is selected in the Task Manager, the files that it references can also be seen if you click the small "plus sign" symbol next to the `.SCL` file's name. This makes it easier to select the correct file.

The order in which files are to be used by the task can be changed using the **Move Up** and **Move Down** buttons. The **Remove** button can be used to remove a file that is not needed from the list (clicking the **Remove** button does not actually erase the file on the server).

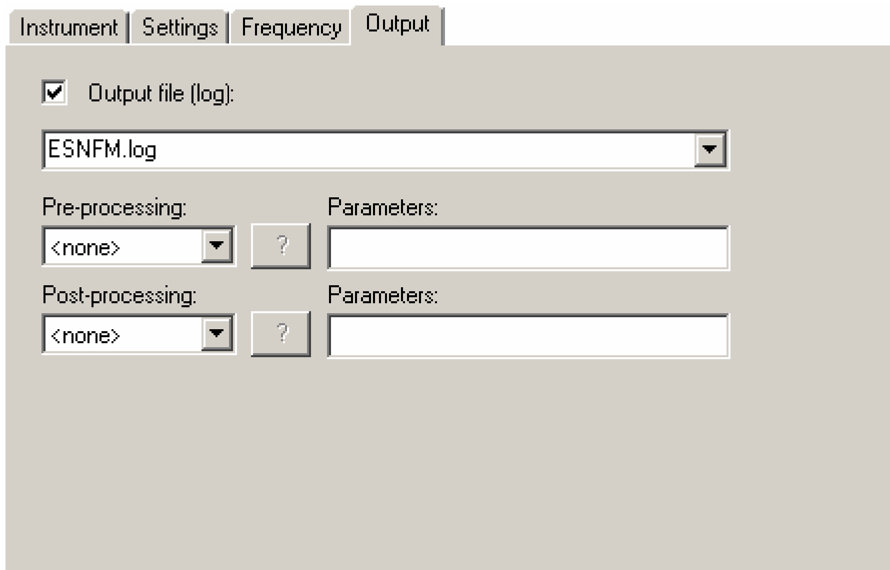
> **Tip:** You cannot change the order of files referenced by an `.SCL` file, nor can you remove such files individually. If an `.SCL` file contains the wrong files, or the right files but in an incorrect order, the `.SCL` file itself has to be edited.

When you are satisfied with the frequency configuration, it is time to move on to the last tab.

2.3.2.7. Output settings

For most tasks, the ultimate goal is to produce a data file in which the task's results are captured. (There are some exceptions: for instance, you may be using an Instrument Control task to set a receiver to a specific frequency, but not record any of the receiver's measurements; instead, you may be using a second task in conjunction to record audio).

The output file for a task is specified using the **Output** tab. The top part of this tab lets you specify whether or not an output file is desired, and the name of that file. Existing files are listed in the dropdown area of the **Output file** field:



The file type is task type and instrument dependent. Typical output file types include the following:

- `.LOG` files contain human-readable logs of measurements. These files are normally produced by instrument control tasks.
- `.WAV` files contain uncompressed audio. These files are produced by audio recording tasks.
- `.MP3` files contain highly compressed MP3 format audio. These files are also produced by audio recording tasks.
- `.ESN` files are binary format files containing the results of frequency scan tasks.

2.3.2.8. Pre- and post-processing

Before a task is executed, or after it completed execution, it is possible to have the ISOC system perform specific pre- and post-processing functions. Pre- or post-processing basically entails invoking an external program that receives information about the task in question and its output file name. Many things can be accomplished by pre- or post-processing tasks; for instance, a post-processing program might package the output file in a suitable format and send it to a predetermined address as an e-mail attachment.

The ISOC system comes with a few example programs, in the form of Windows batch (`.BAT`) files, that demonstrate how pre- and post-processing can be implemented.

To select pre- or post-processing for a task, simply click the dropdown list box in the rows labelled **Pre-processing** or **Post-processing**. These dropdown lists show all available pre- and post-processing command files that are presently installed on the ISOC server. Some command files come with accompanying help files; if a help file is available, you may be able to click on the help button (marked with a question mark). The help file may provide additional information about the types of parameters that the pre- or post-processing program accepts.

2.3.2.9. Updating the server

When you edit jobs and tasks, the result of your editing does not take effect until you submit your changes to the ISOC server. To submit your changes, click the **Submit** button in the toolbar, or select the *Submit* command from the *Server* menu.

If you are not satisfied with your changes, and you wish to cancel your edits, use the **Reload** button. When you press this button, your changes are discarded and the previously existing set of jobs and tasks is downloaded again from the ISOC server.

When you submit your changes to the server, the Task Manager verifies that your new schedule is free of potential errors. For instance, it checks that there are no conflicts (two or more tasks scheduled to run at the same time and utilizing the same physical instrument) or that for all instruments that you are planning to use, a properly configured input signal is selected.

When problems are encountered, the Task Manager displays a warning. It is up to you to decide whether the warnings are harmless and can be safely ignored, or if it is necessary to correct the problems before submitting the schedule.

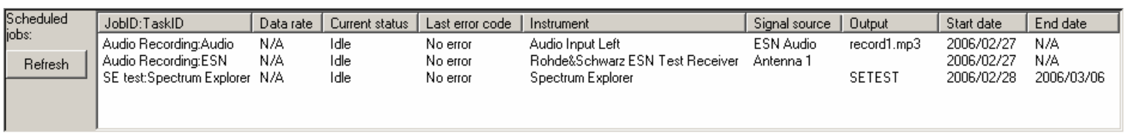
Some problems are detected only by the server after the schedule has been submitted. Specifically, the server verifies the frequency list; if it contains duplicate frequencies, or if the number of frequencies is too high for the selected instrument, a warning is shown. You then have the opportunity to edit and correct the schedule, and resubmit the changes. (Another way to correct the problem is to upload a frequency file that contains the correct set of frequencies.)

Note that when you are submitting a schedule that contains changes for a job or task that is presently running, those changes may not take effect immediately. For instance, if you have an Instrument Control task running for a receiver, you change the frequency of that task, and you resubmit the task, it does not change the frequency of the receiver instantaneously; only after the task ends and starts again at its next scheduled time will the new frequency take effect.

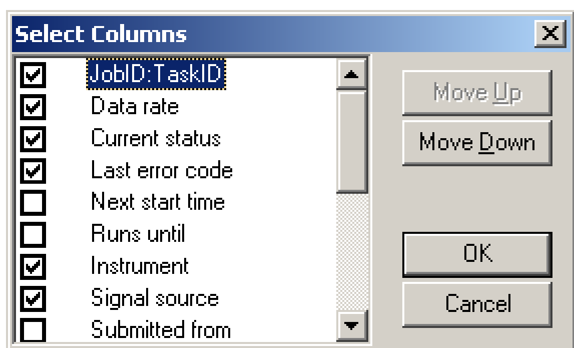
Indeed, perhaps the best (and safest!) way to change the characteristics of a running task is to **Interrupt** the task first, make your changes and submit them, and then **Resume** the task.

2.3.2.10. Job control

Under the toolbar, a horizontal area in the Task Manager window is reserved for scheduled jobs. Scheduled jobs are jobs that, under the current configuration, either ran lately, are presently running, or are scheduled to run sometime in the future. In other words, this horizontal area is where you can get an overview of the server's current status.



This area is designed to display many columns; 17 in total. Chances are you do not need all columns, and to save space, you may decide which ones you'd like to see displayed. To select columns, use the *Columns* command from the *View* menu:



You can also change the order in which columns appear.

The columns, their order, and widths are all saved when you exit the ISOC Task Manager provided the **Save Settings on Exit** menu option is checked in the View menu. These settings are saved in the Registry of your workstation (i.e., don't expect the same appearance if you access the ISOC server from a different workstation).

To refresh the list of scheduled jobs, use the **Refresh** button. The job control area can also be used to control individual jobs. When a currently running job is highlighted, the **Interrupt** button becomes visible; if you click this button, the job in question is interrupted, and the button's label changes to **Resume**.

2.3.2.11. Deleting jobs and tasks

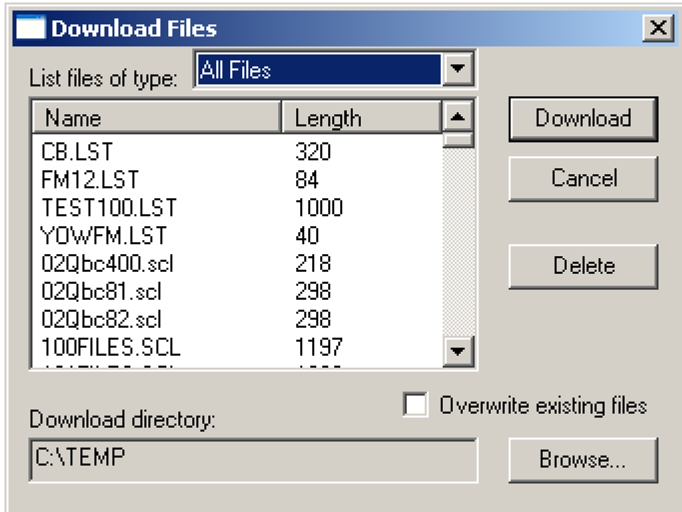
Unwanted jobs and tasks can be deleted easily: select the job or task in question, and use the **Delete** command from the Edit menu, or the Delete toolbar button ( ).

> **Tip: *You are not done yet!*** Merely deleting a task or a job on your workstation does not immediately update the work plan on the server. Indeed this is a frequent source of confusion: think of the work plan you are editing as your *local copy*, while the copy that the server uses will remain unchanged until you choose to upload your modified version by clicking **Submit** in the Task Manager's toolbar. This applies to additions, changes to jobs and tasks, and also to deletions!

2.3.2.12. File management

As the previous sections demonstrated, the Task Manager uses a multitude of files for both input and output. These files reside on the ISOC server. That creates a problem: chances are that you, the user, are not at the same physical location as the server, and you need to transfer files to and from the server.

While there are many alternatives (e.g., Windows file sharing, FTP) to transfer files, the ISOC system provides its own simple built-in file transfer service. With this service, you can upload files to, and download files from, the server, and the software ensures that files on the server are automatically placed in the appropriate folder. To download files from the ISOC server to your client computer, select the **Download** command from the Server menu. This displays the Download Files dialog:



Tip: Do not download files that are still being written to by a running task. This is especially true of .ESN files: if they have not been properly closed by the ISOC server, their contents are not readable, as important header information is missing.

All files of the selected type that are presently found on the server are listed, along with their length (which should give you an approximate indication as to how long it would take to download the file). By default, the Download Files windows shows "All Files", meaning all `.WAV`, `.MP3`, `.SST`, `.LST`, `.SCL`, `.ESN`, `.LOG`, and `.XLS` files (these are all the file types that the ISOC server utilizes). However, if you are only interested in files of a specific type, you can restrict your selection to that file type. You can also select Miscellaneous files, which will display files not normally part of the selection (and not listed even when the All Files option is selected), such as the ISOC server's system log files.

In addition to files that have the specieid filename extension (e.g., `.WAV`), all other files (notably, all `.ZIP` and other archive files) located in the same folder are also listed and are available for download.

After you made your selection, you may also specify the directory location on your local machine where the downloaded files will be stored. To select a directory other than the default, click the **Browse** button.

When you click the Download button, the download process begins. A dialog appears that shows the download progress, and also warns you of any errors that might occur during the download process.

Last but not least, you can also use the Download Files dialog to manage files on the server; the **Delete** button lets you delete files on the server that are no longer of any use.

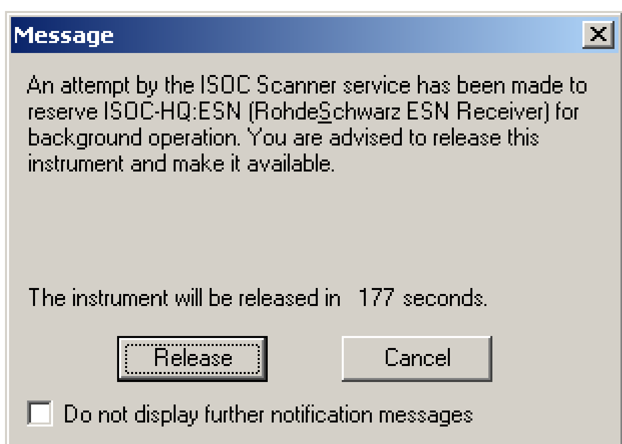
The file upload process is very similar. To upload files, select the *Upload* command from the Task Manager's *Server* menu. A standard file selection dialog then appears, where you can select one or more files for upload. When the upload begins, a progress dialog is again displayed, showing the upload progress and any warnings or errors. The uploaded files are placed in the appropriate folder based on their filename extension.

2.3.2.13. Job and task execution

Exactly what happens on the server when the time comes for a task to execute? How are tasks executed? How are errors and scheduling conflicts handled? How are output files processed?

Exactly four minutes before a task is scheduled to execute, the ISOC Scanner service "wakes up" and attempts to reserve and initialize the instrument. This 4 minute advance time is used to ensure that a) in case the instrument is still in use, it can be obtained, and that b) any instrument initialization is completed in time.

If an instrument is in use when the scheduled task is about to begin, the current user receives a notification message:



If the user does not respond within the indicated time (e.g., if a user has left a workstation unattended) the instrument will be automatically released.

As one of the first steps of the setup operation, if a preprocessing command was specified, it will be called. This happens before the ISOC Scanner attempts to open any files for input or output.

The output file name of the task is adjusted. First, the current date is appended: thus, `OUTPUT.DAT` becomes `OUTPUT-20060629.DAT`, for instance. If a file by that name already exists, it is renamed, first with the .BAK extension, or, if that file exists already as well, then using extensions `.000` through `.999`.

If the instrument(s) and signal source(s) were successfully reserved and initialized, the task begins execution. If an error occurs, then the ISOC Scanner determines if the error is of a recoverable nature; if so, it adjusts the task's schedule by one minute.

Depending on the task type and the driver in use, a task may be suspended and restarted automatically at the end of each hour. If a task is suspended and will restart with the same date, it will continue to use the same output file as before. In this case, no post-processing takes place.

If a task is terminated, or if it is suspended at the end of the day, scheduled to restart on the next day, its output file will be post-processed. In particular, any post-processing command files that may have been specified for the task are called at this time.

If a task fails with an error, its output file is closed. If the error is deemed to be a recoverable error, the task is scheduled to restart with a one minute delay. If the restart occurs on the same date as the current date, the task will reuse its output file; once again, no post-processing takes place.

If an error is not recoverable, or if it is recoverable but the task restart occurs the next day, the output file is closed and post-processed.

Together, these conditions also imply that there may be circumstances when a file is never post-processed; e.g., if the ISOC Scanner is shut down while it is waiting to restart a task that failed with a recoverable error.

If a task ends successfully, its output file is closed and post-processed. This is regardless whether or not the task is scheduled to execute again at a later time on the same date. (In particular, if a task is scheduled to execute on several non-consecutive time slots on the same day, its output file will be post-processed at the successful completion of each run.)

If a task is interrupted by the operator, it is treated the same way as successful completion at the end of the scheduled run: the task's output file is closed and post-processed. If the operator later resumes the task, a new output file is created, and the old file is renamed if necessary.

2.3.3. Task Manager scenarios

Even with this manual at hand, operating the Task Manager can be confusing at first. That is because real life tasks rarely involve a single instrument. Say, you wish to record an audio broadcast using a receiver? That requires setting up a job with two tasks, one for the receiver and one for audio recording. Many other tasks also involve the use of two or more instruments simultaneously.

In this section, a few practical examples are presented, which you may be able to adapt and put to use during the course of your daily work.

2.3.3.1. Frequency scan with a receiver

The simplest task type, indeed the first task type for which support in the ISOC Task Manager was implemented, is the Frequency Scan task. Conceptually, it entails setting up a receiver, downloading to the receiver a set of frequencies, commanding the receiver to perform a scan, and then recording the results into a binary output file.

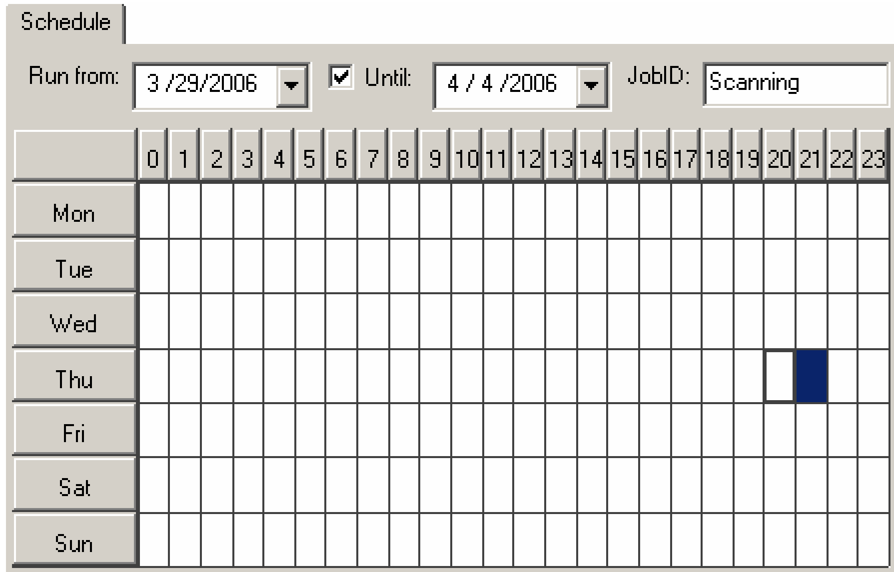
One receiver particularly well suited for frequency scanning is the Rohde & Schwarz ESN. So what, exactly, are the steps you need to take in order to successfully execute a frequency scan task and obtain a results file?

In this example, you will learn to use the Task Manager to create a task for the ESN receiver to scan some frequencies in the VHF band.

First, if you have not yet done so, start the ISOC Task Manager and connect to the ISOC Server. (Needless to say, the server has to be up and running, and it has to have an ESN receiver in order for this exercise to work).

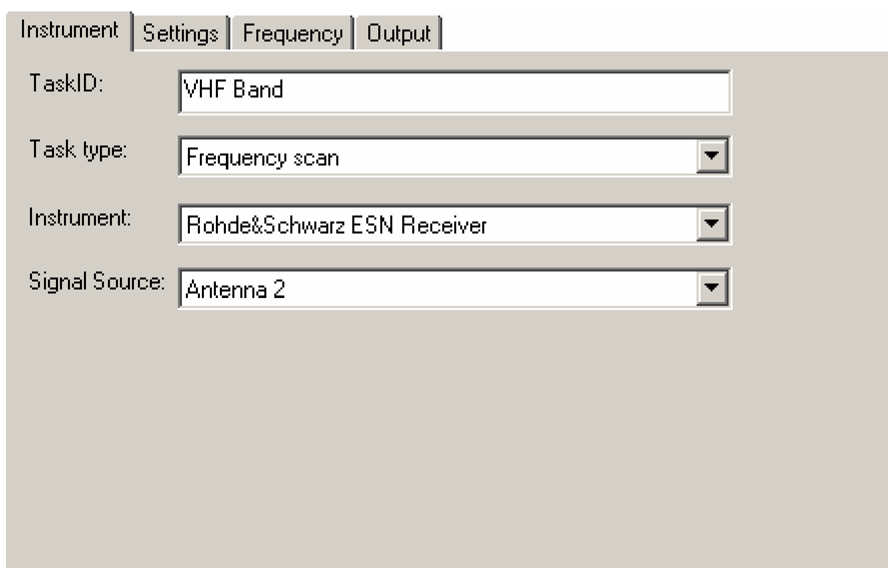
The first step is to create a new job. To do so, select the *Create a New Job* command from the *Edit* menu, or click the first toolbar button ().

When a job is created, you immediately see its default schedule. By default, a job is not scheduled to run at any time during the week; it is also set to expire within a week of its being created. If you want to run a job only once, as in our current example, it is not necessary to change the date of expiry; however, you should check at least one of the hours of the week so that the job will get a chance to be invoked. For example, you may want to select the hour immediately following the current hour. As the current hour is highlighted by a thickened rectangle, it is easy to spot it and select the hour immediately next to it:



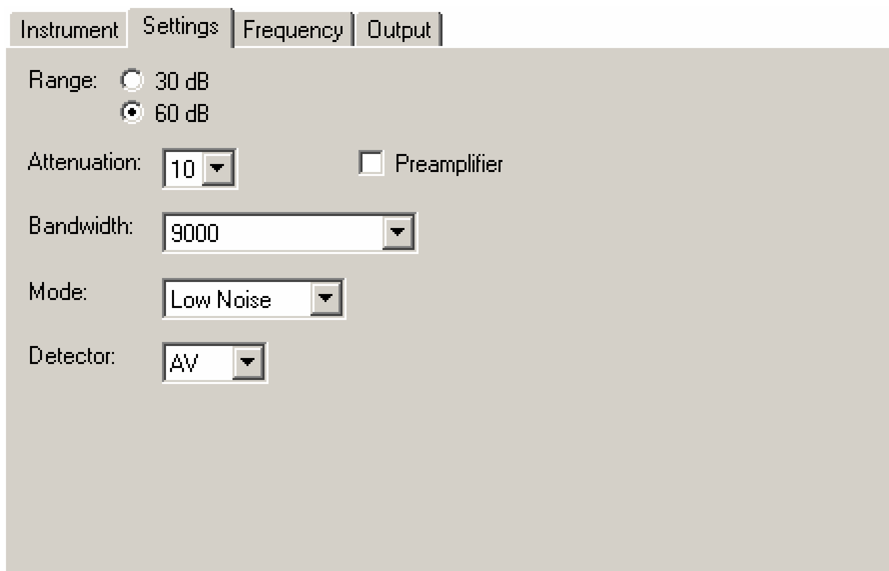
While working with this tab, you may also want to change the **JobID** to something meaningful. This is your one and only chance: once a job has been submitted to the ISOC server, its **JobID** cannot be altered.

A job by itself doesn't do much; you also need a task that controls the receiver. To create a task, make sure the newly created job is highlighted in the left side of the ISOC Task Manager window, and select the *Add a Task* command from the *Edit* menu. (You may also use the second toolbar button instead:). When the new task is created, the **Instrument** tab appears. Here, you can change the **TaskID** (your last chance; as with the JobID, the identifier cannot be changed once the task has been submitted to the server). More importantly, it is here that you specify the **Task type**, **Instrument**, and **Signal Source** fields:



The actual name of the ESN receiver on your server may be different from that shown here; it is up to the server administrator to assign suitable names to instruments. Also, the signal sources are likely to be quite different from what appears in these examples, as your ISOC server is bound to have a different configuration of antennas and instruments. Select a signal source that is appropriate for the frequency band you scan.

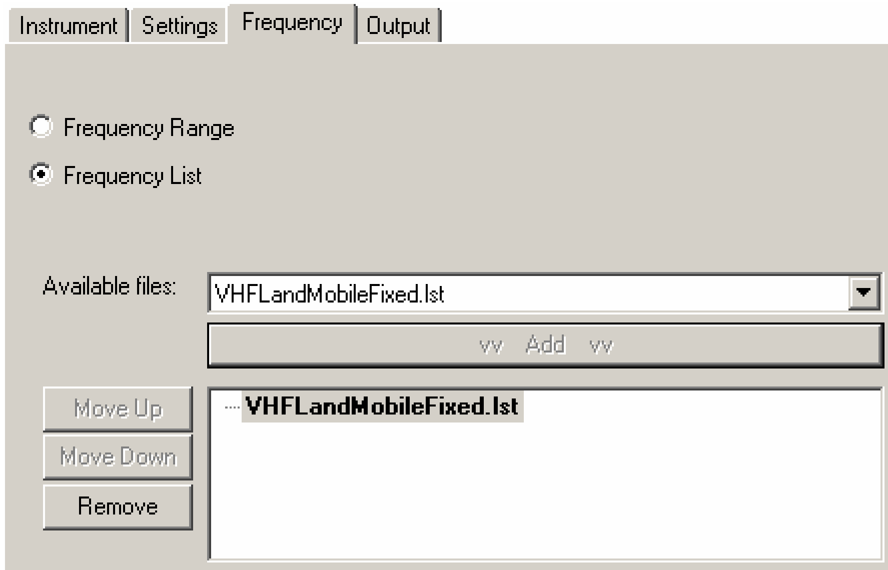
When you are finished with the **Instrument** tab, click **Settings**. Under the **Settings** tab, you can configure the receiver. For scanning the VHF band, the following settings are appropriate:



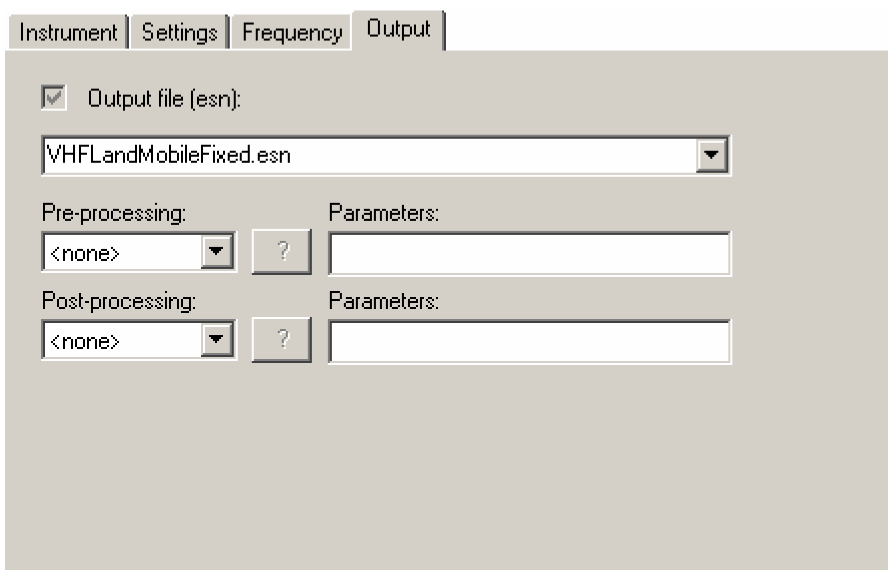
When you are finished with the **Settings** tab, click the **Frequency** tab.

Under the **Frequency** tab, the receiver frequency or frequencies can be configured. Since we intend to scan a set of frequencies, we need to supply that set. There are two ways to do so: you can specify a frequency range, or you can specify the name of one or more files containing the desired frequencies.

In this example, we shall use a frequency list. Specifically, we are using a file that contains frequencies of interest in the VHF land, mobile, and fixed band. The file name is `VHFLandMobileFixed.lst`. To use this file, click the **Frequency List** radio button, and then select the file from the list of Available files, and click the **vv Add vv** button:

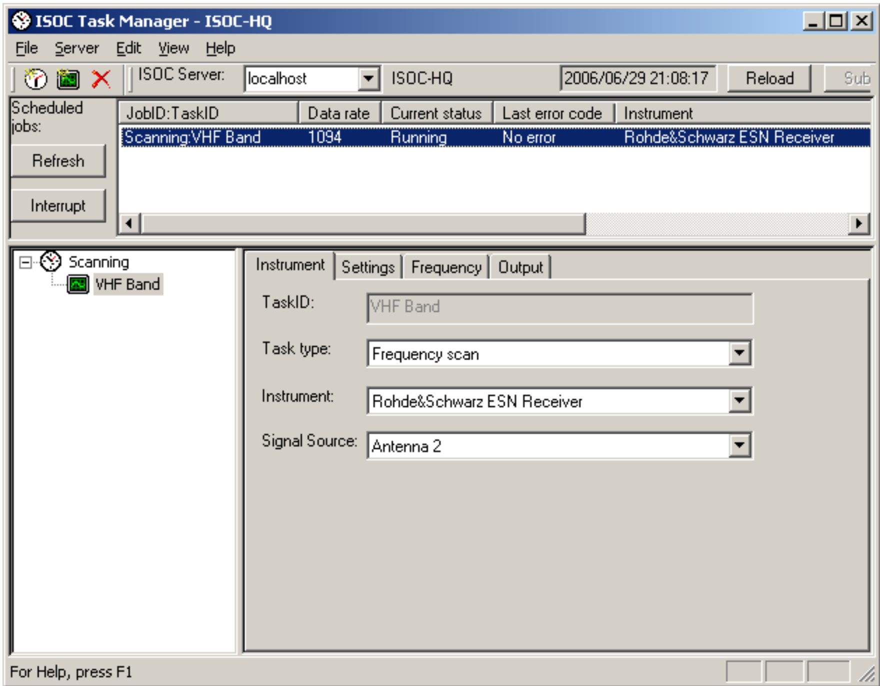


Lastly, we need to specify an output file where the measurements will be recorded. This can be done under the **Output** tab. For frequency scan tasks, an output file is mandatory and therefore, the **Output file** checkbox is always checked; you only need to enter the file name, or select an existing file from the drop-down list. Enter a filename like `VHFLandMobileFixed.esn`:



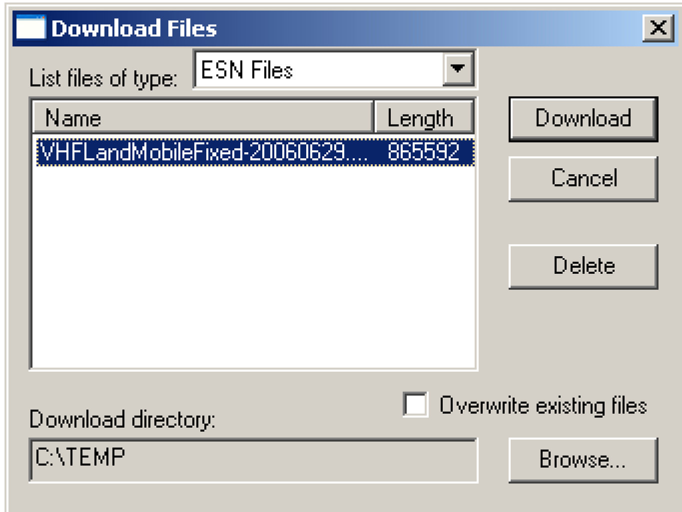
In this example, we need not do any pre- or post-processing on this file, so this is it: the frequency scan task has been fully specified. Now is the time to click the **Submit** button in the ISOC Task Manager toolbar to ensure that the newly defined task is actually set up on the ISOC server. When you click **Submit**, the ISOC Task Manager warns you if you have any apparent errors or omissions in your new job schedule; you shouldn't be seeing any in the case of this simple example, but if you do, read the warning carefully and try to correct the problems.

When the appointed hour comes, the job begins to run. You will know this if you click the **Refresh** button in the Scheduled jobs area; the frequency scan task will now be shown as Running, and the Data rate column will show the number of measurements that this task is obtaining from the receiver:



So what happens when the task runs to completion? (Or if you click the **Interrupt** button?) The task will leave behind a file with the name that you specified, and the date appended to the file name. This file will reside on the server. You can obtain a copy of this file using the file transfer facilities built into the ISOC Task Manager.

To download your results, select the **Download** command from the ISOC Task Manager's Server menu. To make it easier to locate the right file, once the Download Files dialog appears, select ESN Files in the **List files of type** field. You will then see a list of all available ESN files on the server:



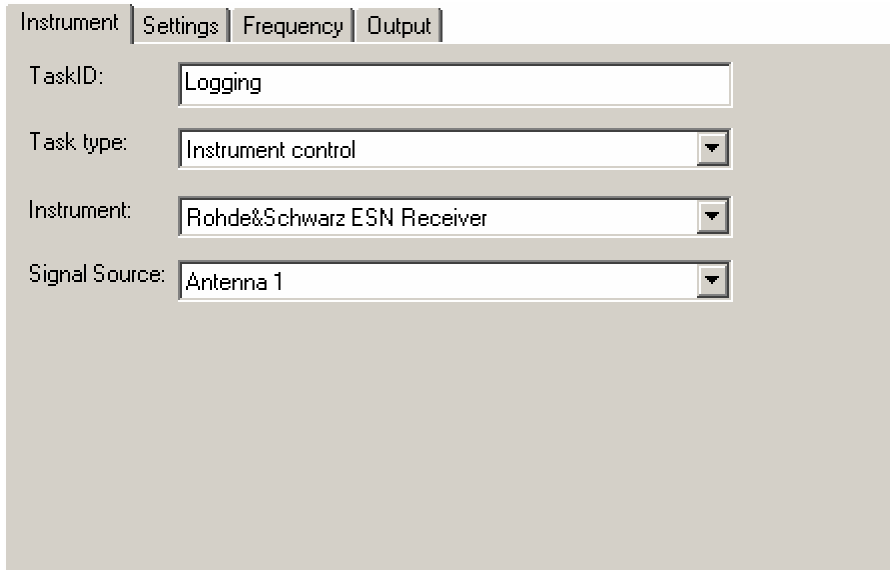
Select the correct file, as identified by its name, and click the **Download** button. (Use the **Browse…** button first if you wish to change the local directory where the downloaded files will be deposited). Depending on the size of the file and the speed of your connection to the ISOC server, the file transfer should complete in a few seconds or minutes.

The ISOC suite does not contain tools to analyse or process ESN files; however, you may have access to other tools supplied by Industry Canada for this purpose (such as *Preview*). With those tools, you should be able to verify that your ESN file contains the correct data.

2.3.3.2. Logging receiver measurements

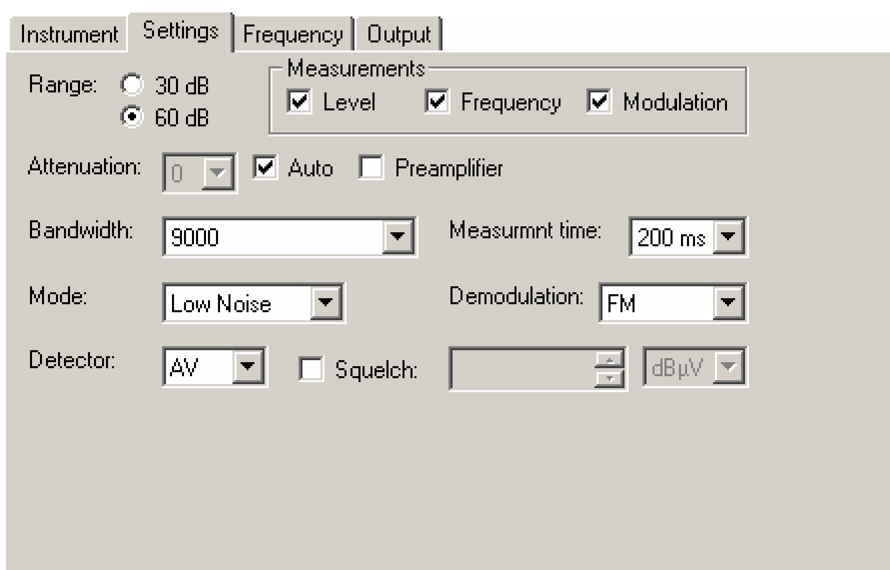
One of the most basic tasks that can be accomplished with the Task Manager is logging the measurements of a receiver. The log format should be familiar: it is the same kind of human-readable log file that can be produced during an interactive session when using a receiver virtual instrument. The difference here is that with the Task Manager, the logging is unattended: it starts and ends at a scheduled time, and executes without operator intervention.

To set up a logging job, create a new job and add a task. For the new task, under the **Instrument** tab, you need to specify the **Task type** of Instrument control and select the desired receiver in the **Instrument** field:



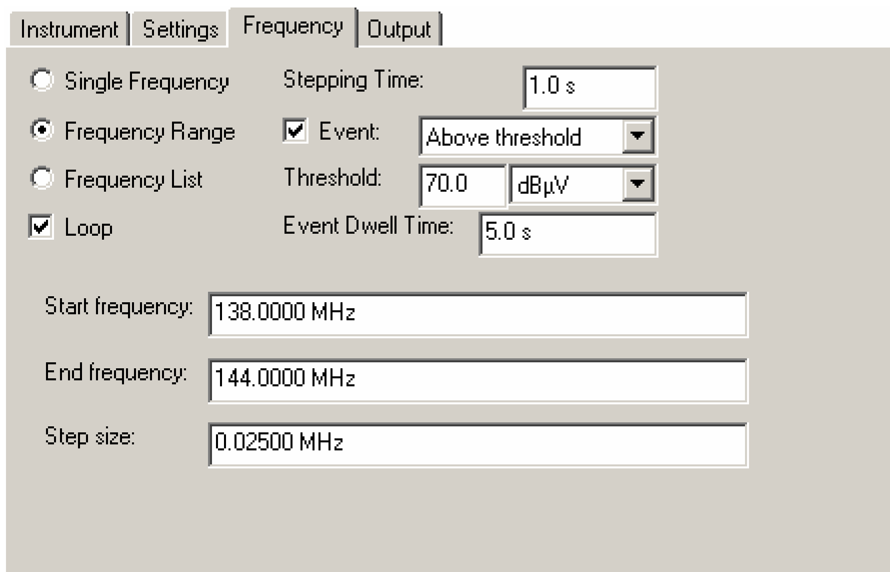
Selecting the Instrument control task type is what ensures that the receiver's measurements will be logged in a human-readable form. This is in contrast with Frequency scan tasks, that produce binary output.

Once the right receiver has been selected, it must be configured. This is accomplished through the **Settings** tab:



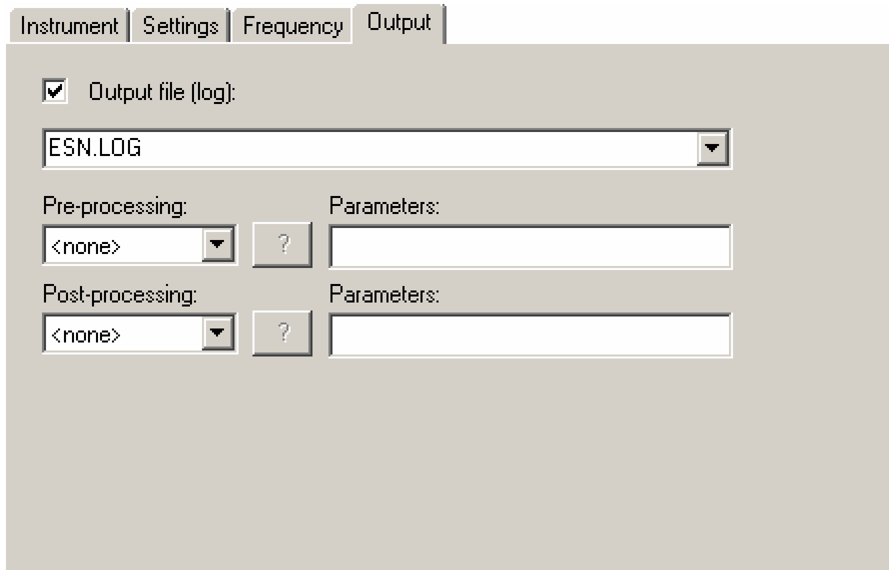
The ESN receiver can measure not just the signal level but its frequency and modulation as well. When the corresponding checkboxes are set, these measurements will also appear in the log file. The remaining settings in the Settings tab control the receiver's behaviour; in particular, leaving the Attenuation at Auto will cause the ISOC software to also get readbacks of the attenuation setting as it obtains measurements, and record any changes in the log file. (That being said, you may prefer to set the **Attenuation** value to a fixed setting, to get more consistent readings and avoid clutter in the log file).

The receiver's frequency is set up through the Frequency tab. This tab must be familiar already: the same interface is used for many different tasks and instruments. In this example, we are configuring the receiver to scan a part of the VHF band. Suppose you wish to search for activity in the VHF Band using a **Frequency Range**:



With these settings, the frequency band between 138 and 144 MHz will be scanned repeatedly, with a **Stepping Time** of 1 second. However, if activity is found on a given frequency (signal level exceeding 70 dBµV), the receiver will pause for 5 seconds, and measurements will be recorded.

Lastly, you need to use the **Output** tab to specify the name of the file that will be used to record measurements. It is not mandatory to specify an output file for Instrument control tasks; in some cases, you may not be interested in the instrument's measurements, you may simply wish to configure the instrument with the correct settings, e.g., when recording audio. In the present example, we do specify a log file:



That is all; just don't forget to submit your modified schedule by clicking the **Submit** button in the toolbar. With these configuration settings and a valid job schedule, the job will run at the appointed time and it will produce a human-readable log file.

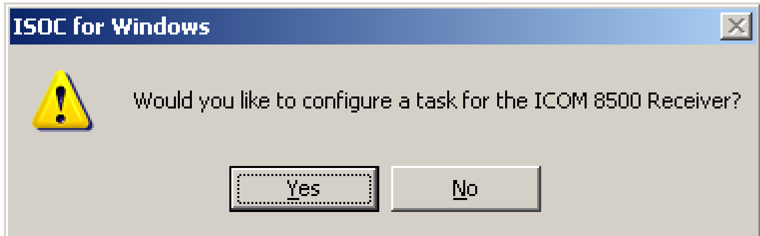
2.3.3.3. Recording with a receiver

Often, what you wish to record is not (or not only) the level, etc. measurements of the receiver, but also the actual audio that was received on a specific frequency. For this, it is necessary to set up a job with two tasks. However, the ISOC Task Manager has some convenience features that make this exercise easier than it would appear at first sight.

For instance, let's say you intend to record audio using an ICOM receiver. To begin, create a new job (Edit menu, **Create a New Job** command), and name it as desired. Make sure you also specify the required schedule and start/stop dates.

Next, add a new task for audio recording. Create a new task (Edit menu, **Add a Task** command). When the new task appears, under the **Instrument** tab, make sure you specify a suitable name, select Audio recording as the Task type, and select the appropriate audio input of the ISOC server. (Which one? Information you receive from the server administrator would help you decide which audio inputs are suitable for which tasks).

Next, select the signal source that corresponds with the ICOM receiver. When you select the signal source, the Task Manager will offer to create a second task, one that will control the receiver itself:



If you click **Yes**, a second task will be automatically created for you.

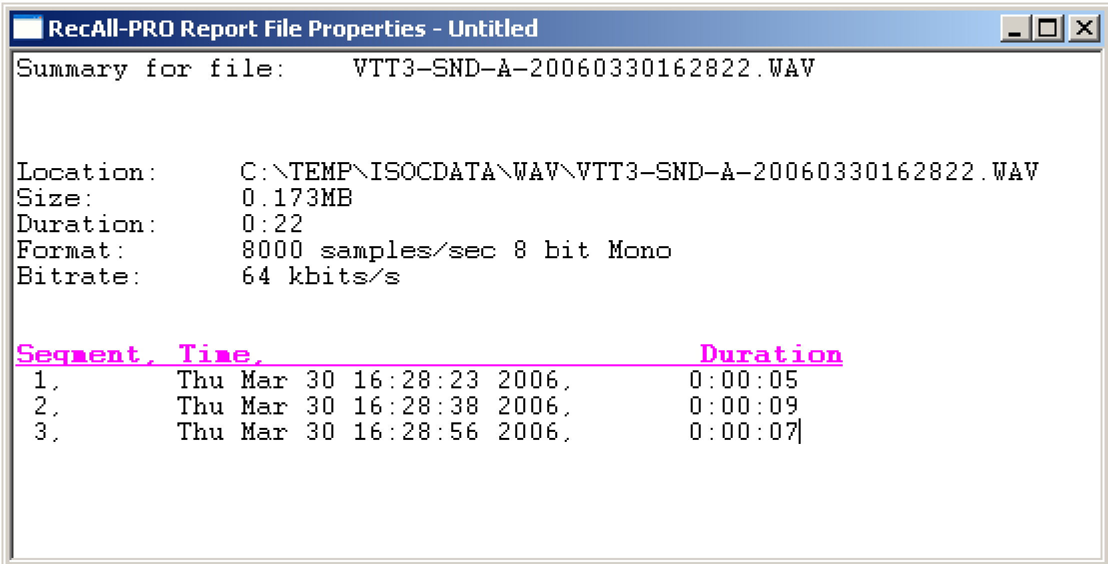
Before you begin editing this new task, it is helpful to finish editing the Audio recording task first. All it needs is an output file name: for this, click the **Output** tab, select either the **MP3** or **WAV** radio buttons to choose the desired audio format, and enter a suitable file name. When this is done, it is time to click on the task created for the ICOM receiver, and make sure that the correct receiver is selected and that it is configured as desired. For the receiver, you probably will not need to specify an output file; not unless you wish to log receiver measurements in addition to the recorded audio. However, in order for the audio recording to be successful, it is very important to set the receiver to the proper bandwidth and demodulation, and of course to the proper frequency.

While an audio recording task runs, it will be shown in the ISOC Task Manager as having a data rate of 8000 bytes per second. This is the sampling rate that the ISOC uses to capture and record telephone quality audio.

When the task is completed, the audio recording will be available as a `.WAV` or `.MP3` format audio file, ready to be played back through standard programs.

You can use one of the squelch options (either RF or audio squelch) if you wish to record only when there is activity (either the RF signal present or there is audio) and avoid recording periods of silence. If you used a squelch function when you set up the audio recording task, it is possible that the recording will be intermittent; periods when the RF signal or audio signal level was below the squelch value would be excluded from the recording. Information about this is stored as part of the header of the recorded audio file.

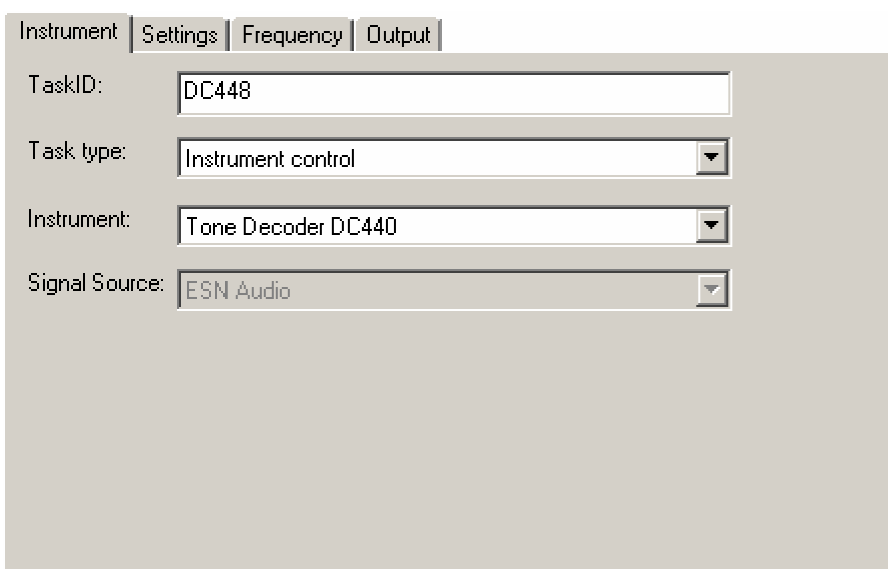
One tool (not part of the ISOC system) that can read this header information is RecAll-PRO by Sagebrush Systems, Inc. When you open an ISOC-generated file using RecAll-PRO and view the file's properties, the segments are displayed in a manner similar to the following:



Note that when a file contains an excessive number of segments (on the order of one thousand or more) tools such as RecAll-PRO may not be able to process the file properly.

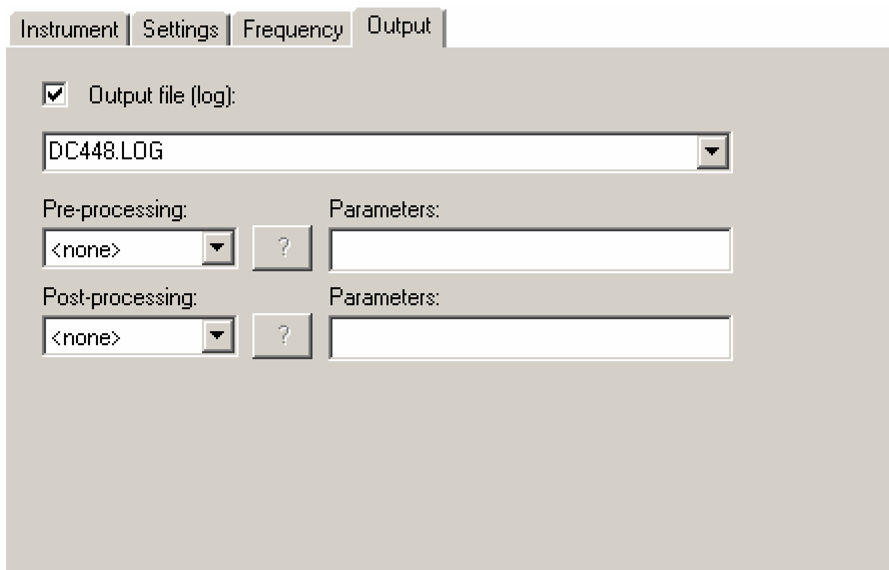
2.3.3.4. Logging with the tone decoder

Another instrument that can be used in conjunction with a receiver, processing the receiver's audio output, is a tone decoder. Readings of a tone decoder are recorded in a human-readable log file. To use a tone decoder, you need to create a job first and add a receiver (or some other instrument that produces an audio signal to decode). Then, add an Instrument control task and specify a tone decoder device:



In this example, the tone decoder is hardwired to the audio output of the ESN receiver. In your configuration, it may be necessary to manually select the appropriate signal source.

A tone decoder is a passive device: it has no configuration settings and (obviously) no frequency setting either. However, you do need to specify the output file where the tone decoder's measurements are logged.

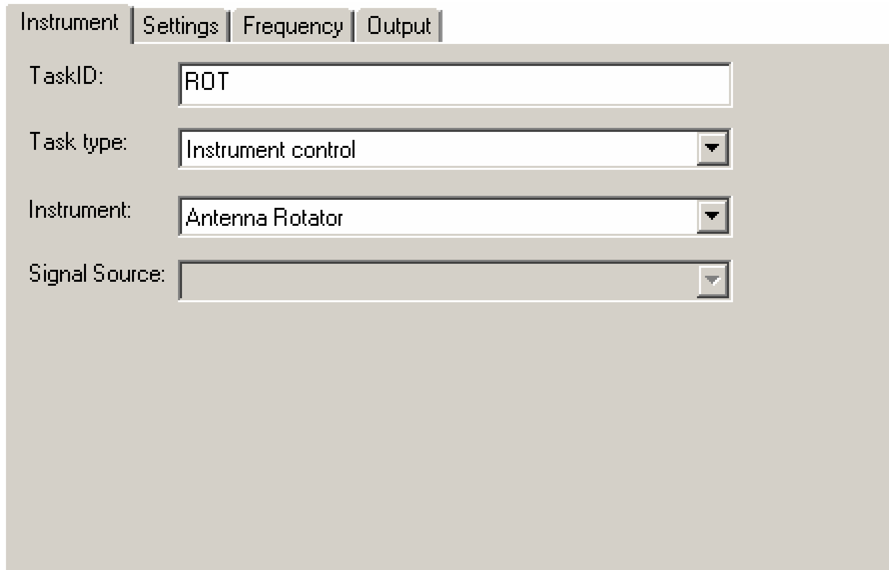


2.3.3.5. Using the antenna rotator

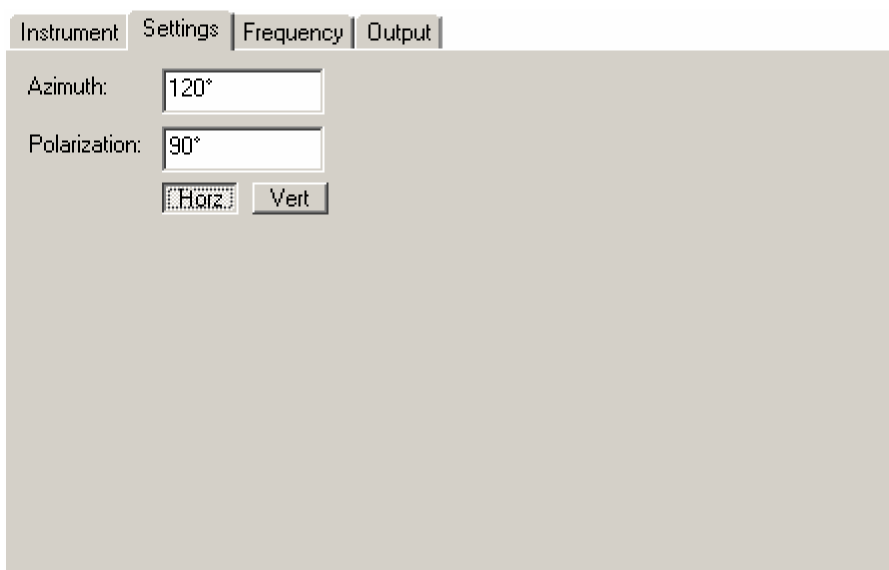
The antenna rotator device can also be used for scheduled jobs. It may be needed when, for instance, a scheduled measurement requires that the antenna rotator be configured to a particular azimuth and polarization setting.

If you configure a new job and a task with a receiver, and select a signal source for the receiver that is associated with the antenna rotator, the ISOC Task Manager automatically offers to set up a task for the antenna rotator. (Signal sources are associated with instruments by the ISOC server administrator when the server site is configured). You may also add a task for the antenna rotator manually.

The antenna rotator task is another Instrument control task, for which you specify the antenna rotator device as the instrument to use. An antenna rotator requires no signal source; it has no inputs:



The antenna rotator must be configured to a specific azimuth and polarization setting through the Settings tab. In this tab, two buttons (**Horz** and **Vert**) provide convenient shortcuts for 90° and 0° polarization:



An antenna rotator has no frequency settings, and it produces no output.

2.3.3.6. Using a signal generator

Signal generators have many uses in the ISOC; one such use is to utilize a signal generator in conjunction with a test antenna to verify that a frequency scan produced a complete and uncorrupted result.

More specifically, sometimes the ISOC Task Manager is used to perform occupancy testing. In these tests, the receiver repeatedly scans a set of frequencies and records the signal level. Afterwards, additional programs (not part of the ISOC suite) can be used to determine the occupancy of a channel: i.e., the percentage of time when a signal was present on that channel, as a function of the total duration of the test.

To verify the results of this testing, sometimes it is beneficial to have the signal generator output a signal on a known frequency, which is then routed to a (transmitting) test antenna. The frequency of this test signal is one of the frequencies that the receiver is instructed to test. As the signal generator is operating continuously, the occupancy at that frequency should always be 100%; this is an easy way to verify that the task did not produce corrupted or nonsensical results.

The best way to set up an occupancy test with the signal generator is through the use of an `.SST` file. This file format allows you to specify a test frequency, which is then recognized by other programs that process the output of a frequency scan task.

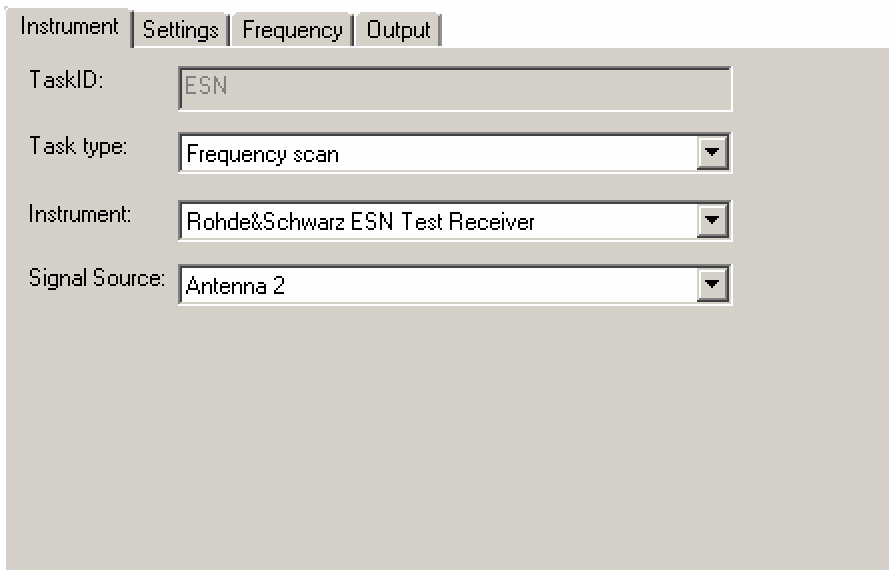
As a specific example, consider a frequency scanning task that scans the 40 channels of the GRS band. To use the SMH, you would need one additional frequency on which no signal is present at your location. You would then set the SMH to this frequency and connect its output to a test antenna. The list of frequencies to be scanned would include all 40 GRS frequencies plus this additional test frequency. In effect, the SMH would operate as a low power transmitter in close vicinity of the ESN receiver.

To set up such a task, you first need an `.SST` format file that contains the 40 GRS frequencies plus the additional test frequency. The file may look similar to the following:

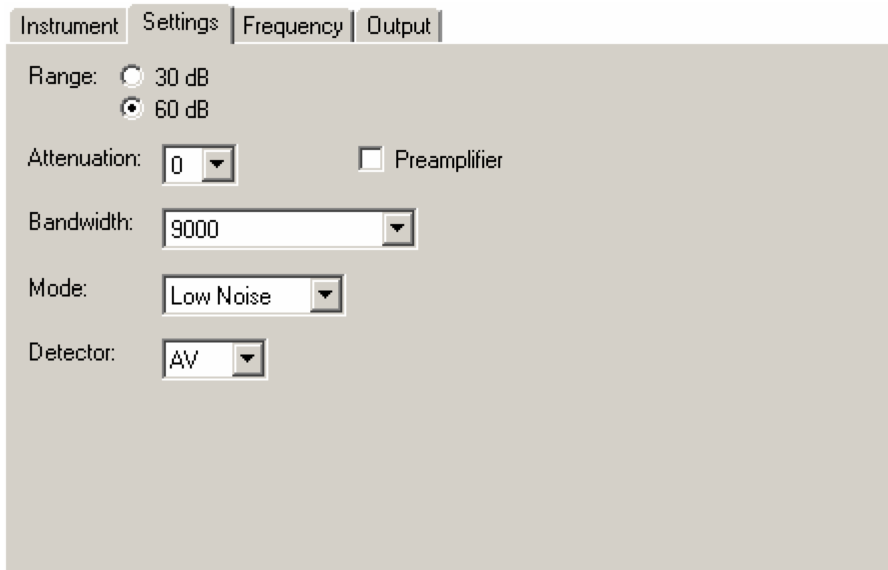
```
CBFREQS 0120060321Test file for CB       ISOC-HQ
T 26.500 0 1 0
  26.965 0 1 0
  26.975 0 1 0
  26.985 0 1 0
  27.005 0 1 0

...

  27.375 0 1 0
  27.385 0 1 0
  27.395 0 1 0
  27.405 0 1 0
```

Before you can utilize this file, it has to be transferred to the ISOC server. One way to transfer it is through the file upload facility built into the ISOC Task Manager. Select the *Upload* command in the ISOC Task Manager's *Server* menu to initiate the upload, and use the file selection dialog that appears to locate the file. The file must have the `.SST` extension (e.g., `CBT.SST`) in order to work properly on the server.

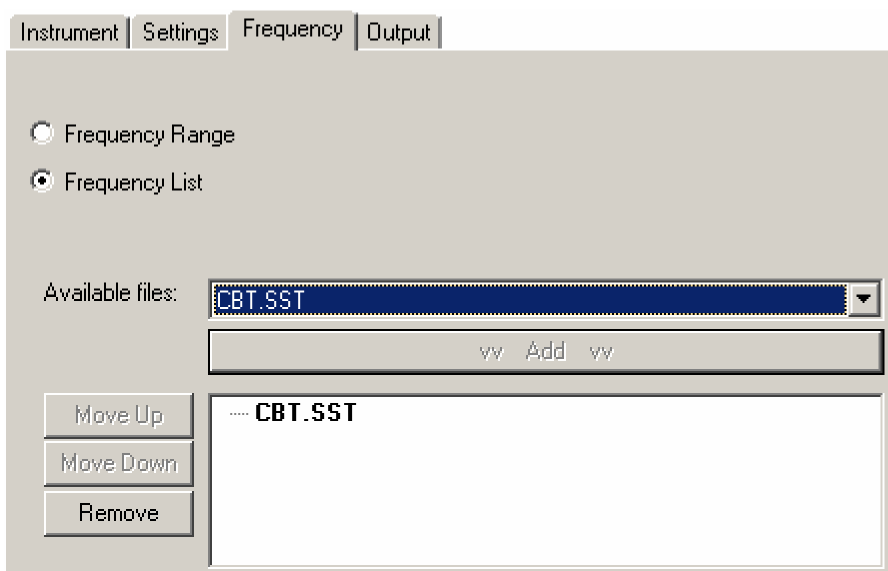
Once the file has been transferred, you can begin setting up the job. Create a new job in the ISOC Task Manager (*Edit* menu, *Create a New Job* command) and give it a suitable JobID. The **Task type** shall be Frequency scan, the **Instrument** the ESN receiver. Select the correct signal source (hint: it is not the SMH signal generator; the generator's signal will go out over the air through the test antenna):



Under the **Settings** tab, make sure the receiver is configured as appropriate for GRS reception. The settings should be self-explanatory:

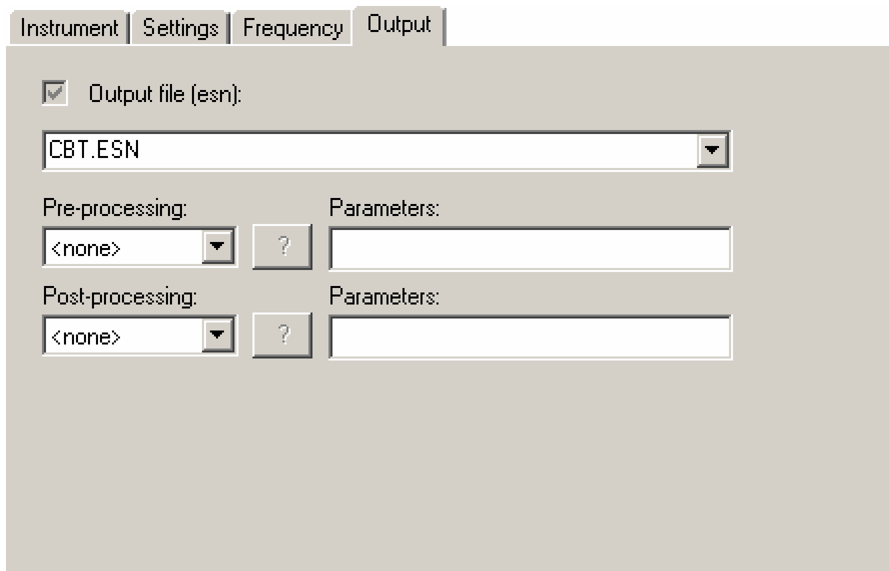


Under the **Frequency** tab, you need to select the `.SST` file that you just created. To do so, make sure that the **Frequency List** radio button is checked, locate the file in the **Available files** field, and click the **vv Add vv** button:

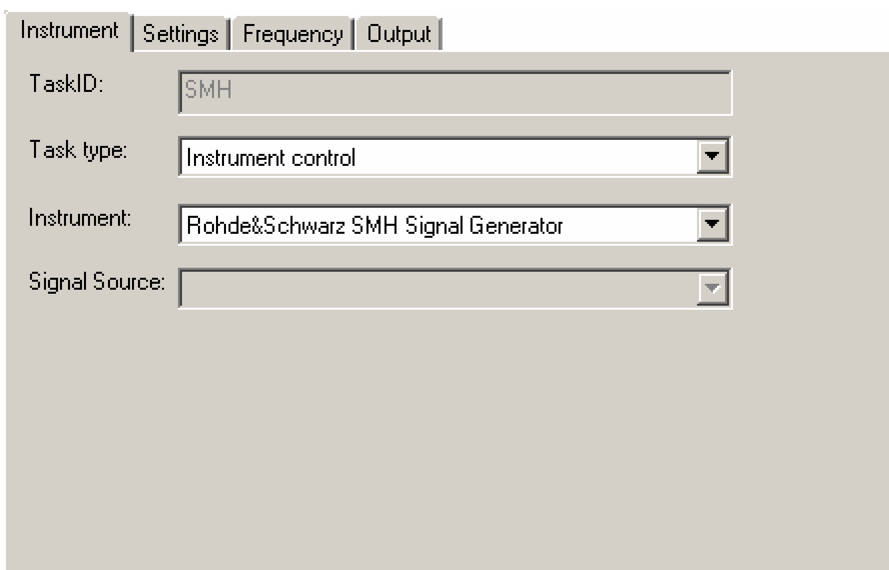


> **Tip:** The ISOC Task Manager acquires the list of available files from the ISOC server when you connect to that server, or when you click the **Reload** button in the toolbar. This means that if you just uploaded a file, it may not be visible in the list of available files until you click Reload. To avoid having to submit an incomplete schedule or discard your changes, upload your files and click **Reload** first before you begin adding or editing jobs or tasks.

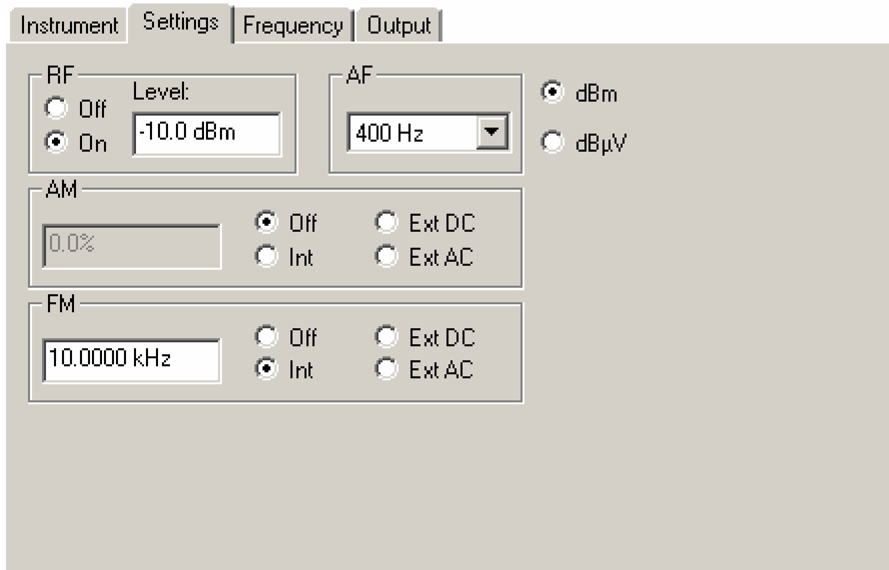
Naturally, you should also select a suitable output file under the **Output** tab, in order to record your measurements. With that done, the configuration of the ESN receiver is complete:



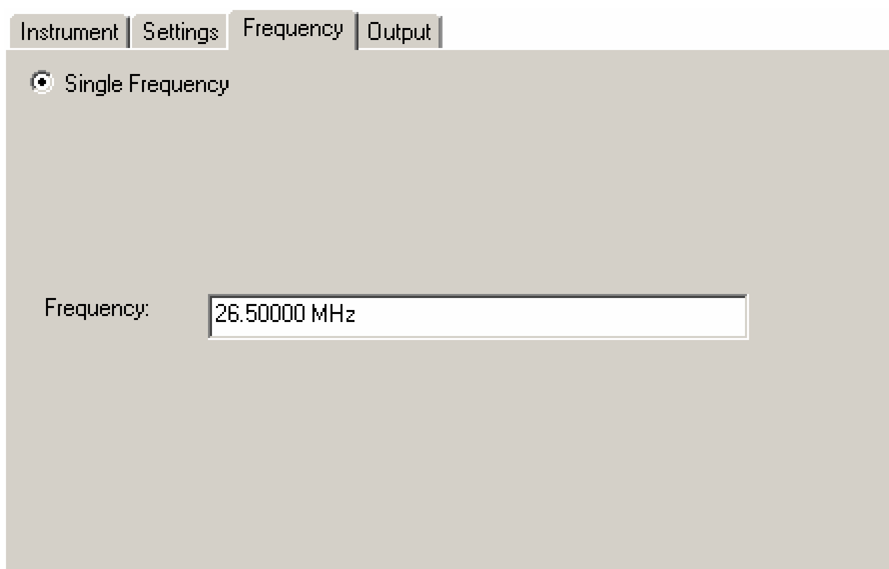
Next, you need to configure the SMH signal generator. To do so, create a new task under the current job. Make it an instrument control task, and select the SMH signal generator as the instrument to use:



Now you can move on to the **Settings** tab and configure the SMH signal generator. Ensure that the signal level is sufficient, and if necessary, set up AM or FM modulation:



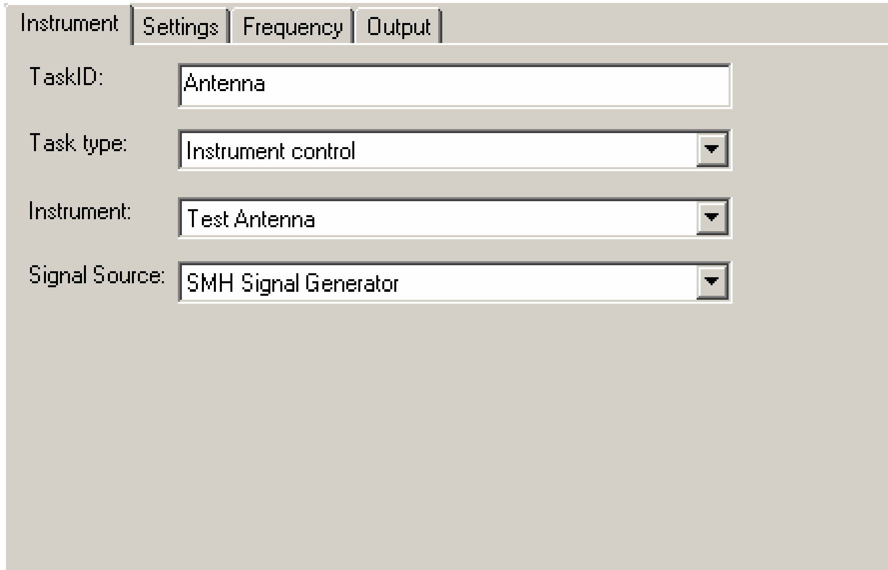
When you're done with the **Settings** tab, use the **Frequency** tab to set the signal generator to the test frequency that you specified in your `.SST` file (26.5 MHz in our current example):



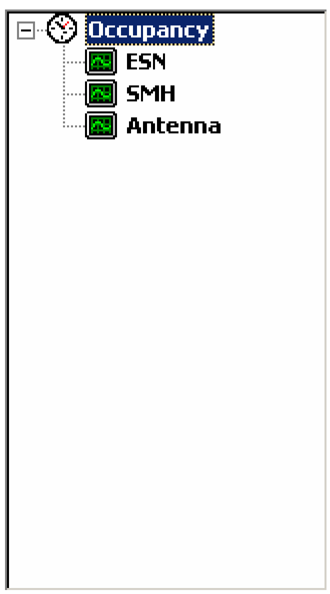
As the signal generator produces no output, its configuration is complete.

We are not quite done yet! Unless your signal generator is permanently connected (hardwired) to a test antenna, it is necessary to configure a task for the test antenna to ensure that for the duration of this job, the antenna is connected to the signal generator's output. Create a new task, make it an instrument control task, and select the test antenna as the instrument to use.

Then make sure that the SMH signal generator's output is the antenna's signal source:



As the test antenna has no settings, the configuration of the new job is now complete. As a reminder, the job should contain three tasks: one for the ESN receiver, one for the SMH signal generator, and one for the test antenna:

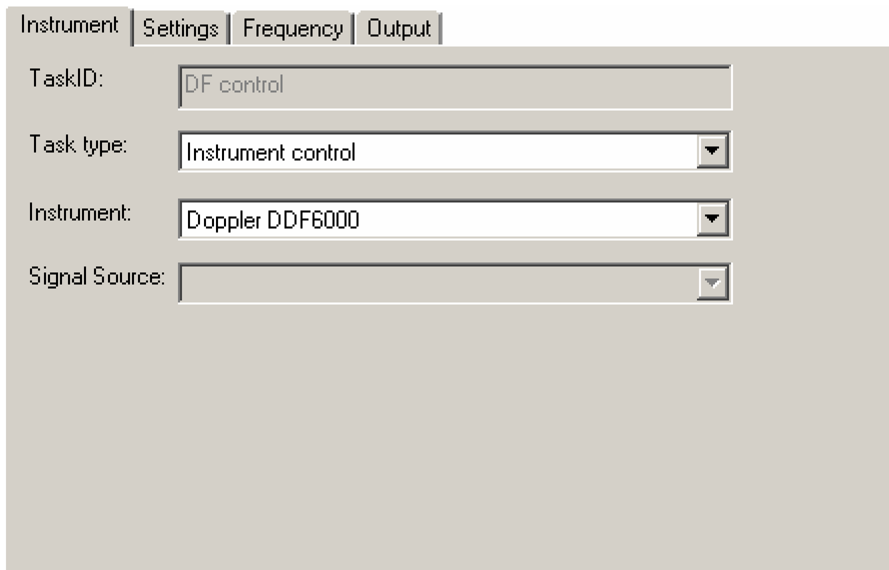


When this task is executed, it should produce an .ESN format output file that shows 100% occupancy for the test frequency, and occupancy values between 0% and 100% for the other 40 GRS channel frequencies.

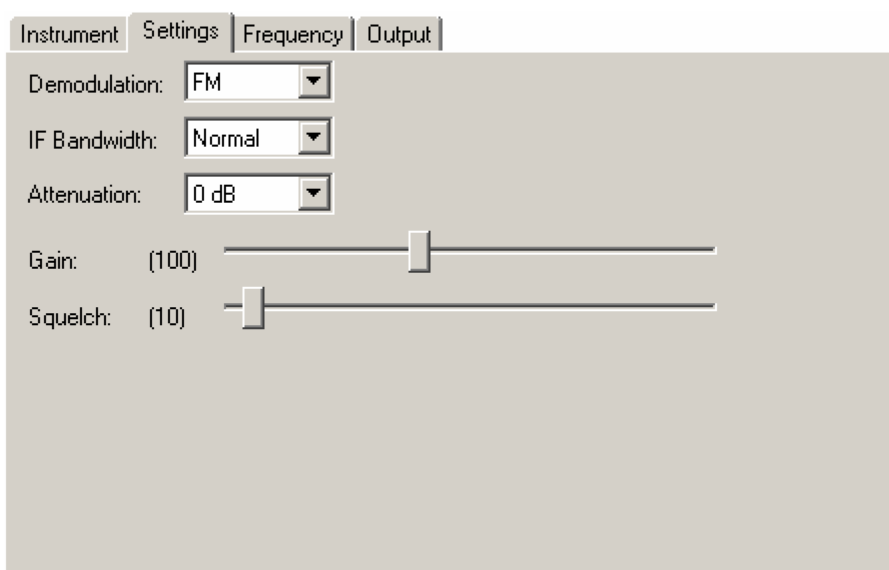
2.3.3.7. Scheduled direction finding tasks

It is also possible to use the ISOC Task Manager to schedule direction finding tasks. Such a task can be used to perform scheduled measurements of the bearing towards a signal of interest.

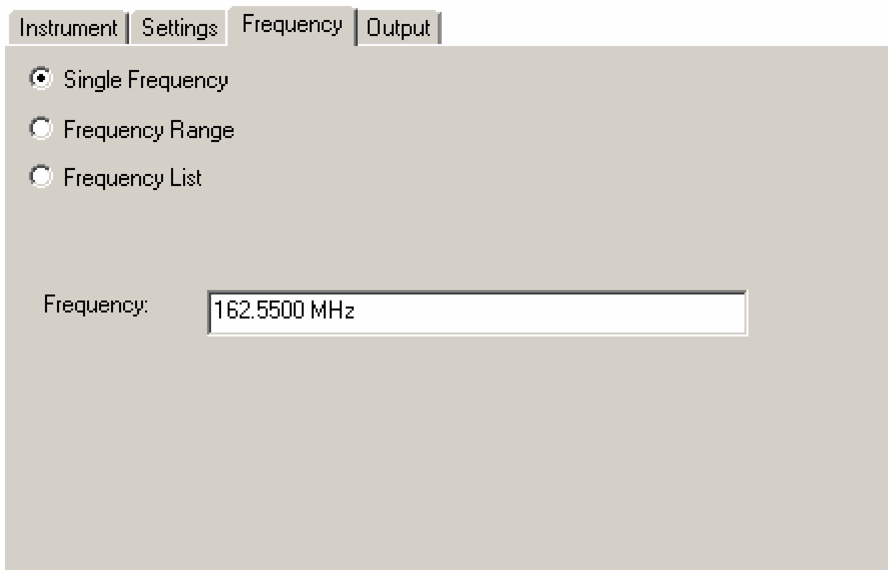
To set up a direction finding task, create a job and add a new task, the type of which should be Instrument control. Select the DF processor as the instrument to use:



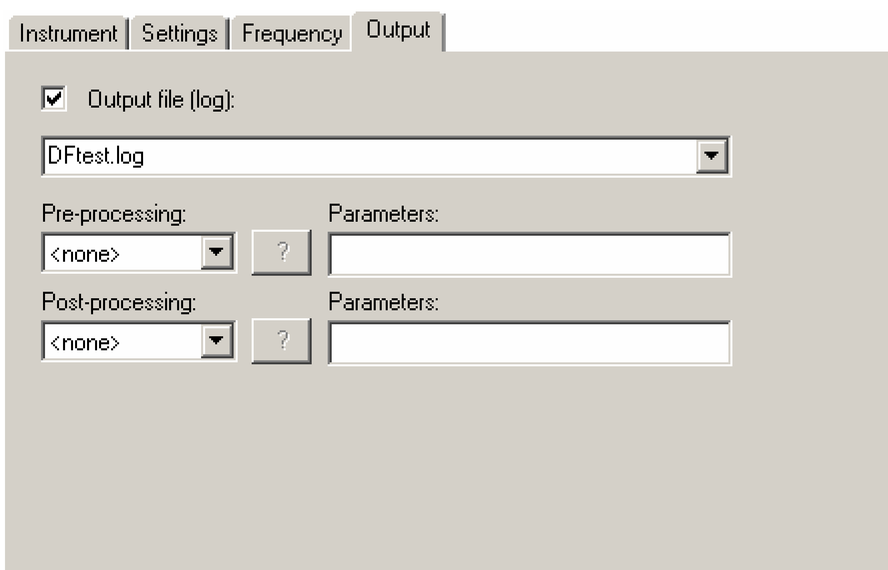
The settings of the DF tasks are used to configure the receiver functions of the DF processor. These configuration options are under the **Settings** tab:



Next, it is important to specify the receiver frequency. For instance, if you wish to monitor the bearing of a single station, you would specify a single frequency here, under the **Frequency** tab:



Lastly, you need to use the **Output** tab to specify the name of the file where DF measurements will be logged:



3. Reference

3.1. Application Reference

The main programs in the ISOC suite visible to the end user are

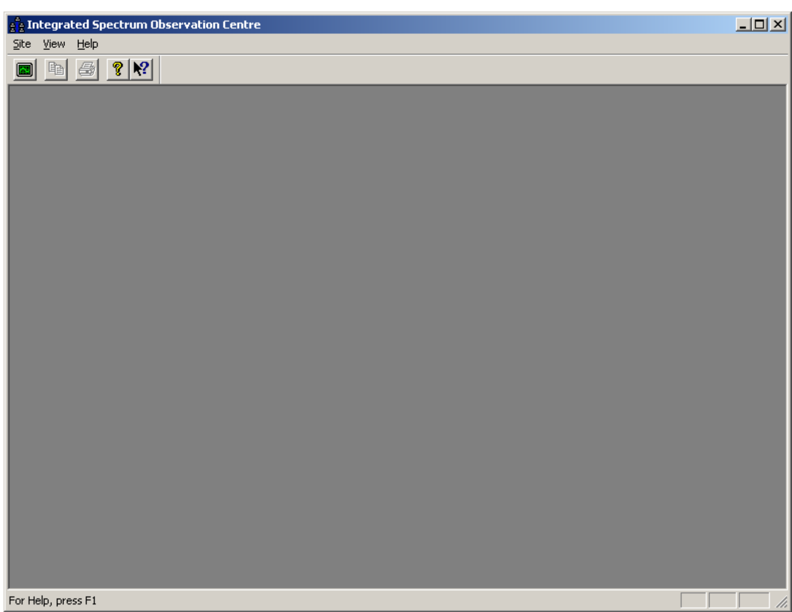
- *ISOC for Windows* (`ISOCNT.EXE`), the main interactive application that provides virtual instrument interfaces for controlling physical instruments;
- *ISOC Task Manager* (`ISOCCRON.EXE`), the scheduling application that can be used to set up unattended tasks to run on an ISOC server; and
- *ISOC - DF* (`ISOCDF.EXE`), the direction finding application.

3.1.1. ISOC for Windows: the interactive application

ISOC for Windows is the main interactive application of the ISOC suite. It has the ability to connect to ISOC servers, obtain instrument lists, and connect to individual instruments through a virtual instrument interface.

3.1.1.1. Application window

The main ISOC for Windows application window is a standard MDI window. With no virtual instruments open, only the window frame, default menu, button bar, and status bar are visible:



3.1.1.1.1. Window frame elements

The three elements of the main ISOC for Windows application window frame are the menu bar, button bar, and status bar.

The menu bar offers different choices depending on whether any virtual instruments are open or not. The menu commands that are available initially are:

Site	Menu title for commands related to connecting or managing ISOC sites.
Connect…	Invokes the Servers window to connect to a site.
Load Workspace…	Loads a previously saved workspace of virtual instruments.
ISOC Task Manager…	Starts the ISOC Task Manager.
Print Setup…	Invokes the standard Windows Print Setup dialog.
Exit	Exits this application.
View	Menu title for commands related to the appearance of the application.
Toolbar	Turns on/off the toolbar (button bar).
Status Bar	Turns on/off the status bar (notification area) at the bottom.
Print/Export Traces in Color	When this option is selected, traces will be printed in color, and clipboard exports in metafile format will also be in color.
Options…	Provides a means to change various application options.
Language…	Provides a means to change the application language.
Help	Help commands.
Help Topics	Opens the Help table of contents for the application.
About ISOC	Provides application version information.

The menu changes when at least one virtual instrument is open. The new menu options are as follows:

Site	Menu title for commands related to connecting or managing ISOC sites.
Connect…	Invokes the Servers window to connect to a site.
Save Workspace…	Saves the currently open set of virtual instruments and their settings in a workspace file.
Close	Closes the active virtual instrument window
ISOC Task Manager…	Starts the ISOC Task Manager.
Print	Prints the trace of the active virtual instrument.
Print Setup…	Invokes the standard Windows Print Setup dialog.
Exit	Exits this application, closing all virtual instruments.

Edit	Clipboard-related commands.
Copy	Copy the trace of the active virtual instrument to the clipboard.
View	Menu title for commands related to the appearance of the application.
Toolbar	Turns on/off the toolbar (button bar).
Status Bar	Turns on/off the status bar (notification area) at the bottom.
Print/Export Traces in Color	When this option is selected, traces will be printed in color, and clipboard exports in metafile format will also be in color.
Options…	Provides a means to change various application options.
Language…	Provides a means to change the application language.
Window	Commands related to window placement and positioning.
Cascade	Arrange virtual instrument windows in a cascading pattern.
Tile	Arrange virtual instrument windows in a tiled fashion.
Restore Size	Restore a maximized or minimized virtual instrument window to its normal size.
Arrange Icons	Arrange the position of minimized windows.
Save Settings on Exit	Causes window positions and arrangements to be saved to the Registry when closing virtual instruments.
Save Settings Now!	Save the window position and arrangement of the active virtual instrument to the Registry.
n <window name>	List of open virtual instrument windows.
Help	Help commands.
Help Topics	Opens the Help table of contents for the application.
About ISOC	Provides application version information.

The button bar provides quick access to some of the main functions of the application. Five buttons are available:

The **New** button ( ) can be used to invoke the ISOC Servers dialog in order to make a connection to a new instrument.

The **Copy** button ( ) is available for virtual instruments that display a graphical trace, and can be used to copy the trace to the Windows clipboard.

The **Print** button ( ) is also available for virtual instruments that display a graphical trace, and can be used to print the trace.

The **About** button ( ) displays application copyright and version information.

The **Help** button (?) invokes context-sensitive help. Note that as the ISOC is still an evolving application, the availability of context-sensitive help is limited.

The button bar can be moved about, positioned as a floating window, or attached to any of the four edges of the ISOC for Windows application window. It can also be removed altogether using the **Toolbar** command from the View menu.

The status bar at the bottom of the ISOC for Windows application displays helpful hints and application status information. It, too, can be removed by selecting the **Status Bar** command from the View menu.

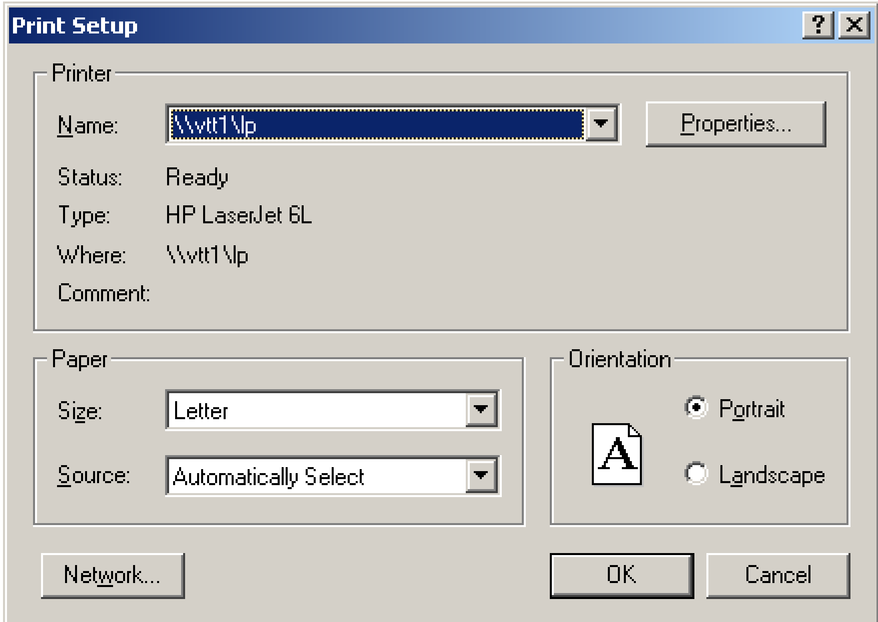
3.1.1.1.2. Standard Windows functions

Some of the functions of the ISOC for Windows application are carried out by standard Windows components.

3.1.1.1.2.1. Printing and print setup

The ISOC for Windows application provides the ability to print a graphical trace. To select the printer on which to print, and configure this printer with the desired options, use the **Print Setup…** command from the Site menu.

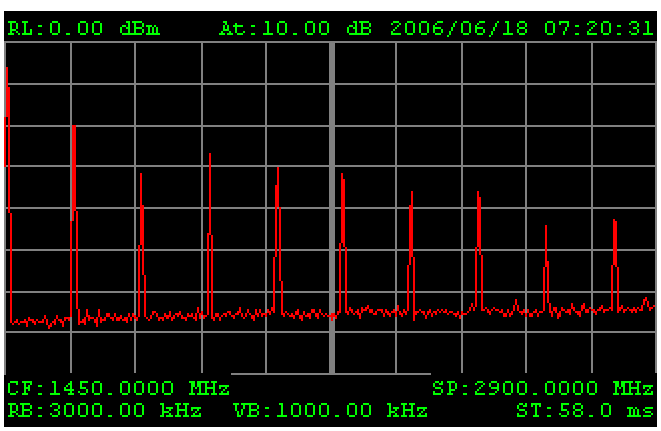
This command displays the standard Windows Print Setup dialog. The actual appearance of this window may differ slightly depending on the Windows version in use, but its functionality remains the same: through this window, you can select one of the installed printers on your computer, choose the desired paper source, size, and orientation. Advanced options for printer setup and networking may also be available:



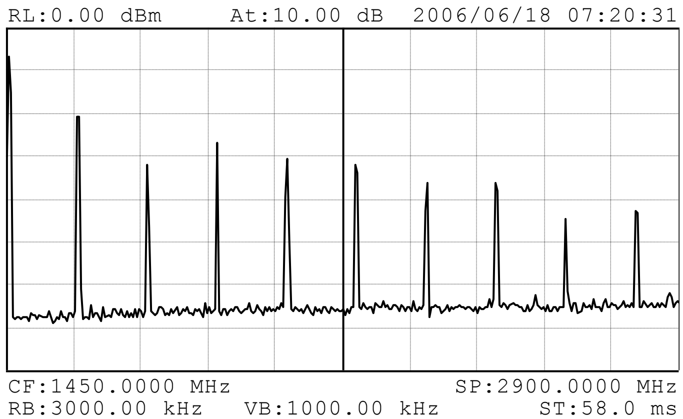
3.1.1.1.2.2. The clipboard

The ISOC provides limited support for the Windows clipboard. Text can be copied from, or pasted into, most text fields.

Furthermore, the graphical trace that is present in many virtual instruments can be copied to the clipboard and pasted into other applications. The ISOC provides two formats for the graphical trace. First, a colour bitmap format suitable for creating, for instance, images for inclusion in a Web page:



The second format is a line art format (Windows metafile format) suitable for use in drawing applications such as Microsoft Visio or CorelDraw:



The line art export can be color or monochrome depending on the state of the *Print/Export Traces in Color* setting in the *View* menu.

Both formats include, in addition to the trace, any text decorations that presently appear in the trace display. Most virtual instruments allow you to configure which text elements should be present.

3.1.1.1.2.3. Managing windows

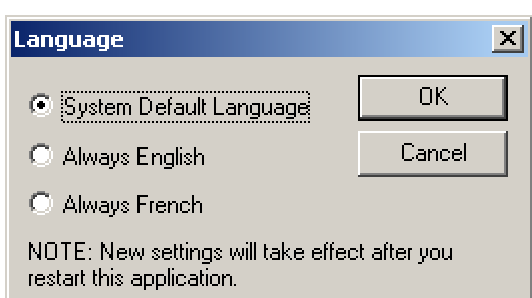
The **Cascade**, **Tile**, **Restore Size** and **Arrange Icons** commands in the Window menu are all standard Windows functions common to many applications.

3.1.1.1.2.4. Help

Windows-style context-sensitive help exists for many ISOC components. However, as the ISOC is still an evolving project, Help contents are often missing or incomplete.

3.1.1.2. Language selection

The ISOC is a fully bilingual application. All user interface elements are available in both English and French. Language selection is accomplished by selecting the **Language…** command from the View menu:



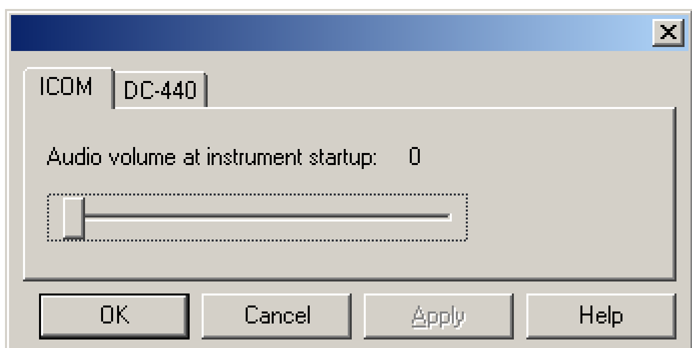
The default behaviour for the ISOC is to use the language in which the operating system was installed (**System Default Language** option). If the language of the Windows installation is a language other than English or French, the ISOC defaults to the English-language user interface.

As it is not possible to reload user interface components that are in use, the effects of language selection are deferred until the next time the application starts.

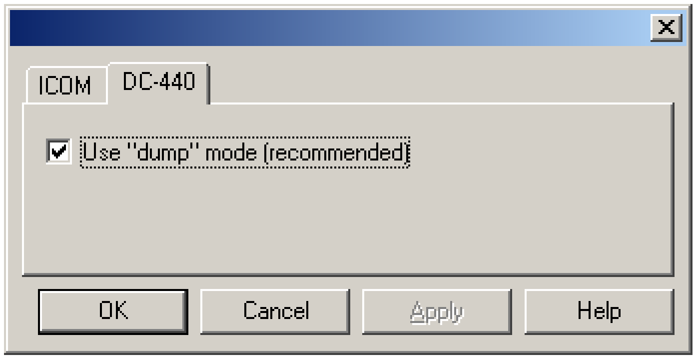
The language selection setting of the ISOC is global; it affects all ISOC components. The ISOC language setting can be made from any of the three main ISOC applications: ISOC for Windows, ISOC Task Manager, or ISOC DF.

3.1.1.3. Options

The ISOC for Windows application provides an Options dialog where miscellaneous settings specific to instrument families can be set. Presently, such settings are defined for two instrument types. For ICOM instruments, the initial audio volume can be specified:

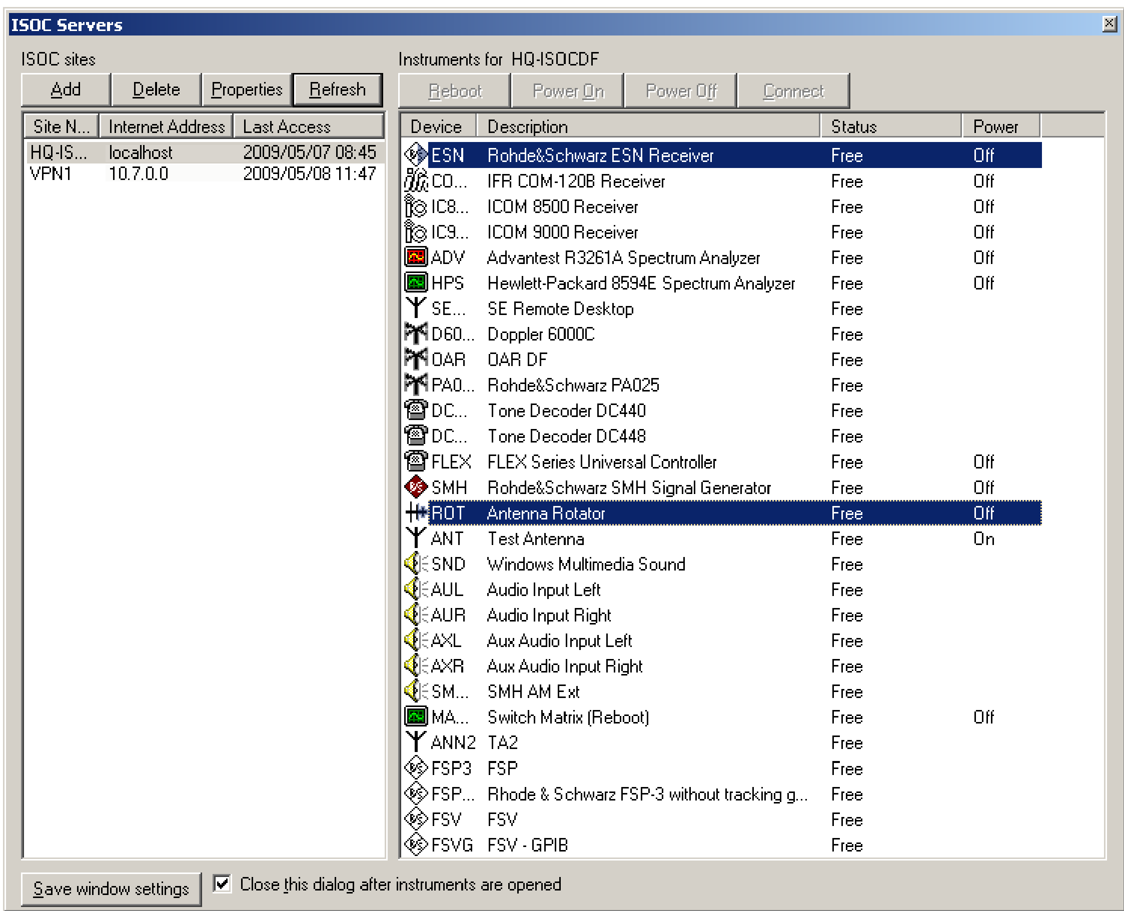


For DC-440 tone decoders, the operating mode of the decoder can be set. The "dump" mode, in which the decoder continuously reports readings to the ISOC computer without the need to query the instrument, is the recommended operating mode; however, if this mode fails to work as expected, it is possible to fall back to the old (query-response type) mode of operation:

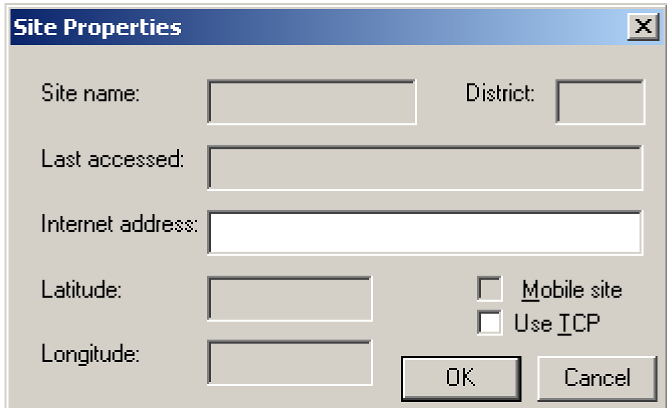


3.1.1.4. Connecting to a site

To operate a virtual instrument, it is first necessary to connect to an ISOC server site. This is accomplished by selecting the **Connect…** command from the Site menu:

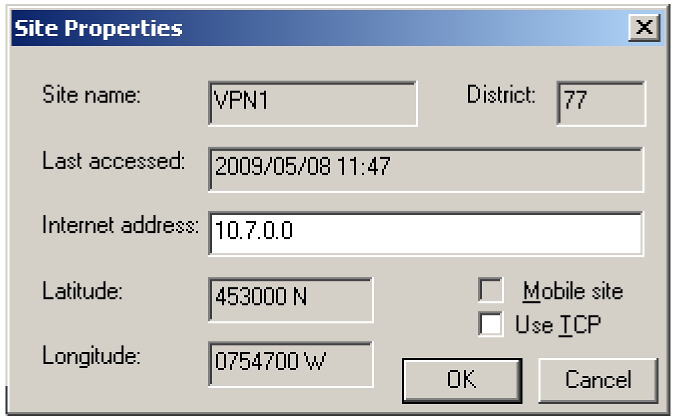


Before the right hand side of this dialog can be populated with instruments, the Internet address of one or more ISOC servers must be specified. This is accomplished by clicking the Add button on the left hand side, which brings up the Site Properties dialog:



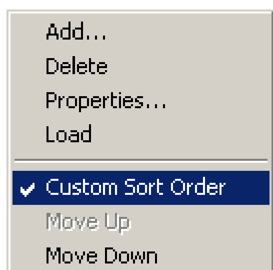
This dialog contains one mandatory field: the **Internet address** field, which must be populated with either the symbolic or the numeric IP address of the desired server (e.g., `server1.isoc.gc.ca`, `127.0.0.1`, or `server1.local`). The user can also click the **Use TCP** checkbox, which controls how the ISOC client program communicates with the ISOC server. The default, when this checkbox is unchecked, is to use a TCP socket for instrument commanding, but use UDP datagrams for audio data, graphical traces, and other repetitive updates. While this method of communication worked well in the past, the increasingly widespread use of network firewalls and network address translation made it necessary to implement an alternative. When the **Use TCP** checkbox is checked, the ISOC client uses a different method of communication: all communication takes place via TCP sockets, and all TCP sockets are initiated from the client site. This way, significantly improved compatibility with network firewalls is achieved.

Other fields in the Site Properties dialog are inactive when a server is set up for the first time. However, this dialog can be invoked later, by selecting a site in the ISOC Servers dialog and clicking the **Properties** button. For servers to which a successful connection has been established already in the past, all fields will be populated:



Some of the information shown in the Site Properties dialog also appears in tabular form on the left hand side of the ISOC Servers dialog.

The list of sites in the ISOC Servers dialog can be sorted by clicking the appropriate column heading. A custom sort feature is also available and can be invoked by right-clicking the list, which activates the following popup menu:

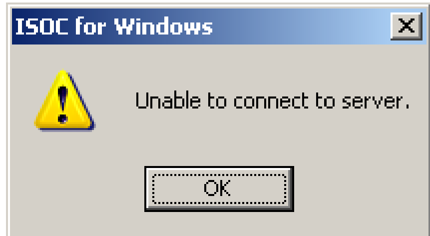


In addition to the same commands that can also be accessed by clicking the appropriate button (namely, **Add**, **Delete**, **Properties**, and **Load**), the menu also lets you specify a Custom Sort Order, which can be altered by right clicking a site name and using the **Move Up** and **Move Down** commands.

A site that is no longer required to be present in this list can be removed using the **Delete** command.

The list of sites and the selected search order are saved automatically in the Registry when a successful connection is made to a server.

In order to populate this dialog with a list of instruments, click the **Load** button. After a few seconds (may take several seconds over a slow network connection) the list of available instruments on the selected server will appear. The label of the Load button also changes to **Refresh**, indicating that the list of instruments has already been loaded for this site. In case of an error (e.g., when the ISOC application is unable to establish a connection to the server, because a network error) an appropriate error message will be displayed:



In case of some network errors, a long time (30 seconds or more) may elapse before the error message appears.

After a connection to a server has been successfully made, the server's ISOC name also appears to the right of the **ISOC Server Name** field.

The list of available instruments consists of five columns, some of which may be hidden:

Device	The unique instrument identifier, set up by the administrator of the ISOC server site.
Type	The instrument type, as known internally to the ISOC software.
Description	A brief description of the instrument, as set up by the administrator of the ISOC server site. May appear in English or French depending on your language setting.
Status	The current status of the instrument. Free indicates the instrument is available; otherwise, the DNS name or IP address of the computer presently using that instrument is listed here.
Power	The power state of the instrument. The words On or Off have obvious meaning; the field may also contain blinking text indicating that an instrument is powering up (power has been applied but the instrument is still initializing) or powering down (instrument is no longer in use and will be powered down after a set period of time.

The instrument list allows you to select one or more instruments simultaneously. To select multiple instruments, press and hold down the Ctrl key on the keyboard while making the selection with the mouse. Selected instruments are highlighted in the list. The power control buttons and the **Connect** button on the right apply to all selected instruments.

Instrument power is controlled by the **Reboot**, **Power On**, and **Power Off** buttons. Power On and Power Off take effect immediately; in particular, **Power Off** overrides any pending power-down of the instrument. The Reboot button turns power off temporarily to an instrument, turning power back on after a few seconds of delay.

After power has been successfully turned on or off, a message is displayed informing you of this fact:

To connect to an instrument or a set of instruments, first select the desired instruments in the instrument list and click the **Connect** button. The ISOC software will then connect to each of the selected instruments in sequence, opening the corresponding virtual instrument windows as appropriate.

> **Tip:** It is recommended that you only use the feature to connect to multiple instruments simultaneously with servers with which you are familiar, and which are known to work reliably.

The **Close this dialog after instruments are opened** checkbox determines whether or not the ISOC Servers dialog is closed after a successful connection is made when you click the Connect button. In some cases, you may prefer to keep this dialog (which appears as a floating window, allowing you to view the list of virtual instruments at all times) open.

The **Save window settings** button can be used to save the current size, position, and column settings of the ISOC Servers dialog.

3.1.1.5. Using an instrument

As soon as you make a connection to an instrument and the corresponding virtual instrument appears in the ISOC for Windows application window, it can be used for interactive operation. Meanwhile, you may also use the ISOC Servers dialog to connect to additional instruments. More significantly, you may also connect to *another* ISOC site and use instruments there. In other words, the ISOC for Windows program allows you to utilize multiple instruments simultaneously, even if they are not collocated and are not controlled by the same ISOC server.

3.1.1.6. Power control

Some ISOC instruments are connected to a remote control power bar. The power state of these instruments can be managed using the **Power On**, **Power**

Off, and **Reboot** buttons in the ISOC Servers window. The power state of these instruments is shown in the Power column of the instrument list in the ISOC Servers window.

When you try to connect to an instrument that is not powered up, the ISOC applies power to that instrument. However, some instruments are not immediately usable after power has been applied. In this case, the following message is displayed:

The amount of time it takes for an instrument to power up is defined by the ISOC server administrator who configures instruments.

Similarly, the server administrator may also define a power-down time for each instrument. If an instrument is idle for this period of time, it is powered down automatically. If at any time during the power-down time period another connection is made to that instrument, the power-down is cancelled.

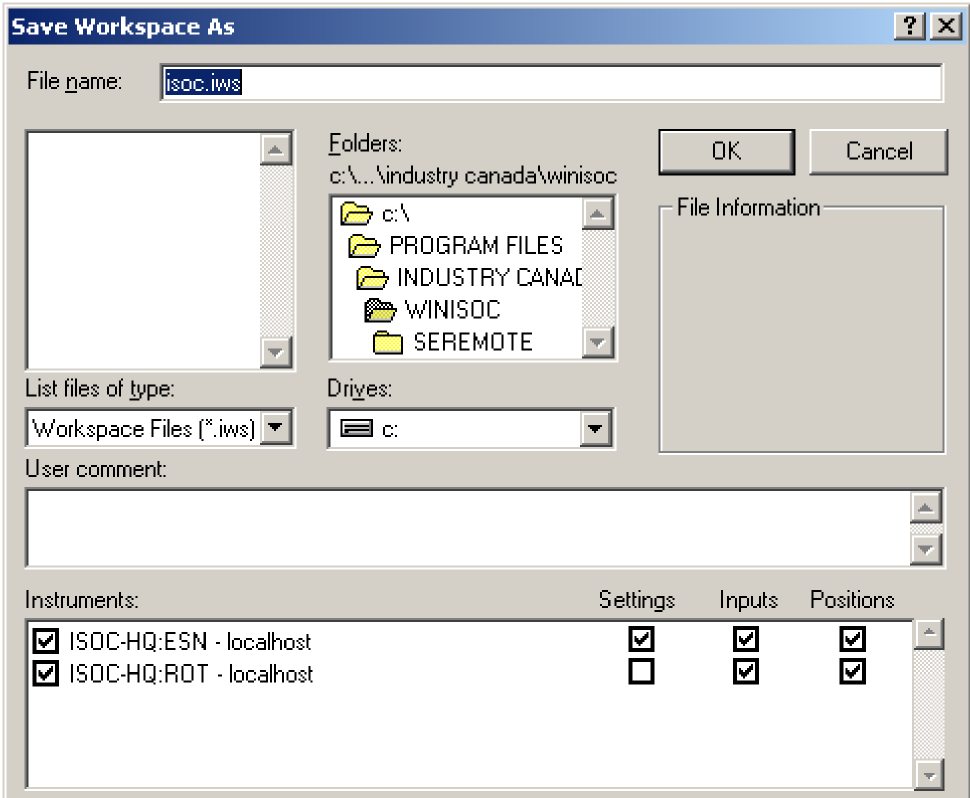
3.1.1.7. Saving a workspace

A powerful feature of the ISOC is its ability to save a set of virtual instruments in a file that is called a workspace file.

The workspace file contains information about each selected instrument. This includes the current settings of the instrument, the window size, position, and panel arrangement of the virtual instrument, and any switch matrix selections related to that instrument.

To save a workspace, select the **Save Workspace…** command from the Site menu. Needless to say, this command is only available if at least one virtual instrument is open; otherwise, you'd be saving an empty workspace.

The **Save Workspace…** command invokes the Save Workspace As dialog:



The upper portion of this dialog is a variation of the standard Windows Save As… dialog, containing standard fields like **File name**, **Folders**, **List files of type**, and **Drives**. These fields can be used to navigate the file system on the computer, select a folder, select an existing file, or enter the name of a new file in which the workspace will be saved.

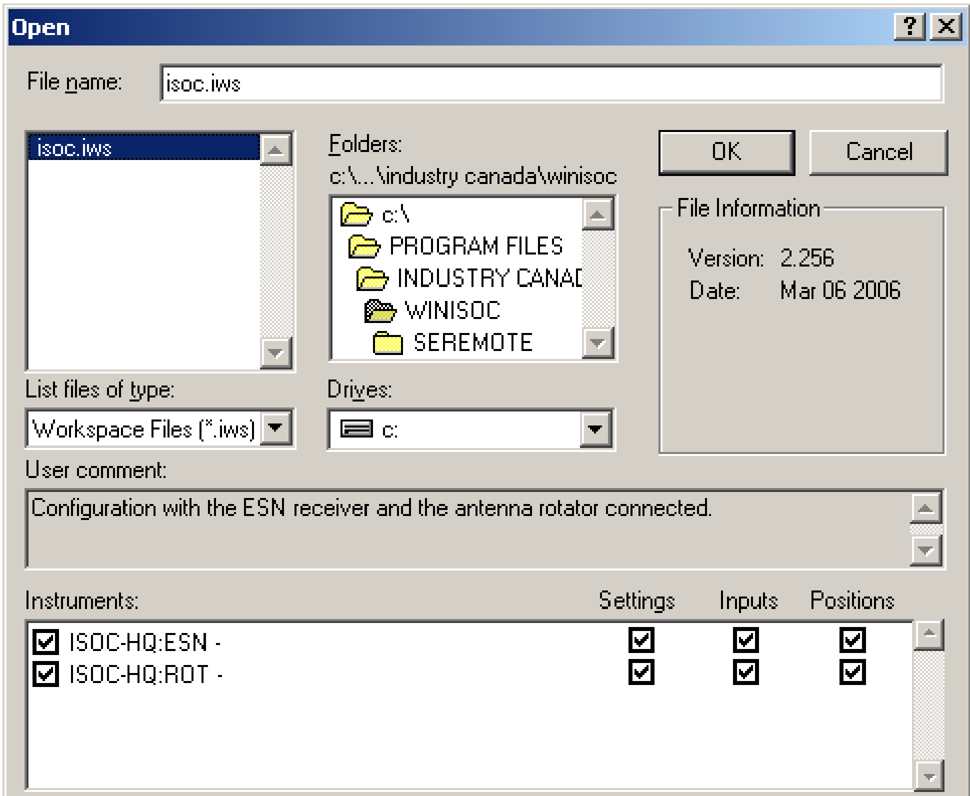
The dialog also contains several new areas. Most important of these is the area labelled **Instruments** at the bottom. Here, a list is presented containing all presently open virtual instruments. You can choose which of these to include in the workspace file, by checking or clearing the checkbox to the left of the instrument window name. On the right-hand side of this list, three checkboxes are presented for each instrument: they let you selectively choose whether or not to save instrument settings, switch matrix settings, and window arrangements for that instrument.

You may also enter arbitrary text in the **User comment** field. This text appears before a workspace is being loaded, making it easier to identify a workspace.

3.1.1.8. Loading a workspace

To load a workspace, select the **Load Workspace…** command from the Site menu. To avoid conflicts with previously opened instruments, the **Load Workspace…** command is only available when no virtual instruments are open.

When the **Load Workspace…** command is invoked, it displays the Open dialog:



Once again, this is a dialog that is a modified version of the standard Windows Load dialog. The **File name**, **Folders**, **List files of type**, and **Drives** fields can be used to navigate the file system and select a workspace file for loading.

When you click (*not* double-click) a file name in the file list area of this dialog, the file is opened briefly, and workspace information is extracted from it. This information includes the version of the ISOC under which the workspace was saved, the date, any user comments that may have been entered, and the list of instruments in the workspace. The version and date are displayed in the **File Information** area on the right. Comments are displayed in the **User comment** field. The list of instruments is shown in the **Instruments** area.

In the Instruments area, you can select which instruments to load, and how. To the left of each instrument, a checkbox controls whether or not that instrument is to be loaded. On the right side of the list, three fields control whether to load the instrument's settings, switch matrix settings pertinent to that instrument, and window positions and arrangements for that instrument.

To actually load the workspace, click the **OK** button. If the workspace contained several instruments, it may take a while for all of them to be loaded and initialized.

3.1.1.9. Saving settings

The position and appearance of ISOC virtual instrument windows can be saved. This information, identified by the name of the ISOC server and instrument (e.g., `ISOC-HQ:ESN`), is stored in the Windows Registry, and it is used to restore the window to its previous appearance when the instrument is reopened.

Saving of this information happens either when you invoke the **Save Settings Now!** command from the Window menu, or if the **Save Settings on Exit** menu option is checked when the virtual instrument is closed.

What is saved, specifically? The information stored in the Registry includes:

- The window position,
- The window size,
- The position and arrangement of the toolbar in that window,
- The visibility of panels in a virtual instrument window,
- The position and size of each of the panels.

As mentioned above, this information is associated with the name of the virtual instrument, as displayed in the title bar of the virtual instrument window. Therefore, if the name of an instrument (or the server where the instrument resides) changes, any old information about that instrument will no longer be valid, and the virtual instrument will be loaded with default settings. It will then be necessary to arrange the virtual instrument again in accordance to your preferences, and save the new settings.

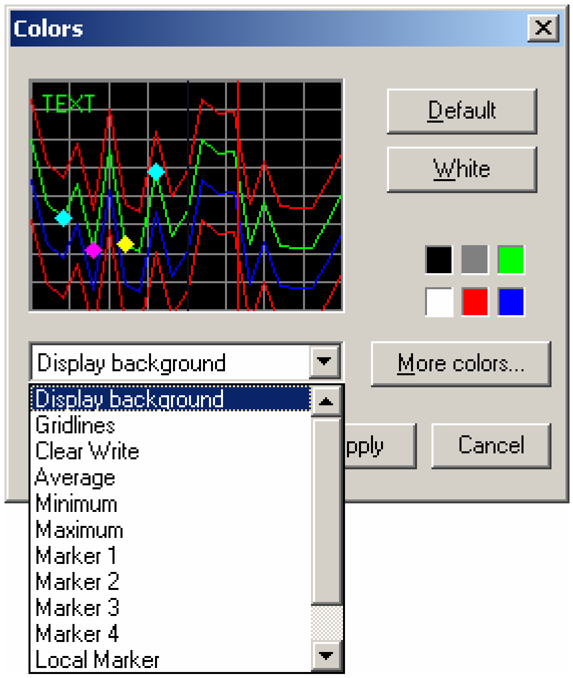
Under rare circumstances (e.g., when a new version of the ISOC is installed) old settings in the Registry may no longer be compatible with the ISOC suite. This may be the case when a virtual instrument opens with a corrupted appearance (e.g., a non-resizable window that's obviously too small to display all its contents) or fails to open altogether. The remedy is to manually remove old settings from the Registry. This can be done by hand if you are familiar with the Registry editor.

3.1.1.10. Common user interface elements

Some user interface elements are shared by several virtual instruments.

3.1.1.10.1. The Colors dialog

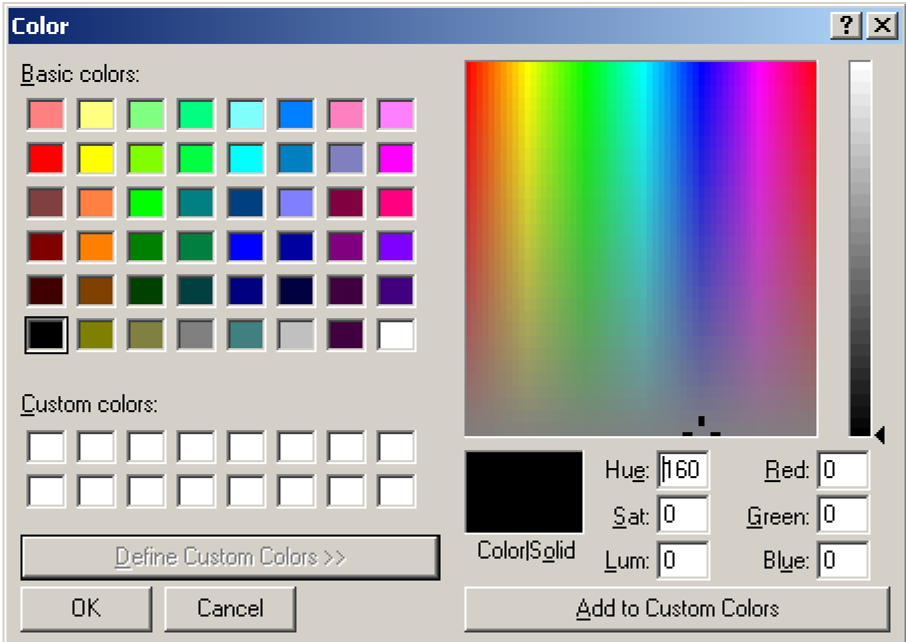
Virtual instruments that offer a graphical trace window also offer a means to customize this window. This is done through the Colors dialog:



The Colors dialog contains a simulated version of the ISOC trace display along with several controls that let you change the appearance of this display. First, the **Default** and **White** buttons allow you to select one of two default colour schemes. Alternatively, you may choose to change the colour of individual display elements, by selecting the desired element from the dropdown list, and choosing a colour. The selected element is also highlighted in the simulated trace display area.

To choose a colour, you may click one of the six primary colours on the right-hand side of the Colors dialog. Or, if you prefer to choose some other colour, you may use the **More colors…** button.

The **More colors…** button displays the standard Windows colour selection dialog. Through this dialog, any colour can be selected using a variety of ways: you can pick on of the Basic colours, or click the **Define Custom Colors** button and create any colour you wish:

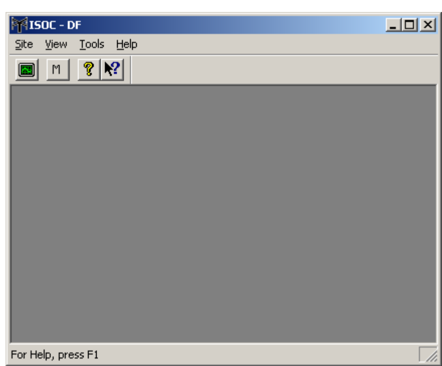


3.1.2. ISOC DF

The ISOC DF program has a user interface that is similar to, and in many ways, an extension of, the ISOC for Windows main application interface. The ISOC DF application builds upon the ISOC's ability to utilize instruments from multiple sites simultaneously; its main purpose is to utilize direction finding equipment at multiple locations to obtain a fix on a radio source.

3.1.2.1. Application window

When started, the ISOC DF program presents a blank multiple-document interface window not unlike that presented by the ISOC for Windows application:



3.1.2.1.1. Window frame elements

The ISOC DF program window frame contains a menu, a toolbar (button bar) and a status bar at the bottom.

The menu commands of the ISOC DF program are as follows:

Site	Menu title for commands related to connecting or managing ISOC DF sites.
Connect…	Invokes the DF Servers window to connect to a site.
Manual Site	Set up a site by hand.
Site Simulation	Simulate a site using data in a file.
Playback	Play back a log file.
Exit	Exits this application.
View	Menu title for commands related to the appearance of the application.
Toolbar	Turns on/off the toolbar (button bar).
Status Bar	Turns on/off the status bar (notification area) at the bottom.
Language…	Provides a means to change the application language.
Tools	Tools that control the behaviour of the application.
Settings…	Provides a means to change application settings.
Window	Commands related to window placement and positioning.
Cascade	Arrange virtual instrument windows in a cascading pattern.
Tile	Arrange virtual instrument windows in a tiled fashion.
Restore Size	Restore a maximized or minimized virtual instrument window to its normal size.
Arrange Icons	Arrange the position of minimized windows.
Save Settings on Exit	Causes window positions and arrangements to be saved to the Registry when closing virtual instruments.
Save Settings Now!	Save the window position and arrangement of the active virtual instrument to the Registry.
n <window name>	List of open windows.
Help	Help commands.
Help Topics	Opens the Help table of contents for the application.
About ISOC	Provides application version information.

The **Site Simulation** and **Playback** commands are only available when no site is open. The Window menu is only visible when a site is open.

The button bar provides quick access to some of the main functions of the application. Five buttons are available:

The **New** button ( ) can be used to invoke the ISOC DF Servers dialog in order to make a connection to a new instrument.

The **Manual Site** button ( ) is used to enter information of a DF site that is not part of the DF network, but whose information can be used in the calculation of the fix.

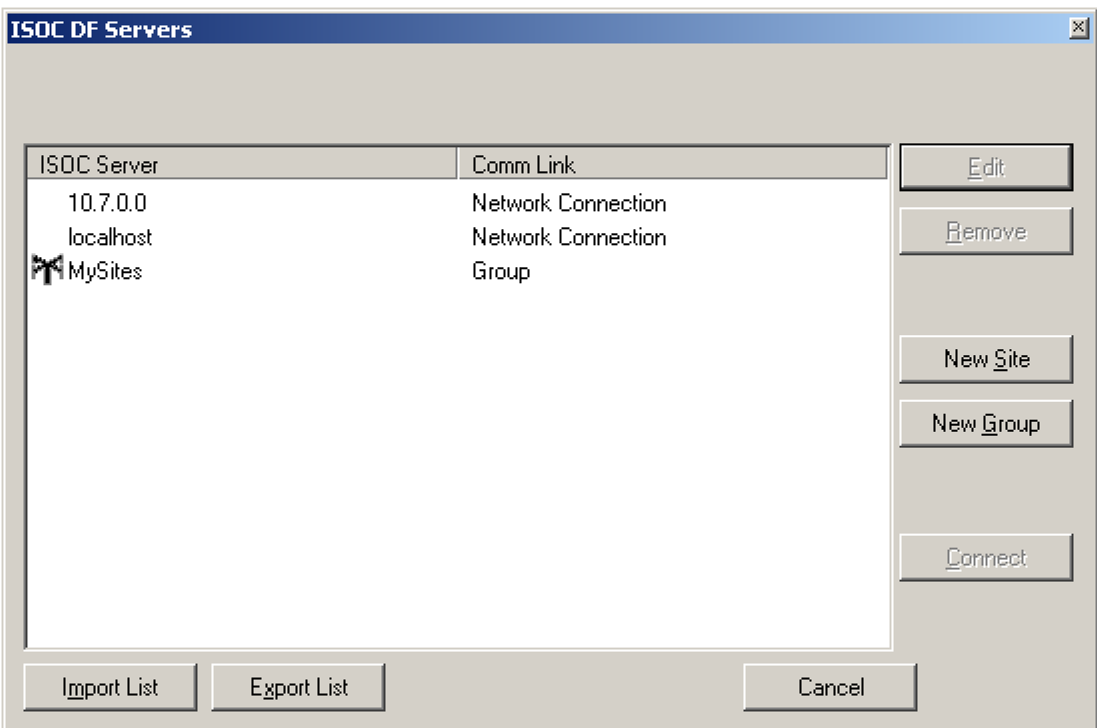
The **About** button ( ) displays application copyright and version information.

The **Help** button ( ) invokes context-sensitive help. Note that as the ISOC is still an evolving application, the availability of context-sensitive help is limited.

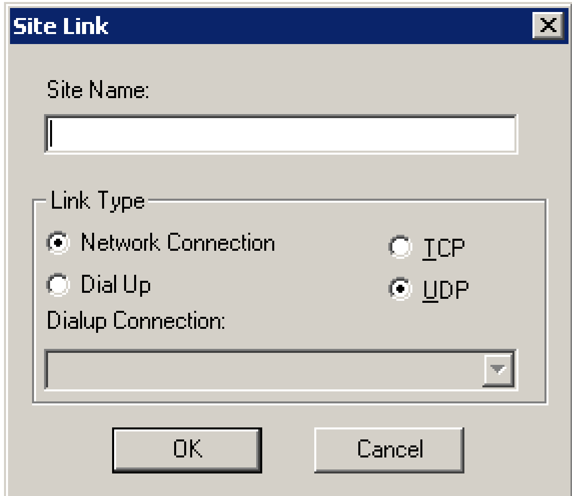
The button bar can be moved about, positioned as a floating window, or attached to any of the four edges of the ISOC for Windows application window. It can also be removed altogether using the **Toolbar** command from the View menu.

The status bar at the bottom of the ISOC for Windows application displays helpful hints and application status information. It, too, can be removed by selecting the **Status Bar** command from the View menu.

When you select the **Connect** command, the ISOC DF Servers dialog is displayed. This dialog shows all previously defined sites as well as site groups:

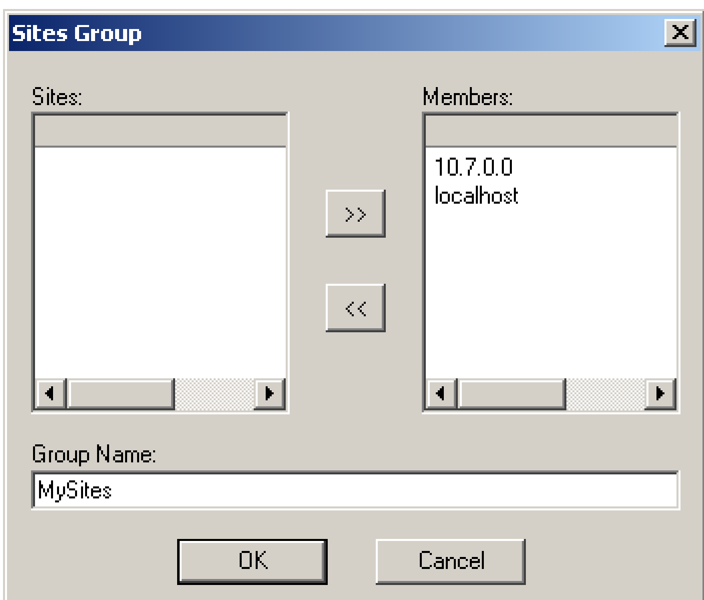


To edit an existing site, click the Edit button; this brings up the Site Link dialog. The same dialog appears when you click **New Site**:



To specify a site, you must enter its **Site Name**, which must be the site's DNS name or IP address. If the site is accessed through dial-up, select the **Dial Up** radio button; this allows you to also select a **Dialup Connection** from the list of dial-up network connections that are presently defined on your workstation.

Sites can also be organized into groups, for easier access. To create a new group, click the **New Group** button in the ISOC DF Servers dialog. An existing group can also be edited by selecting the group and clicking the **Edit** button. Groups are created/edited through the Sites Group dialog:

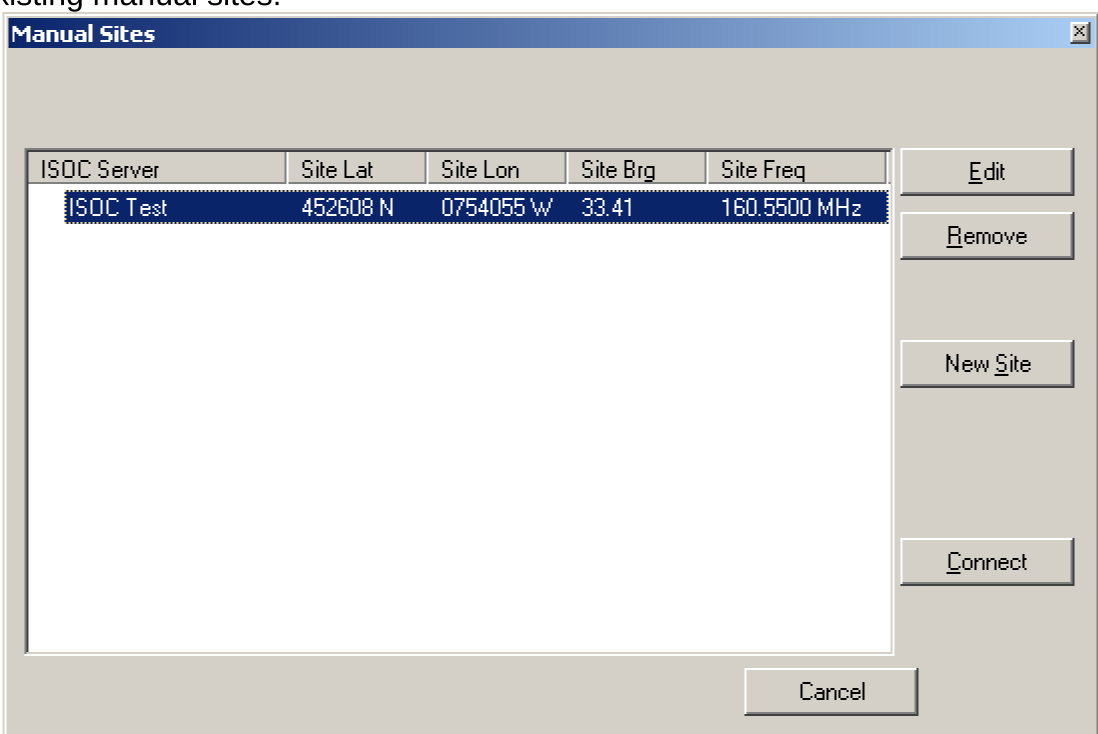


The **Sites** list on the left-hand side contains sites that are not yet members of the group. To move sites to the **Members** list, click the **>>** button. Similarly, the **<<** button can be used to remove sites from a group and move them back to the **Sites** list.

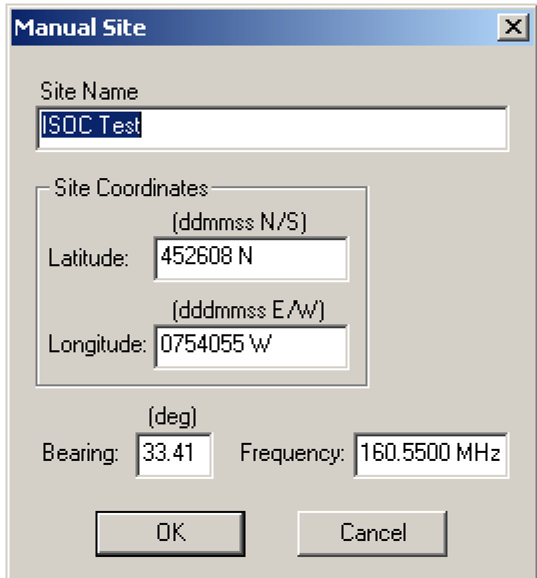
Before finishing the edits, make sure you also specify an appropriate **Group Name**.

The ISOC DF Servers dialog can also be used to import a site list (**Import List**) or export the list of sites to a file (**Export List**). Site lists are stored in the Windows Registry file format.

The **Manual Site** command can be used to specify a site that is not controlled by ISOC DF software (e.g., bearing information communicated via telephone). When you invoke this command, the Manual Sites dialog appears, listing all existing manual sites:

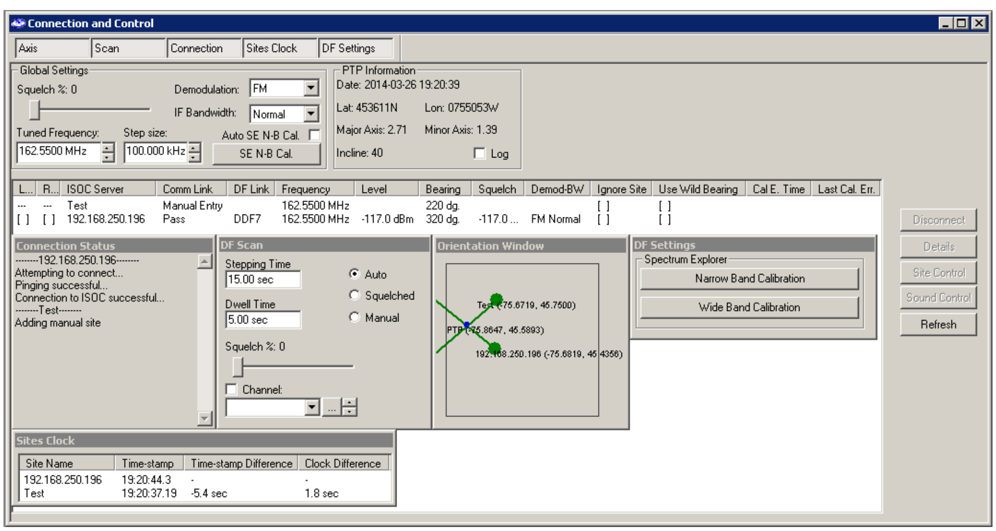


When you click **Edit** to edit an existing manual site, or **New Site** to enter a new manual site, the Manual Site dialog appears:



A site is specified by entering the **Site Name**, **Latitude** and **Longitude** coordinates, the **Bearing** of the signal and its **Frequency**. A Manual Site can be edited at any time, even when it is "connected"; thus, updated readings can be entered as needed.

When you connect to a site or sites (manual or otherwise), the ISOC DF Application displays the Connection and Control window:



This multifunction window is the primary DF interface. Through this window, you can view a list of all sites participating in the DF measurement, see the fix on the signal source, and control settings common to all sites.

The list of DF sites is interactive. By clicking the Left or Right columns, you can turn on audio for the selected site. When audio is on, you can use the **Sound Control** button to control audio output from that site. The **Ignore Site** and **Use Wild Bearing** columns are also interactive. If you click **Ignore Site**, bearing from that site is ignored even if otherwise, it would be considered a valid bearing for location determination. Contrariwise, the **Use Wild Bearing** setting ensures that bearing from a site is included in location determination even if otherwise it would not be considered valid. When both settings are enabled, the **Ignore Site** setting takes precedence.

The **Cal E. Time** column shows the time elapsed since the last calibration (if applicable) whereas the **Last Cal Err.** column shows the most recent calibration error message.

The **Site Control** button can be used to control individual sites. For a manual site, this control invokes the Manual Site dialog; for non-manual sites, the interactive ISOC interface appears, through which the instruments can be controlled.

The **Disconnect** button can be used to disconnect an individual site, while leaving all other sites connected.

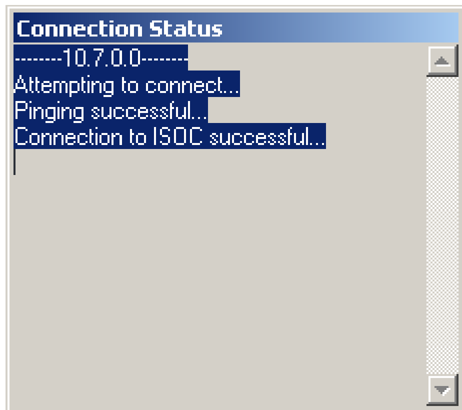
The window frame contains a button bar: three buttons control which optional panels appear inside the window. The **Axis** button causes the Orientation Window panel to appear or disappear; the **Scan** button controls the DF Scan panel, while the **Connection** button controls the Connection Status panel. Clicking the **Sites Clock** button activates a panel that contains information about the time stamps of the latest bearings from all sites, whereas the **DF Settings** button invokes a panel that contains settings specific to the DF instrument.

The top left portion of the Connection and Control window is reserved for **Global Settings**. Settings common to all connected DF processors can be adjusted here. These include the **Tuned Frequency**, **Demodulation**, **IF Bandwidth**, and **Squelch** settings. The **Tuned Frequency** field can also be adjusted using the up-down control positioned at the right of this field; the step size is controlled by the **Step size** field.

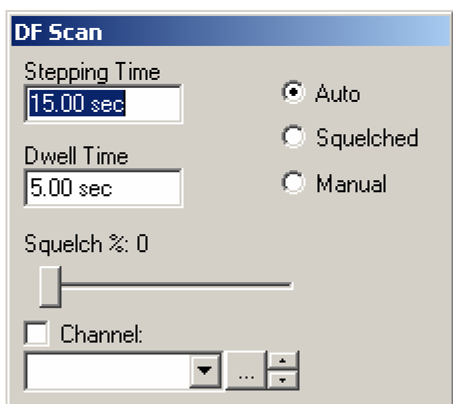
Next to the **Global Settings** area is the **PTP Information** area; this area is populated with values whenever the ISOC DF application obtains a fix on a source. The fix information includes the **Date**, **Lat**itude, and **Lon**gitude of the fix, as well as the parameters of the 50% probability ellipse containing the fix: its **Major Axis**, **Minor Axis**, and **Inclin**ation.

Fix information can be logged. To initiate logging, make sure that the **Log** checkbox is set. The log file is stored in the ISOC installation directory (e.g., C:\Program Files\Industry Canada\WinISOC) and it is named IsocDF-*yyyymmdd*-*hhmmss*.log, where *yyyymmdd* is the date, *hhmmss* is the time when the logging began. For information about the contents of ISOC DF log files, consult appendix A.5.2. The location and name of the log file can be changed by invoking the **Settings** command from the Tools menu.

The Connection Status panel provides feedback when an attempt is made to connect to an ISOC site. If a connection attempt fails, this panel may provide useful information that can help you determine the cause of the failure:



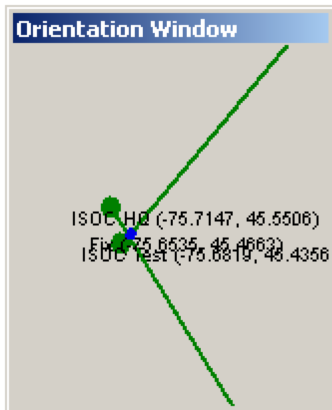
The ISOC DF program has the ability to perform DF measurements on a series of frequencies, by simultaneously setting all participating DF processors and receivers to a series of frequencies in sequence. This behaviour is controlled through the DF Scan panel:



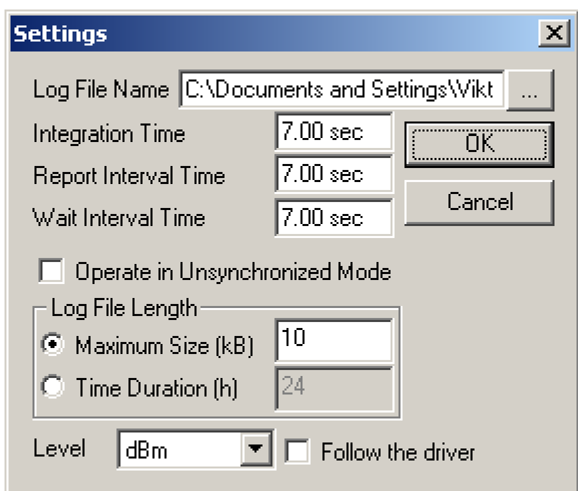
Scan is accomplished using a series of frequencies that are stored in a .LST or .SST file. To begin, click the **Channel** checkbox; this will cause the Open dialog to appear, where the desired frequency list file can be selected. (Another frequency list file can be selected later by clicking the ... button).

Once you have selected a set of frequencies, you can use the **Channel** dropdown list to pick any frequency, or the up-down control to the right of this field to step through frequencies. Or, by using the **Auto** or **Squelched** radio buttons, you can have the ISOC DF program automatically step through the selected frequencies, optionally using the **Squelch** setting to determine whether the desired signal level has been detected. The **Stepping Time** and **Dwell Time** settings control how rapidly the software steps through frequencies.

The Orientation Window panel provides graphical feedback on the fix. Valid signals (those that contribute to a fix) are distinguished from wild signals by colour:



To change some of the basic settings of the ISOC DF program, select the **Settings** command from the Tools menu. This displays the Settings dialog:



The **Log File Name** field is used to set the folder and "stem" portion of the DF log file; the date and time will be appended to the file name as discussed above.

The **Integration Time** setting determines the size of a moving average window that is used to calculate a bearing. The **Report Interval Time** setting controls how often bearings are recorded in the DF log file. The **Wait Interval Time** setting determines how long the application waits after the last valid bearing before it deems a site no longer valid.

In normal operation, the ISOC DF program ignores bearings with a time stamp that is more than several seconds behind other sites. The **Operate in Unsychronized Mode** setting instructs the program to ignore time stamps and use all bearings when calculating the location of the transmitter.

The length of the DF log file can be controlled by specifying either a **Maximum Size** in kilobytes, or a **Time Duration** in hours. To change this setting, click the desired radio button and enter the appropriate numeric value in the corresponding field.

The unit of measurement used for **Level** readings can also be set: **dBm**, **dBµV**, and **S-meter** are the available choices, where the latter is the device-specific amplitude unit used by ICOM receivers.

3.1.3. ISOC Task Manager

The ISOC Task Manager is the third main application in the ISOC for Windows suite: its purpose is to provide a user interface to the ISOC Background Scanner, a server-side component of the ISOC system that can perform unattended operations.

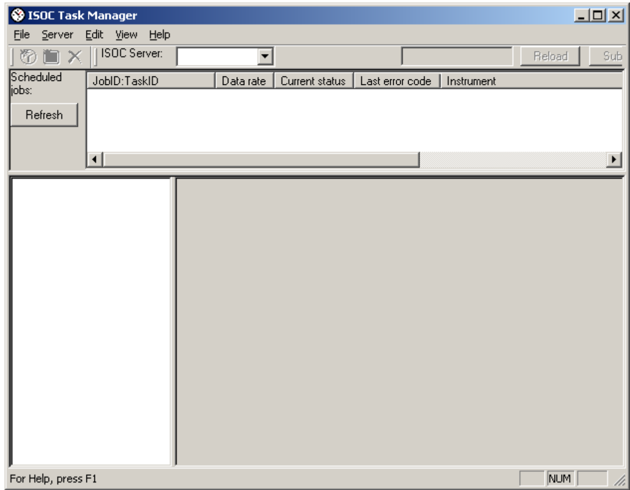
3.1.3.1. Application window

The ISOC Task Manager can be launched from the Windows Start menu, or by selecting the **ISOC Task Manager…** command from the Site menu of the ISOC for Windows application.

Once started, the ISOC Task Manager presents its basic user interface. The ISOC Task Manager window is divided into several areas, each of which is designed to present a different view of the tasks scheduled to run on an ISOC server.

The fields in this user interface are initially unpopulated, and will remain empty until a connection is established to an ISOC server:

To connect to a server, enter its name in the **ISOC Server** field, or select a previously used server from the dropdown list in this field. (Up to ten previously used servers are stored; this is the same list of servers that is stored by the ISOC for Windows application):



The top portion of the Task Manager window is reserved for a toolbar/button bar that can be used to establish connection to a server. Underneath, the next area is used to display all the currently active jobs on that server. The large main area of the window, divided into two parts, is used to provide details about a task.

3.1.3.1.1. Window frame elements

The three elements of the Task Manager window frame are the menu bar, button bar, and status bar.

The menu bar offers different choices depending on whether any virtual instruments are open or not. The menu commands that are available initially are:

File	Commands related to files (sets of jobs).
Save Jobs…	Save the current set of jobs to a file on the local file system without uploading to the server.
Load Jobs…	Load a set of jobs from a locally saved file.
Validate Jobs…	Validate jobs for consistency without uploading.
Exit	Exit this application.
Server	Commands related to the ISOC server.
Reload	Reload the job set from the server.
Refresh	Refresh the status of active jobs.
Submit	Submit the job set to the server.
Upload	Upload one or more files to the server.
Download	Download one or more files from the server.
Edit	Commands related to editing jobs.
Create a New Job	Create a new blank job.
Add a Task	Add a task to the currently selected job.
Delete	Delete the currently selected job or task.
Terminate Task	Interrupt a task presently running on the server.

Resume Task	Resume execution of an interrupted task.
View	Commands related to the application's appearance.
Toolbar	Show/hide the toolbar (button bar).
Server Bar	Show/hide the server bar containing the server name.
Task List	Show/hide the task list (status) area.
Status Bar	Show/hide the status bar at the bottom.
Save Settings on Exit	Save window position/arrangement on program exit.
Options…	Configure application options.
Language…	Select the operating language.
Columns…	Choose which columns are displayed in the task list.
Help	Help commands.
Help Topics	Opens the Help table of contents for the application.
About ISOC	Provides application version information.

The button bar provides quick access to some of the main functions of the application. Five buttons are available:

The **Create a New Job** button ( ) creates a new job, initially with no tasks.

The **Add a Task** button ( ) adds a task to the currently selected job.

The **Delete** button ( ) deletes the currently selected job or task.

The button bar can be removed from the Task Manager window using the **Toolbar** command from the View menu.

The status bar at the bottom of the Task Manager window displays helpful hints and application status information. It, too, can be removed by selecting the **Status Bar** command from the View menu.

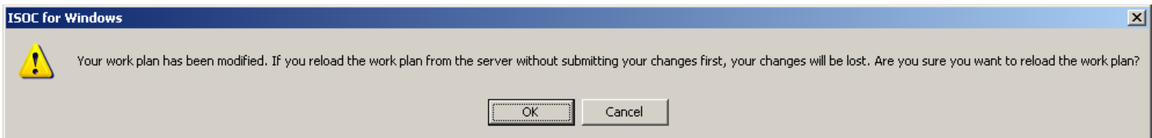
3.1.3.1.2. The server bar

Next to a standard button bar, another toolbar appears in the Task Manager window, called the server bar:

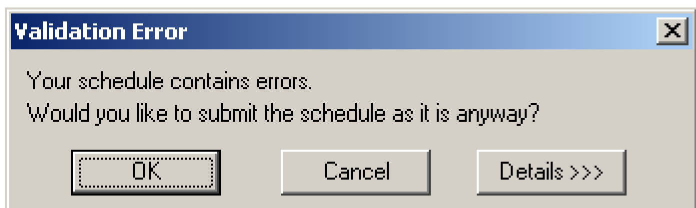
The main function of the server bar is to provide a means to connect to an ISOC server. The server name can be entered by hand in the **ISOC Server** field, or selected from the dropdown list.

The name of the server that the Task Manager last connected to, along with the date and time when that last connection was made, are also displayed in the server bar.

Clicking the **Reload** button causes the list of jobs and tasks to be (re)loaded from that server, replacing what is presently stored by the Task Manager. If you have made changes that were not submitted to the server, and click the **Reload** button, a warning is displayed:



To submit changes to the server, click the **Submit** button. Before your new schedule is submitted, it is validated. When the validation procedure finds potential errors, a warning is displayed:

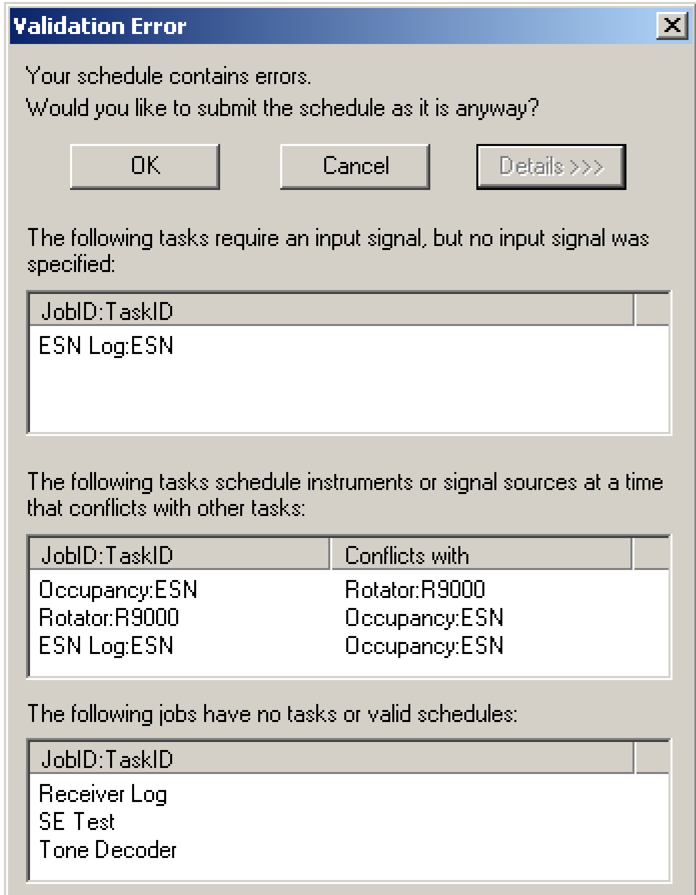


Clicking the **Details >>>** button provides details about the errors that were encountered during validation.

Specifically, the validation procedure checks for the following types of errors in the schedule:

- Missing input signal: One of your tasks uses a device for which switch matrix definitions exist, but you have not selected an input signal. The likely consequence of this error is that the task will run, but no signal source will be connected to the instrument, and the instrument will measure nothing.
- Scheduling conflicts: Two or more tasks are scheduled to use the same instrument, or different instruments connected to the same input signal, at the same time. A schedule with this error will likely fail; at least one of the conflicting tasks will not run successfully, and there is no way to tell in advance which one of the conflicting tasks will fail.
- Jobs without valid tasks/schedules: Jobs are listed here that either have no tasks at all, or their schedule is empty. This is not necessarily an error, as you may be editing jobs that are not yet intended to run. The purpose of this warning is to help you avoid inadvertent errors that may cause jobs or tasks to not perform as expected.

These three types of errors are displayed in three different lists in the Validation Error dialog:



Note that the same task, or same pair of tasks, may appear more than once if there is more than one error or conflict associated with the task or tasks.

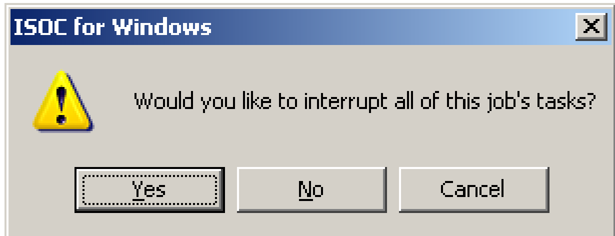
The Validation Error dialog can be used to easily locate the offending task: double-clicking the error causes the dialog to be dismissed, and the Task Manager will open the offending task for editing. The schedule will not be submitted to the server in this case.

3.1.3.1.3. The task list

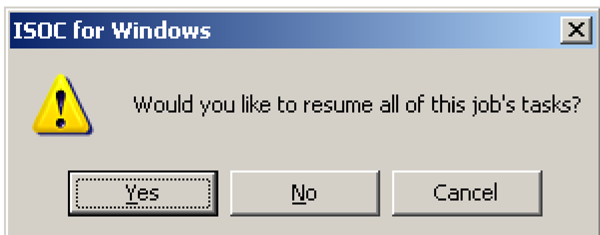
The task list area, located under the area reserved for the toolbar (button bar) and server bar, contains a list of tasks that are presently active or scheduled to run sometime in the future on the server. The task list can also be used to control the running state of jobs and tasks.

3.1.3.1.3.1. Job control

For each task listed in the task list, the task status can be seen in the Current status column. If a task that is presently running is highlighted, the Interrupt button appears on the left side of the task list. Clicking this button causes the task to be interrupted. If the task is part of a job with several tasks, you are offered the option of stopping all the tasks that are part of that job:

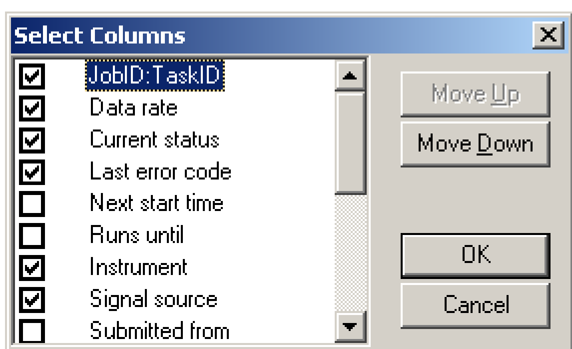


A task that has been interrupted can be resumed. (NB: This will not cause a task to run outside its scheduled time). To resume an interrupted task, selected the task and click the Resume button. If the task belongs to a job that has several tasks, you are offered the option to resume all the tasks of that job:



3.1.3.1.3.2. Column selection

There are many columns that can appear in the task list. You will find that you will only want to use a small subset of columns most of the time, but you may prefer to arrange them in a way that best suits your preferences. To do so, select the **Columns** command from the View menu, which displays the Select Columns dialog:



The individual columns that can appear in the task list are defined as follows:

JobID:TaskID The full identifier of a task consisting of the job identifier, the colon character, and the task identifier.

Data rate	The measured scanning rate at the server for active tasks. May always be 0 for some task types. The value is always 8000 for audio recording tasks, which always record at 8000 samples/second.
Current status	The current status of the task. May contain the text `Idle`, `Running`, `Interrupted`, or `Failed`.
Last error code	For failed tasks, the most recent error is displayed.
Next start time	The time when the task is next expected to run.
Runs until	The time when the task is next expected to stop running. For tasks that are scheduled to run each hour of the week, it is midnight, Monday, on the following week.
Instrument	The identifier of the instrument that the task uses.
Signal source	The signal source (if any) specified for the task's instrument.
Submitted from	Name (or IP address) of the computer that was used to submit the most recent changes to this task.
Last executed	The time when the task ran most recently.
Input	The name of the input file that the task uses.
Output	The name of the output file where the task's results are stored.
Start date	The first date on which the task is scheduled to become active.
End date	The last date on which the task is scheduled to be active.
IF	IF bandwidth setting (RF scanning tasks only).
Attenuation	Attenuation setting (RF tasks only).
#Frqs	Number of frequencies to scan (RF scanning tasks only).

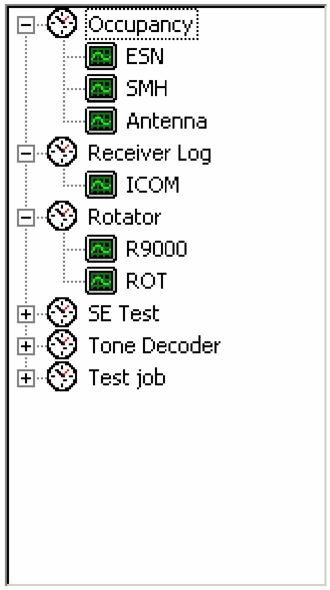
Not only can you decide which of these columns to appear by selecting or clearing the checkbox next to each, you can also change the order of their appearance by using the **Move Up** or **Move Down** buttons. When you are satisfied with the result, click the **OK** button. Clicking **Cancel** discards your changes and leaves the task list's column arrangement unchanged.

The new column arrangement is saved when you exit the Task Manager, provided the **Save Settings on Exit** option (View menu) is checked. Otherwise, your new settings are discarded when the Task Manager terminates.

The contents of the task list can be updated manually by clicking the **Refresh** button. The task list is also updated automatically shortly after a new schedule is submitted, a task is terminated, or a task is resumed. Furthermore, the task list area can be updated automatically at regular intervals by selecting the appropriate option in the Options dialog (Section 3.1.3.3 below).

3.1.3.1.4. The job list

After a successful connection to the server, the list of all jobs on that server is displayed in the left side of the main area of the Task Manager window. The list contains, in fact, both jobs and tasks in a hierarchical arrangement:



Clicking the small ⊞ graphic to the left of each job expands that job, showing its tasks; clicking the graphic again causes that branch of the hierarchy to collapse. This way, the job list area provides an efficient overview of the jobs and tasks present on the server.

You will notice that as you edit a job or task, its label is highlighted in bold in this area, indicating its changed status. Once the schedule has been submitted to the server, these labels revert to normal in appearance.

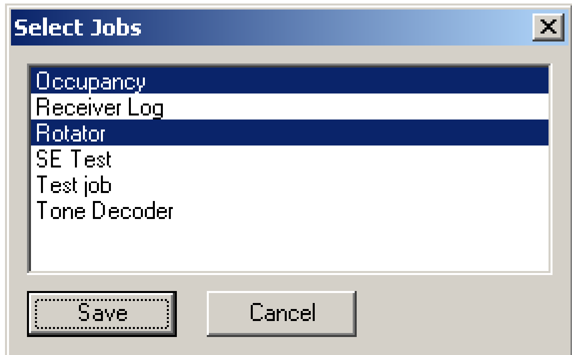
3.1.3.1.5. The job/task detail area

Every time you click a job or task in the left side of the main area of the Task Manager window, its details are displayed on the right-hand side. The right-hand side is organized in the form of one or more tabs. For jobs, only a single tab, the Schedule tab is visible; for tasks, several tabs may be present. These tabs are described in detail in the subsequent paragraphs.

3.1.3.1.6. Saving and loading jobs

A set of jobs can be saved locally in a file; for instance, you may use this functionality to create a local backup of a set of jobs on a server, or even copy a set of jobs from one server to another.

To save jobs, make sure you are connected to a server first (i.e., jobs are listed) and then select the **Save Jobs…** command from the File menu. This command displays the Select Jobs dialog, where you can select which jobs are to be saved:



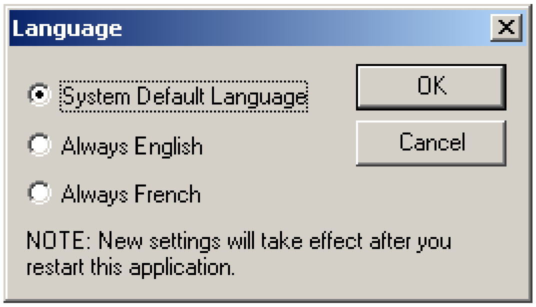
To select multiple jobs with the mouse, press and hold the Ctrl key. Once jobs have been selected, you can click the Save button that, in turn, invokes the standard Save As dialog. The default filename extension for ISOC job files is `.ICR`.

To load a previously saved set of jobs, select the **Load Jobs…** button. This command displays the File Open dialog where you can select the file that contains the jobs to be loaded. When you load a set of jobs, any identically named jobs and tasks are replaced by the contents of the file; other jobs and/or tasks will not be changed. In other words, loading jobs adds the loaded jobs to the existing set, or replaces jobs/tasks in the existing set, never causes jobs or tasks to be deleted from the current set.

Any jobs and tasks that are freshly loaded will be shown in bold in the list of jobs and tasks to the left, indicating that they have been changed.

3.1.3.2. Language selection

The operating language of the Task Manager can be changed by selecting the **Language…** command from the View menu:



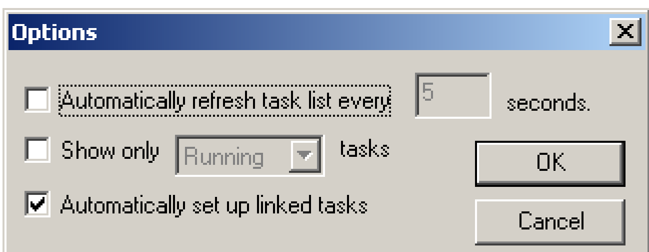
The default behaviour for the ISOC is to use the language in which the operating system was installed (**System Default Language** option). If the language of the Windows installation is a language other than English or French, the ISOC defaults to the English-language user interface.

As it is not possible to reload user interface components that are in use, the effects of language selection are deferred until the next time the application starts.

The language selection setting of the ISOC is global; it affects all ISOC components. The ISOC language setting can be made from any of the three main ISOC applications: ISOC for Windows, ISOC Task Manager, or ISOC DF.

3.1.3.3. Options

Several options control the overall behaviour of the Task Manager. These options can be changed by using the **Options** command from the View menu, which invokes the Options dialog:



If you wish the task list to be automatically updated at regular intervals, make sure the **Automatically refresh task every [ ] seconds** checkbox is set, and enter a suitable value for the update interval.

Tip: Be careful not to select an update interval that is too short. While an update is taking place, the mouse cursor changes to the hourglass symbol and the Task Manager remains nonresponsive.

You can select which tasks are to appear in the task list by setting the **Show only [ ] tasks** checkbox, and choosing either running or scheduled tasks from the drop-down list. The default (when the checkbox is unchecked) is to show all tasks in the task list area.

A convenience function of the Task Manager is to offer the automatic setup of related tasks. For instance, if you add an audio recording task to a job and select the AF output of a receiver as the signal source, the Task Manager offers to set up a task for the receiver as well. If you do not wish to use this convenience feature, clear the **Automatically set up linked tasks** checkbox.

To save your changes to Task Manager options, click **OK**. Clicking **Cancel** causes your changes to be discarded, and the system will continue to operate as previously.

3.1.3.4. Connecting to a site

As mentioned previously, connecting to a site is accomplished by entering a site name in the server bar and clicking the **Reload** button. When a connection to a site is made, the Task Manager downloads several blocks of information from the server. (This may take a noticeable amount of time if the connection to the server is slow). This includes the list of tasks and jobs, the list of available instruments and signal sources, and other relevant pieces of information the Task Manager needs to properly represent a server. Once this is done, the **Create a New Job** and **Add a Task** commands become available (from the Edit menu or from the toolbar).

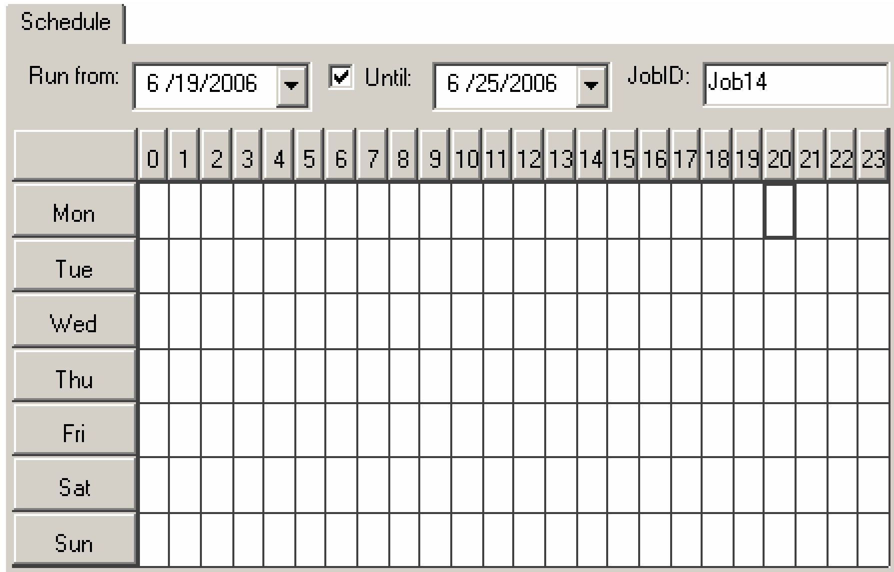
3.1.3.5. Creating and editing jobs

To create a new job, select the **Create a New Job** command from the Edit menu, or click the **Create a New Job** button (). (Note that you need to be connected to a server first before this commands become available).

When a new job is created, it is initially devoid of tasks and has an empty schedule.

3.1.3.5.1. Editing the schedule

The Schedule tab lets you edit a job's schedule. The schedule consists of a start date, an end date, and an hourly grid that determines which hours of the week the job should be running:



The Schedule tab also displays the job's name (**JobID**). The job name can only be changed for new jobs, so long as they have not yet been submitted to the server.

The start date of the job is defined in the **Run from** field. The end date of the job is defined in the **Until** field; however, if the corresponding checkbox is cleared, the job will not have an end date, i.e., it will run repeatedly at the scheduled time and day of the week until the schedule is altered.

The weekly grid can be manipulated with the mouse; individual cells corresponding with the hours of the week can be highlighted or, if you click on a particular column or row header (the name of the day or the hour) that entire column or row will have its highlight reversed. Clicking the blank area in the upper left of the schedule grid reverses the highlight state for all cells of the grid. You can also click and drag with the mouse to "paint" a desired area.

3.1.3.6. Creating and editing tasks

A job by itself does nothing; it merely provides a schedule for tasks to be executed. Each task in the ISOC system controls a specific instrument.

To create a new task, first select the job to which the task is to be added, then use the **Add a Task** command from the Edit menu, or click the **Add a Task** button ().

Once a task has been added, its details are displayed on the right. Four tabs are shown: The Instrument tab controls the task type and the instrument to be used, the Settings tab contains instrument-specific settings, the Frequency tab determines what frequencies the task will use, while the Output tab provides a means to specify where and how measurement results will be stored.

3.1.3.6.1. Instrument and task type selection

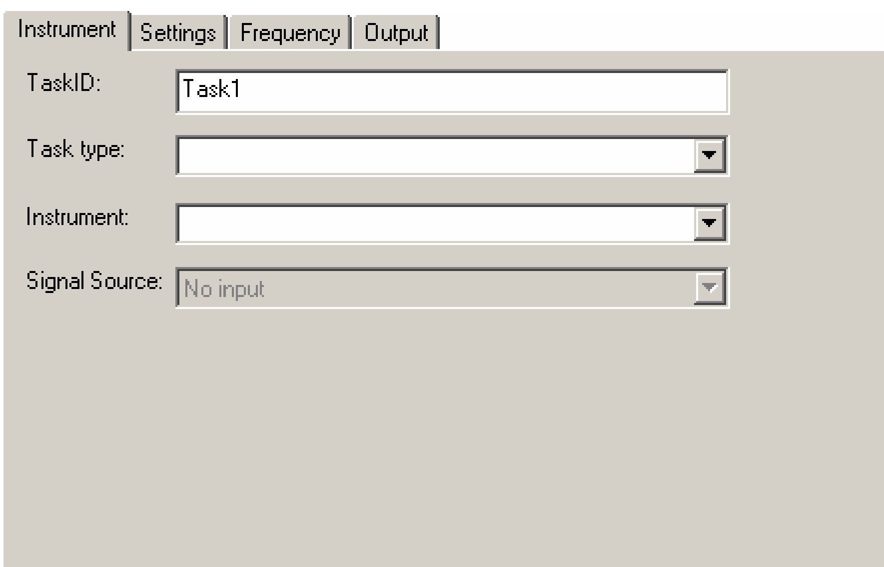
Each task in the ISOC system has a type and an instrument on which the task runs. The system recognizes three task types:

Audio recording tasks are used to record digitized audio on the server. The schedule controls the duration of the recording; the task settings specify the signal source, the recording file format, squelch, and other settings.

Frequency scan tasks are high-speed frequency scans. Only a small set of instruments (receivers) support high-speed scans, either natively or under ISOC software control. Typical high-speed scanning speeds range from a few frequencies up to a few thousand frequencies per second. High-speed scan results are recorded in a binary format file specific to the ISOC, the `.ESN` file format.

Instrument control tasks are used to set up an instrument with specific settings, and optionally, slowly change those settings under software control. In the case of some instruments, measurements can also be performed and recorded in human-readable log files.

To select the instrument and the task type, use the Instrument tab:



For a new task, you can specify the task name (**TaskID**). This is a task's unique identifier; once a task has been submitted to a server, this value can no longer be edited.

The task type can be selected in the **Task type** field.

The task type selection determines which instruments appear in the **Instrument** field. Only instruments that are appropriate for the chosen task type are listed in this dropdown.

Once an instrument has been selected, if any switch matrix definitions exist for that instrument on the server, the list of available signal sources are listed in the **Signal Source** field. As a rule of thumb, if the **Signal Source** field is editable, you should usually make the appropriate selection here, otherwise the instrument is unlikely to receive a usable signal when the task executes. The field may also display hardwired connection information for instruments that are marked as such on the server, and for which switch matrix settings are not available.

3.1.3.6.2. Instrument settings

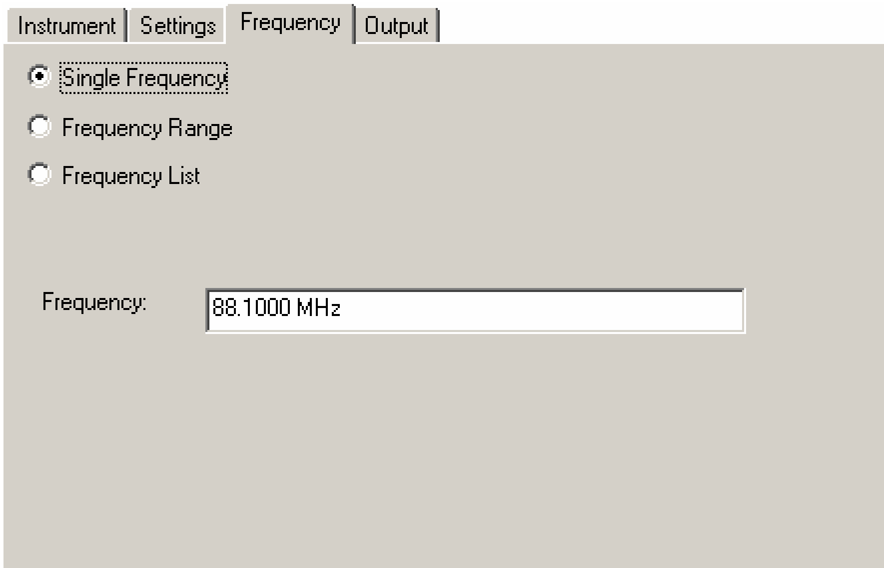
The Settings tab controls settings specific to each instrument. The dialog that appears under this tab is specific to each instrument. Instrument specific details for background scanning are provided later in this section where the individual instruments that the ISOC supports are described.

3.1.3.6.3. Frequency settings

The Frequency tab provides a means to control the frequency of the instrument while the task executes. Obviously, this tab is only valid for RF tasks; for tasks that involve non-RF equipment (e.g., audio recording tasks, or instrument control tasks for AF equipment such as a tone decoder) the tab remains blank.

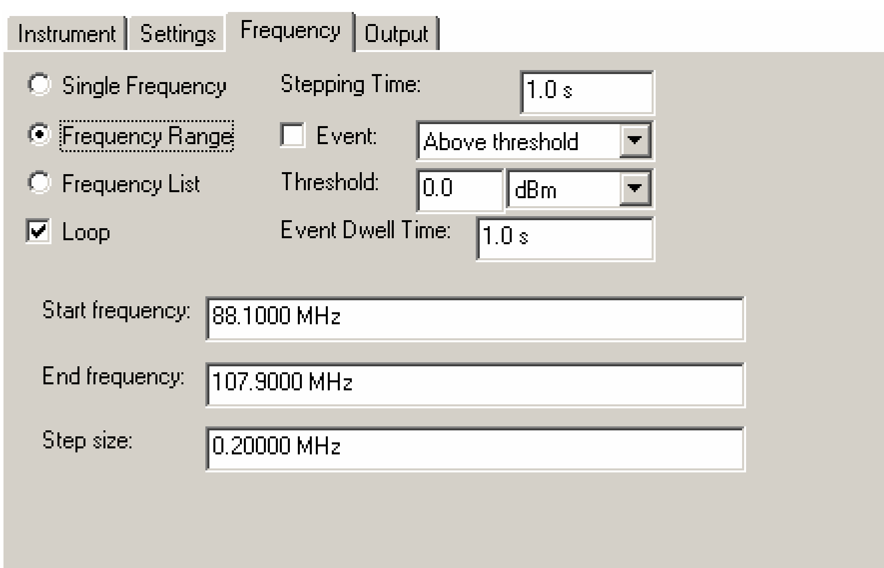
The controls that appear in the Frequency tab vary depending on the task type and the frequency mode selected. The frequency mode can be **Single Frequency**, **Frequency Range**, and **Frequency List**, in accordance with the radio buttons that appear in the upper left area of the Frequency tab:.

In **Single Frequency** mode, the instrument is tuned to a constant frequency, and the frequency is not changed throughout the duration of the task.



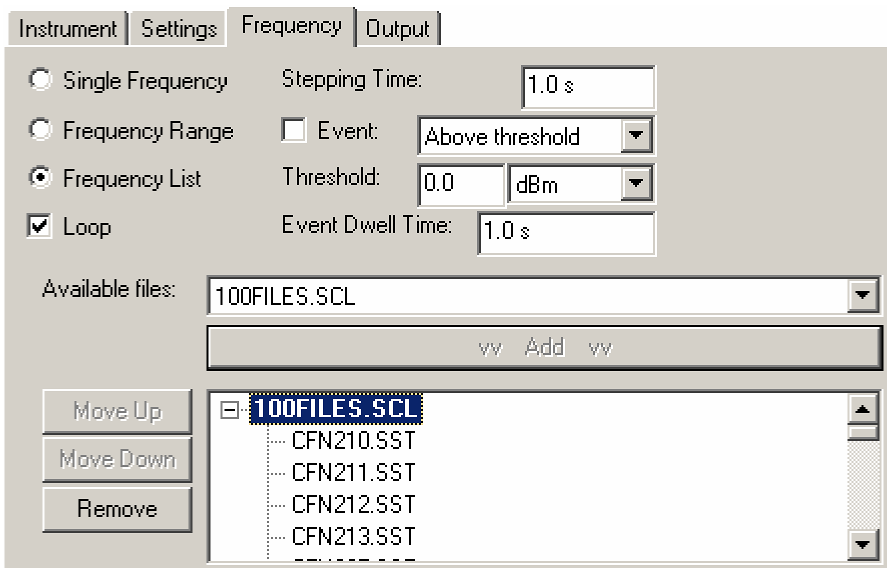
The operating frequency of the instrument can be entered in the **Frequency** field. Units of measure can be used, as well as abbreviations; for instance, to enter a frequency of 2.1 GHz, you may type 2.1g. As soon as the text cursor leaves the **Frequency** field, the field's contents are updated; the value entered is read and redisplayed using a standard, normalized format.

In **Frequency Range** mode, the instrument cycles through a range of frequencies defined by a **Start frequency**, **End frequency**, and **Step size**:



The third option is to use a **Frequency List** stored in a file or a set of files. The ISOC recognizes several file types that can be used for storing frequencies. A simple list (one frequency value per line) can be stored on a `.LST` file. A `.SST` file also contains one frequency per line, but additional information is also stored along with the frequency. The ISOC also recognizes Microsoft Excel format files containing frequency lists. For more information on these file formats, please consult Appendix A.

One other file type, the `.SCL` file, can contain a list of names of `.LST`, `.SST`, or `.XLS` files. (Multiple indirection is not permitted; a `.SCL` file cannot contain references to other `.SCL` files). When the Frequency List option is used, the bottom part of the Frequency tab displays the selected files:

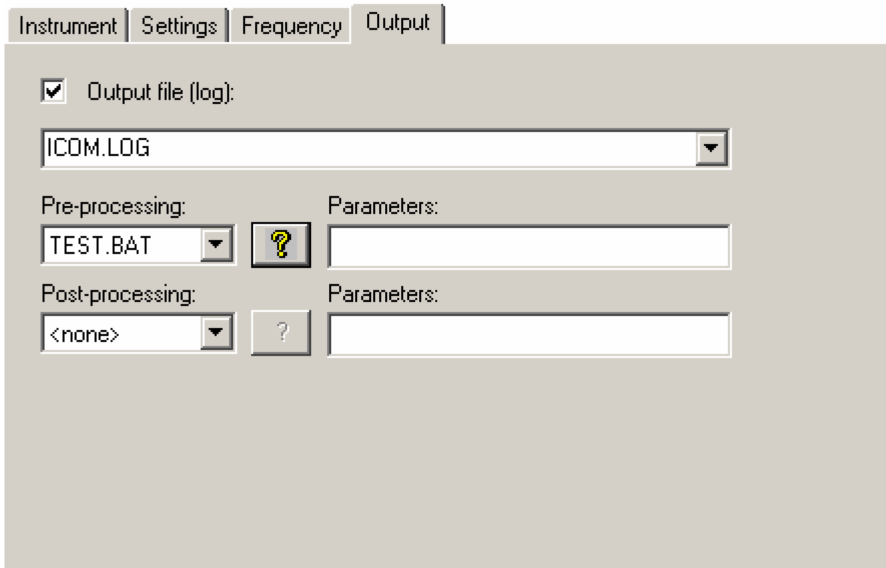


The **Available files** control contains a list of all files presently available on the server. To add a file, select it from the dropdown list, and click the **vv Add vv** button. You can change the order in which the files appear in the list using the **Move Up** and **Move Down** buttons; you can remove a file completely from the list by clicking **Remove** (note that this does not remove the file from the server).

For `.SCL` files, the constituent files referenced by the `.SCL` file are also displayed, in hierarchical form.

3.1.3.6.4. Output file settings

Most scheduled tasks generate some form of output. This can be a human-readable log file; a binary data file containing scan results; or an audio file containing an audio recording. In all cases, the output file is specified using the Output tab:



The **Output file** field is where the desired filename can be entered. The dropdown list contains existing files that are of a compatible type. The file type is displayed in parentheses as part of the **Output file** field label. Next to the label, a checkbox is also present; for tasks where the generation of the output file is optional, you can use this checkbox to indicate that an output file is (or is not) required.

An important feature of the ISOC is its ability to run user-defined pre-processing and post-processing programs right before a task is about to be executed, and right after it finished execution. To select a pre-processing or post-processing program, select its name from the Pre-processing or Post-processing dropdown list. (Both pre- and post-processing can be used for the same task).

The pre- and post-processing command files are usually DOS batch files. If they are so configured, they may also come with brief instructions, which are displayed when you click the  button next to the file name. Some pre- and post-processing files also require additional parameters; these can be specified in the **Parameters** field.

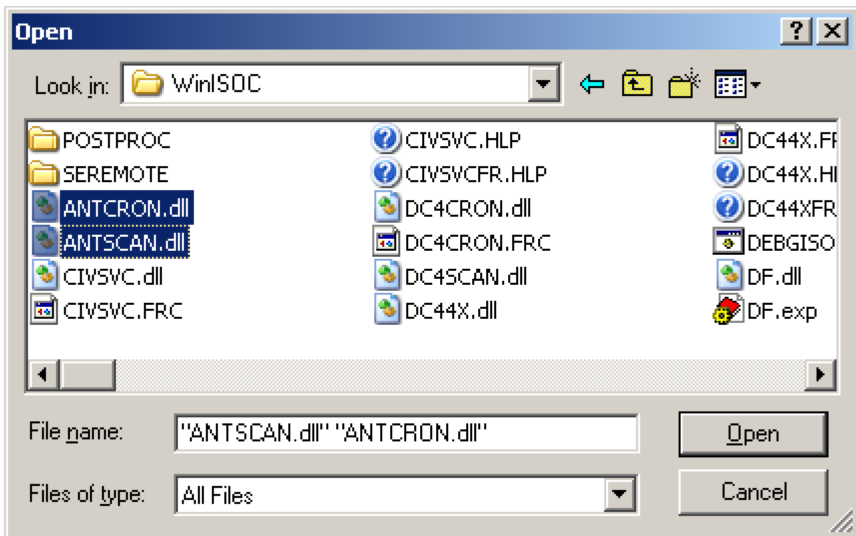
For more information on how to construct and use pre- and post-processing command files, consult Section 3.1.3.9 below.

3.1.3.7. File transfer

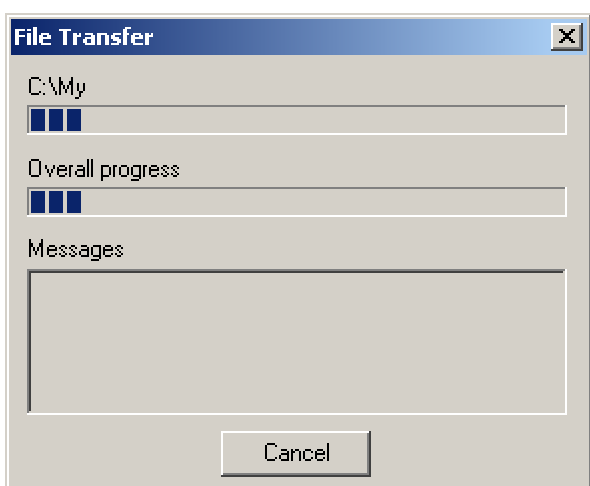
Running scheduled tasks on an ISOC server often entails exchanging files with that server. You may need to upload files that contain frequency lists, for instance, or download files that contain results. While there are many ways to exchange files between your workstation and an ISOC server (e.g., network file sharing, FTP, etc.) the ISOC offers a simple built-in file transfer mechanism to upload and download files.

3.1.3.7.1. Uploading

Before you can upload a file, you need to connect to the ISOC server. To upload a file to the server, select the **Upload** command from the Server menu. This command displays the standard Windows file selection dialog where you have the ability to select one or more files:

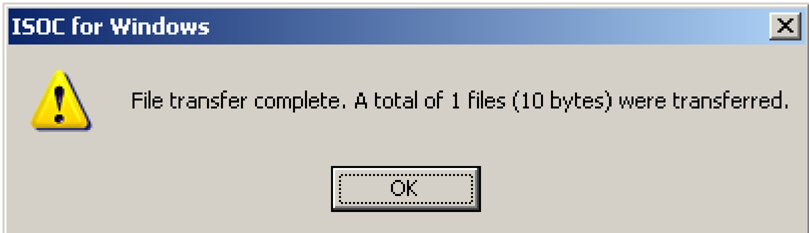


To select multiple files for upload, press and hold down the Ctrl key while making your selection with the mouse. When you are done selecting the desired files, click the **Open** button to begin the upload. This, in turn, displays the File Transfer dialog that shows the progress of the upload:

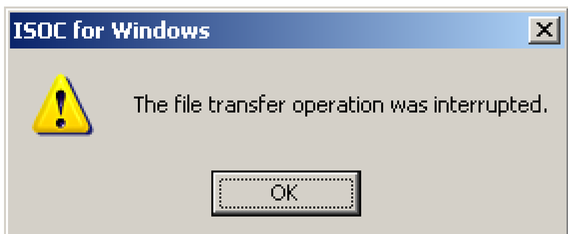


The upper portion of this dialog contains two progress bars: the first indicates the progress of the current file, the second, the overall progress of the uploading process. The actual speed of the upload is a function of many parameters, including the speed of the transmitting and receiving computer, and the bandwidth of the network connection between the two. Any errors or warnings that arise during the upload process are displayed in the **Messages** area.

When the upload is completed, a message is displayed informing you of this fact:



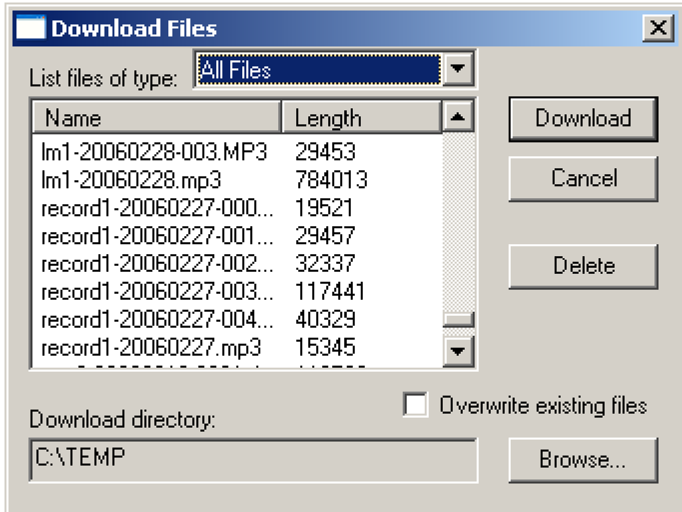
You may also cancel the upload by clicking the Cancel button in the **File Transfer** dialog. Cancellation takes effect only after the transfer of the current file has been completed. If the upload is cancelled, the following message is shown:



So where do the uploaded files go? The server has several directories reserved for files of various types. Uploaded files are deposited in the appropriate directory based on their file type, as determined by the filename extension; for instance, a file whose name ends with `.SST` will be placed in the server directory reserved for `.SST` files. In particular, you cannot use the ISOC upload feature to place files on the server at arbitrary locations in the file system, preventing accidental (or intentional) overwrite of important system files, for example.

3.1.3.7.2. Downloading

The ISOC can also download files from the server. To begin downloading, select the **Download** command from the Server menu. Needless to say, you need to be connected to a server before this command can be used. When the command is invoked, it first displays the **Download Files** dialog:



The **List files of type** field determines which files on the server are listed. What this means specifically is that files on the server are organized into separate folders depending on their type (e.g., `.WAV` audio files, `.SST` frequency list files, etc.); the **List files of type** option determines which directory's contents are listed for downloading. The default (All Files) lists the contents of all ISOC folders on the server.

In addition to all ISOC file types, the **List files of type** field contains an additional option, Miscellaneous Files. This option lists ISOC files, such as server log files, that are not stored in an ISOC subfolder. These files only appear when the Miscellaneous Files option is selected; they do not appear when you select All Files.

The selected files are listed in the form of a two-column list, from which one or more files can be selected. You may choose to either **Download** or **Delete** the selected files. For downloading, you can specify the **Download directory**, by clicking the **Browse…** button and selecting the folder of your choice.

The Overwrite existing files checkbox determines what to do when a file of a given name already exists in the download directory; if this checkbox is set, the download will proceed, otherwise, the download will fail if an attempt is made to download a file that already exists on your workstation.

3.1.3.8. File types

The ISOC Scanner service utilizes files of many different types. Some of these are used as input to a background task, while other file types are used to record results. Details on these file types are provided in Appendix A.

3.1.3.8.1. Input files

Input files to the ISOC Scanner service contain lists of frequencies. The service accepts frequencies in four different file formats: `.LST` files (plain list of frequency values), `.SST` files (legacy format containing frequencies, bandwidths, and other settings), and `.XLS` files. An additional file format, the `.SCL` file format, is a wrapper format that contains a list of `.LST`, `.SST`, and `.XLS` files.

3.1.3.8.2. Output log files

Background scan processes generally produce three types of output: human-readable log files (`.LOG`), binary scanning result files (`.ESN`) and audio files, which may be in the uncompressed Windows (`.WAV`) or compressed MPEG-3 (`.MP3`) format.

3.1.3.8.3. The ESN file type

The `.ESN` file type is a unique binary file format used by the ISOC system (see Appendix A.1). This format is not readable without additional software (not part of the ISOC). One particular software application used to process `.ESN` files is called *TMRS Preview*. *TMRS Preview* is an interactive program that can analyse `.ESN` files and graphically present statistical occupancy results to the user. *TMRS Preview* can produce

- Hourly Occupancy histograms
- Channel Amplitude Histograms (CAH) (signal strength over a 24 hours period)
- Threshold settings
- Analysis functions

TMRS Preview can also generate SQL files containing the summary results and upload them to the TMRS (Technical Measurement and Reporting System) database.

There are also other applications (AWM apps) that integrate TMRS data and licence data to produce occupancy reports and maps depending on input criteria.

3.1.3.9. Batch files: pre- and post-processing

Before a scheduled task is processed, or after it has been completed, the ISOC offers the opportunity to invoke an external program with the task's parameters. This capability can be used, for instance, to generate an input file for the task, or to post-process (e.g., compress and transmit via FTP) the task's results file.

While typically, the external program would be a batch file script, it can be any executable that can run on the server. Valid external programs that can be invoked through this mechanism must be present in the `POSTPROC` subdirectory under the ISOC installation directory of that server. For security reasons, it is not possible to upload or modify a pre/post-processing command file to the server through the ISOC Task Manager.

The external program, when invoked, receives several parameters. There are

1. The output file name
2. The task type
   - 1 = Audio recording
   - 2 = High-speed scan
   - 4 = Instrument control
3. The instrument name
4. The task status
   - 1 = Initializing
   - 2 = Setup (reserving instruments, opening files)
   - 3 = Reading input file (frequency list)
   - 4 = Running
   - 5 = Terminating
   - 6 = Terminated successfully
   - 7 = Failed
   - 8 = Interrupted
5. Any additional parameters specified through the Task Manager.

Pre-processing is normally invoked when the task is in state 2 (Setup). Post-processing is invoked when the task terminates either successfully or with a failure (states 6 through 8). Post-processing is not invoked if a task is terminated but is about to be restarted, appending data to the same file that was used previously; this is to avoid processing a file prematurely. However, this may also mean that under some circumstances (e.g., when a task fails to be restarted for some reason) post-processing may never take place.

3.1.4. Application Components

The following is a list of all files installed in the ISOC installation directory, along with their brief descriptions. During a normal ISOC installation, some additional system files (e.g., `MSVCRT.DLL`) are installed in the main Windows directory if they are not present on the system.

`ANTCRON.dll`	Antenna rotator scheduler user interface
`ANTSCAN.dll`	Antenna rotator scheduler driver
`CIVSVC.dll`	CI-V interface driver
`CIVSVC.FRC`	CI-V interface driver French user interface

CIVSVC.HLP	CI-V interface driver help file
CIVSVCFR.HLP	CI-V interface driver French help file
CRCRDC.EXE	Helper application to invoke Remote Desktop
CRCSE.dll	CRC Spectrum Explorer interactive driver
CRCSE.FRC	CRC Spectrum Explorer French user interface
DC44X.dll	DC-44*x* Tone Decoder instrument driver
DC44X.FRC	DC-44*x* Tone Decoder French user interface
DC44X.HLP	DC-44*x* Tone Decoder help file
DC44XFR.HLP	DC-44*x* Tone Decoder French help file
DC4CRON.dll	DC-44*x* Tone Decoder scheduler user interface
DC4CRON.FRC	DC-44*x* Tone Decoder French scheduler user interface
DC4SCAN.dll	DC-44*x* Tone Decoder scheduler driver
DEBGISOC.BAT	Script to start ISOC services in debug mode
DF.dll	DF user interface library
DF.FRC	DF French user interface
DFCRON.dll	DF Task Manager user interface
DFCRON.FRC	DF Task Manager French user interface
DFLIB.dll	DF program library extensions
DFSCAN.dll	DF scheduler driver
DFSVC.dll	DF interface driver
DFSVC.FRC	DF interface driver French user interface
ESNCRON.dll	ESN Receiver scheduler user interface
ESNCRON.FRC	ESN Receiver French scheduler user interface
ESNCRON.HLP	ESN Receiver scheduler help file
ESNCRONF.HLP	ESN Receiver French scheduler help file
ESNSCAN.dll	ESN Receiver scheduler driver
FLEX.dll	FLEX Tone Decoder instrument driver
FLEX.FRC	FLEX Tone Decoder French user interface
GPIBSVC.dll	GPIB interface driver
GPIBSVC.FRC	GPIB interface driver French user interface
GPIBSVC.HLP	GPIB interface driver help file
GPIBSVCF.HLP	GPIB interface driver French help file
GPSSCAN.dll	GPS scheduler driver
GUIRESET.REG	Registry script to delete window positions and settings
ICOM.dll	ICOM Receiver instrument driver
ICOM.FRC	ICOM Receiver French user interface
ICOM.HLP	ICOM Receiver help file
ICOMCAL.exe	Command-line program to calibrate ICOM receivers
ICOMCRNF.HLP	ICOM Receiver scheduler user interface French help file
ICOMCRON.dll	ICOM Receiver scheduler user interface
ICOMCRON.FRC	ICOM Receiver scheduler French user interface
ICOMCRON.HLP	ICOM Receiver scheduler user interface help file
ICOMDUMP.exe	Command-line utility to dump ICOM calibration data
ICOMFR.HLP	ICOM Receiver French user interface
ICOMSCAN.dll	ICOM Receiver scheduler driver
IFRCRON.dll	COM IFR scheduler user interface
IFRCRON.FRC	COM IFR scheduler French user interface
IFRSCAN.dll	COM IFR scheduler driver
ISOCCNFF.HLP	ISOC Configurator French help file

ISOCCONF.cnt	ISOC Configurator help TOC
ISOCCONF.exe	ISOC Configurator
ISOCCONF.FRC	ISOC Configurator French user interface
ISOCCONF.HLP	ISOC Configurator help file
ISOCCRNF.HLP	Task Manager French help file
ISOCCRON.cnt	Task Manager help TOC
ISOCCRON.exe	Task Manager
ISOCCRON.FRC	Task Manager French user interface
ISOCCRON.HLP	Task Manager help
ISOCDF.exe	ISOC DF
ISOCDF.FRC	ISOC DF French user interface
ISOCDF.HLP	ISOC DF help
ISOCDFFR.HLP	ISOC DF French help
ISOCGPS.exe	GPS monitor helper application
ISOCGPS.FRC	GPS monitor French user interface
ISOCInstrument.dll	ISOC virtual instrument driver module
ISOCInstrument.FRC	ISOC virtual instrument French driver module
ISOCLIB.dll	ISOC program library
ISOCLOG.dll	Event viewer log strings
ISOCMGR.cnt	ISOC Service Manager help TOC
ISOCMGR.exe	ISOC Service Manager
ISOCMGR.FRC	ISOC Service Manager French user interface
ISOCMGR.HLP	ISOC Service Manager help
ISOCMGRF.HLP	ISOC Service Manager French help
ISOCNT.cnt	ISOC help TOC
ISOCNT.exe	ISOC
ISOCNT.FRC	ISOC French user interface
ISOCNT.HLP	ISOC help
ISOCNTFR.HLP	ISOC French help
ISOCSCAN.exe	ISOC background scanner service executable
ISOCSVC.exe	ISOC service executable
ISOCUI.dll	ISOC virtual instrument user interface driver
ISOCUI.FRC	ISOC virtual instrument French user interface driver
ISOCUI.HLP	ISOC virtual instrument user interface help
ISOCUIFR.HLP	ISOC virtual instrument user interface French help
KNOBCtrl.dll	Rotating knob control
Lame_enc.dll	LAME MP3 encoder library
LISEZMOI.RTF	French-language ISOC readme file
METER.dll	Analog meter control
MSRDP.OCX	Helper library to invoke Remote Desktop
MULTISND.exe	Sound mixer utility
MultiWnd.dll	Multi-level child window library
OARSCAN.dll	OAR receiver scheduler driver
R8500CAL.BAT	Calibration script for ICOM R-8500 receivers
R9000CAL.BAT	Calibration script for ICOM R-9000 receivers
README.RTF	English-language ISOC readme file
ReadMeISOCDF.rtf	ISOC DF readme file
ROTCAL.cnt	Antenna rotator calibrator help TOC
ROTCAL.exe	Antenna rotator calibrator

ROTCAL.FRC	Antenna rotator calibrator French user interface
ROTCAL.HLP	Antenna rotator calibrator help
ROTCALFR.HLP	Antenna rotator calibrator French help
ROTCRON.dll	Antenna rotator scheduler user interface
ROTCRON.FRC	Antenna rotator French scheduler user interface
ROTSCAN.dll	Antenna rotator scheduler driver
RS232SVC.dll	RS-232 interface driver
RS232SVC.FRC	RS-232 interface driver French user interface
RS232SVC.HLP	RS-232 interface driver help
RS232SVF.HLP	RS-232 interface driver French help
RSFSP.dll	R&S FSP/FSV instrument driver
RSFSP.FRC	R&S FSP/FSV instrument driver French user interface
Rsib32.dll	RSIB low-level driver
RSIBSVC.dll	RSIB interface driver
RSIBSVC.FRC	RSIB interface driver French user interface
RSSCAN.dll	R&S PA025 scheduler driver
SCHEDULE.dll	Weekly scheduler grid control
SECRON.dll	Spectrum Explorer scheduler user interface
SECRON.FRC	Spectrum Explorer French scheduler user interface
SEREMOTE	Spectrum Explorer control program folder
SEREMOTE\Empty.xls	Empty frequency table for use by Spectrum Explorer
SEREMOTE\SEREADME.TXT	Spectrum Explorer readme file
SEREMOTE\SEREMOTE.exe	Spectrum Explorer control program
SESCAN.dll	Spectrum Explorer scheduler driver
SMHCRON.dll	SMH scheduler user interface
SMHCRON.FRC	SMH French scheduler user interface
SMHCRON.HLP	SMH scheduler user interface help
SMHCRONF.HLP	SMH French scheduler user interface help
SMHSCAN.dll	SMH scheduler driver
SNDCRON.dll	Sound scheduler user interface
SNDCRON.FRC	Sound French scheduler user interface
SNDCRON.HLP	Sound scheduler user interface help
SNDCRONF.HLP	Sound French scheduler user interface help
SNDSCAN.dll	Sound scheduler driver
SOUNDSVC.dll	Sound interface driver
SOUNDSVC.FRC	Sound interface driver French user interface
SOUNDSVC.HLP	Sound interface driver user interface help
SOUNDSVF.HLP	Sound interface driver French user interface help
STRTISOC.BAT	Script to start ISOC services in debug mode
TBTCK.dll	Telonic-Berkeley instrument driver
TBTCK.FRC	Telonic-Berkeley instrument driver French user interface
TCKCRON.dll	Telonic-Berkeley scheduler user interface
TCKCRON.FRC	Telonic-Berkeley French scheduler user interface
TCKSCAN.dll	Telonic-Berkeley scheduler driver
TCPIPSVC.dll	TCP-IP interface driver
TCPIPSVC.FRC	TCP-IP interface driver French user interface
TCPIPSVC.HLP	TCP-IP interface driver help file
TCPIPSVCF.HLP	TCP-IP interface driver French help file
zlib.dll	ZLIB data compression library

3.1.5. Registry reference

Like all complex application systems, the ISOC relies on the Windows Registry to store many of its configuration settings. Settings specific to a server or a client computer are stored under the Registry key `HKLM\SOFTWARE\Industry Canada\ISOC for Windows`:

Name	Type	Description
`ScheduleDir`	string value	Location where ISOC data files are stored
`MonitorCenter`	string value	Name of the ISOC server
`DistrictNumber`	string value	District number of the ISOC server
`LogToFile`	dword	If non-zero, all log entries are written to a log file
`LogArchive`	dword	Set if logs are to be archived regularly
`LogRotDay`	dword	Day of week or month for log rotation
`LogRotMode`	dword	Rotation mode (daily, weekly, monthly)
`FiltAddr`	binary	List of IP addresses that should be filtered from logging
`NumFiltAddr`	dword	Number of IP addresses in filter list
`ResolveNames`	dword	If non-zero, the ISOC uses DNS to obtain names for IP addresses
`Latitude`	string	The latitude of a fixed ISOC site, formatted as *ddmmmm N* where *dd* is degrees, *mmmm* is hundredths of minutes, *N* is the letter `N` or `S`
`Longitude`	string	The latitude of a fixed ISOC site, formatted as *dddmmmm E* where *ddd* is degrees, *mmmm* is hundredths of minutes, *E* is the letter `E` or `W`
`MobileSite`	dword	Non-zero indicates a mobile site (latitude/longitude obtained from GPS)
`MobileTime`	dword	Non-zero indicates that the server time will be updated from GPS
`Key`	binary	Two-byte value used to authenticate ISOC clients and servers
`AuditCodes`	multi-string	List of English and French usage tracking reason codes
`DefaultAuditCodes`	multi-string	List of installation defaults for `AuditCodes`
`ClientDLLs`	string	Semicolon-delimited list of ISOC client DLLs, configured during installation
`CRONDLLs`	string	Semicolon-delimited list of Task Manager DLLs, configured during installation
`ScannerDLLs`	string	Semicolon-delimited list of DLLs used by the ISOC Scanner service
`ServerDLLs`	string	Semicolon-delimited list of DLLs used by the ISOC Service.
`Antennae`	key	Key containing a list of string values corresponding with antenna types that the ISOC recognizes

Name	Type	Description
Ddf6Matrix	key	Key containing DF-specific switch matrix settings
Instruments	key	Key containing ISOC instrument definitions
Instruments\ID	key	Key containing definitions for a specific instrument identified by *ID*
Instruments\ID\@	string	(default value) Instrument type for *ID*
Instruments\ID\English	string	English name of *ID*
Instruments\ID\Nom	string	French name of *ID*
Instruments\ID\Interface	binary	Interface type and configuration settings for *ID*
Instruments\ID\Absent	dword	If non-zero, the instrument is not seen by users
Instruments\ID\Power	binary	Power configuration settings for *ID*
Instruments\ID\Order	dword	Ordinal number of instrument in instrument lists
Instruments\ID\Calibration	dword	For antenna rotators, calibration data
Instruments\ID\Park	key	Antenna rotator park settings
Instruments\ID\Park\Azimuth	dword	Antenna rotator park position azimuth
Instruments\ID\Park\DoPark	dword	Antenna rotator park settings
Instruments\ID\Park\Elevation	dword	Antenna rotator park position elevation
Instruments\ID\Park\Timeout	dword	Timeout before attempting to park
Instruments\ID\Init	string	Extra initialization commands for *ID*
Instruments\ID\3db	key	Calibration table for ICOM instrument *ID*
Instruments\ID\3db\BW	key	Calibration table for ICOM instrument *ID* for bandwidth\demodulator setting *BW*
Instruments\ID\Inputs	key	Switch matrix inputs for *ID*
Instruments\ID\Inputs\@	string	Default input for *ID*
Instruments\ID\Inputs\INP	string	Switch matrix commands to select *INP* for *ID*
Instruments\ID\Parameters	key	Contains string values that are the server-side variables for this instrument
InstrumentTypes	key	Instrument types recognized by the ISOC
InstrumentTypes\ID	key	Definitions for instrument type *ID*
InstrumentTypes\ID\Interfaces	dword	Allowable interfaces for instrument type *ID*
InstrumentTypes\ID\Name	string	English name of instrument type *ID*
InstrumentTypes\ID\Nom	string	French name of instrument type *ID*
InstrumentTypes\ID\Flags	dword	Configuration flags for instrument type *ID*
InstrumentTypes\ID\Parameters	Key	Server-side variables that are configurable through the ISCU
InstrumentTypes\ID\Parameters \VAR\Name	string	English-language description of variable *VAR*
InstrumentTypes\ID\Parameters \VAR\Nom	string	French-language description of variable *VAR*
InstrumentTypes\ID\Parameters \VAR\Values	multi-string	English-language list of dropdown list values
InstrumentTypes\ID\Parameters \VAR\Valeurs	multi-string	French-language list of dropdown list values

Name	Type	Description
InstrumentTypes\ID\Parameters\VAR\Order	dword	Numerical order in which the parameters are to appear to the user
InstrumentTypes\ID\Parameters\VAR\Type	dword	Parameter type: 1=string, 2=dropdown list
Matrix	key	Switch matrix configuration
Matrix\Init	string	TCP switch matrix initialization command
Matrix\Interface	binary	Switch matrix interface configuration
Matrix\INP	key	Settings for signal source *INP*
Matrix\INP\@	string	Input type (A for AF, R for RF)
Matrix\INP\English	string	English name for signal source *INP*
Matrix\INP\French	string	French name for signal source *INP*
Matrix\INP\Type	string	Antenna type for signal source *INP*
Matrix\INP\Tune	string	Name of instrument providing signal for this source
Matrix\INP\TuneFrequency	string	Frequency if source is an IF output
Matrix\INP\TuneSwap	string	Set to 1 for signal sources that swap the signal in the frequency domain (e.g., ESN IF)
Matrix\INP\Order	dword	Ordinal number of signal source in lists
Schedule	key	All background task schedules
Schedule\JOB	key	Scheduled tasks for *JOB*
Schedule\JOB\@	string	Encoded schedule string for *JOB*
Schedule\JOB\TASK	string	Task settings for *TASK* in *JOB*
Subdirectories	key	List of ISOC subfolders
Subdirectories\.LOG	string	Subfolder for .LOG files
Subdirectories\.ESN	string	Subfolder for .ESN files
Subdirectories\.XLS	string	Subfolder for .XLS files
Subdirectories\.SCL	string	Subfolder for .SCL files
Subdirectories\.LST	string	Subfolder for .LST files
Subdirectories\.SST	string	Subfolder for .SST files
Subdirectories\.MP3	string	Subfolder for .MP3 files
Subdirectories\.WAV	string	Subfolder for .WAV files
GPSInfo	key	Current (measured) GPS information
GPSInfo\GMT_DDMMYYYY	string	GPS date
GPSInfo\GMT_HHMMSS	string	GPS time
GPSInfo\Latitude	string	GPS latitude
GPSInfo\Longitude	string	GPS longitude
GPSInfo\Heading	string	GPS heading
GPSInfo\Speed	string	GPS speed
GPSInfo\MagVar	string	GPS magnetic variation
GPSInfo\RMC_Status	string	GPS RMC status
GPSInfo\NBR_SAT	string	Number of GPS satellites presently acquired
GPSInfo\FIX_IND	string	GPS status

User-specific settings, such as window position information, are stored under HKCU\SOFTWARE\Industry Canada\ISOC for Windows:

Name	Type	Description
_-Bar*n*	Key	Settings for various toolbars
_-Summary	Key	Toolbar summary
Calibration*server*:*instrument*	Key	Cached calibration data
Colors*instrumenttype*	Key	Trace colour settings
CRON-Bar*n*	Key	Settings for Task Manager toolbars
CRON-Summary	Key	Task Manager toolbar summary
DownloadLocation	Key	Download settings
DownloadWnd	Key	Download settings
ISCUWnd	Key	ISOC Server Configuration Utility settings
RecentServers	Key	List of recently used ISOC servers
ServerWnd	Key	Servers window settings
Settings	Key	Global configuration settings
UploadLocation	Key	Upload settings
WindowPos	Key	Position data for various windows
server:*instrument*-Bar*n*	Key	Settings specific to instrument windows
server:*instrument*-Summary	Key	Settings specific to instrument windows

User-specific settings for the DF program are stored under HKCU\SOFTWARE\Industry Canada\ISOCDF for Windows:

Name	Type	Description
_-Bar*n*	Key	Settings for various toolbars
_-Summary	Key	Toolbar summary
Calibration*server*:*instrument*	Key	Cached calibration data
Connection and Control-Summary	Key	Toolbar settings
Connexion et contrôle-Summary	Key	Toolbar settings (French)
DFServers\SitesGroupList\MySites	Key	List of DF site groups
DFServers\SitesList	Key	List of DF sites
MapInterface\SitesList	Key	
Settings	Key	
WindowPos	Key	Position data for various windows
server:*instrument*-Bar*n*	Key	Settings specific to instrument windows
server:*instrument*-Summary	Key	Settings specific to instrument windows

3.1.6. Server program reference

On the server side, the ISOC requires several server programs to run continuously.

The main ISOC server program is called `ISOCSVC.EXE`. This program provides access to ISOC instruments. The program accepts three options from the command line:

`ISOCSVC -debug`
Run the ISOC server in "debug mode" from the command prompt; print all log and warning messages on the terminal.

`ISOCSVC -install`
Install the ISOCSVC service on this system.

`ISOCSVC -remove`
Remove the ISOCSVC service from the list of installed services on this system.

The service is designed to be normally run as a Windows service. Windows services are started through the Services applet, located in the Control Panel (on older Windows systems) or in the Administrative Tools folder. The ISOC Service Manager can also be used to start or stop the service. Lastly, it can also be started or stopped from the command line:

```
net start "ISOC Service"
net stop "ISOC Service"
```

The second ISOC server program is called `ISOCSCAN.EXE`. This program is responsible for executing scheduled tasks. Like `ISOCSVC.EXE`, this program also accepts the `-install`, `-remove`, and `-debug` arguments from the command line. It, too, is designed to be used under normal circumstances as a Windows service, and can be started and stopped from the command line using the commands

```
net start "ISOC Scanner"
net stop "ISOC Scanner"
```

The "ISOC Scanner" service is dependent upon the "ISOC Service" service, so starting "ISOC Scanner" also causes "ISOC Service" to start, and stopping "ISOC Service" also causes "ISOC Scanner" to stop.

The ISOC Service Manager is a simple graphical application designed to help with starting and stopping ISOC services. It is installed under the Start menu if ISOC server components are installed. It provides a start () and stop () control for both the **ISOC Service** and the **ISOC Scanner**:

The ISOC Service Manager also enforces service dependency. The ISOC Scanner cannot operate unless the ISOC Service is running already; hence, if both services are stopped and you attempt to start the ISOC Scanner service, both services will start. Conversely, if both services are running and you attempt to stop the ISOC Service without stopping the ISOC Scanner service first, an error message is displayed:

3.2. Instrument Reference

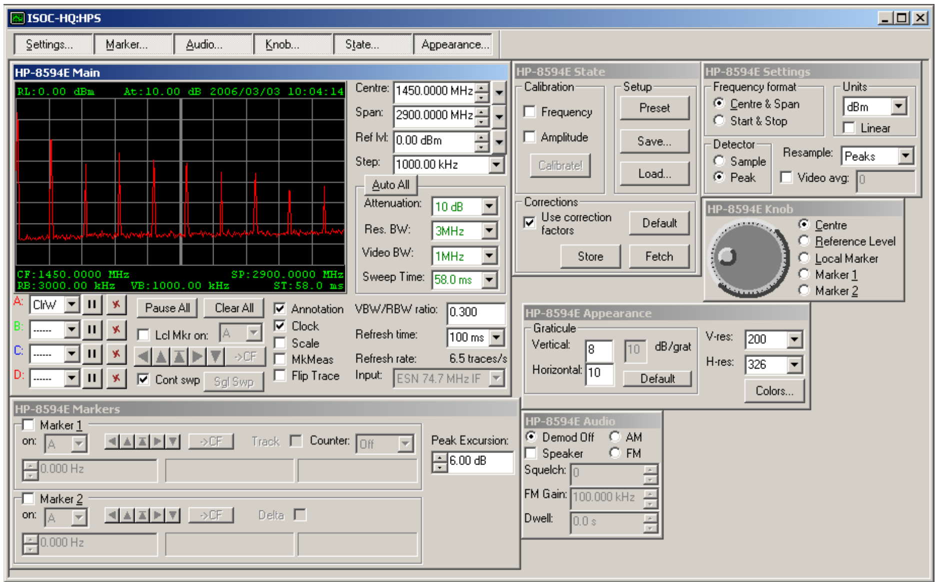
3.2.1. Spectrum Analysers

The ISOC supports the Advantest R3261A, the Hewlett Packard HP8594E, and the Rohde & Schwarz FSP-3/FSP-7 spectrum analysers. Other spectrum analysers from these manufacturers that are compatible with these models may work with the ISOC; however, they have not been tested. Other devices with spectrum analyser functionality (e.g., IFR COM-120B) are also supported but are described elsewhere.

3.2.1.1. Shared spectrum analyser functionality: the HP8594E

All supported spectrum analysers share a common user interface, with relatively minor differences. The first spectrum analyser for which support was implemented in the ISOC is the Hewlett-Packard HP8594E. This instrument is used below to describe spectrum analyser virtual instrument functionality; differences specific to other spectrum analysers are described in subsequent sections.

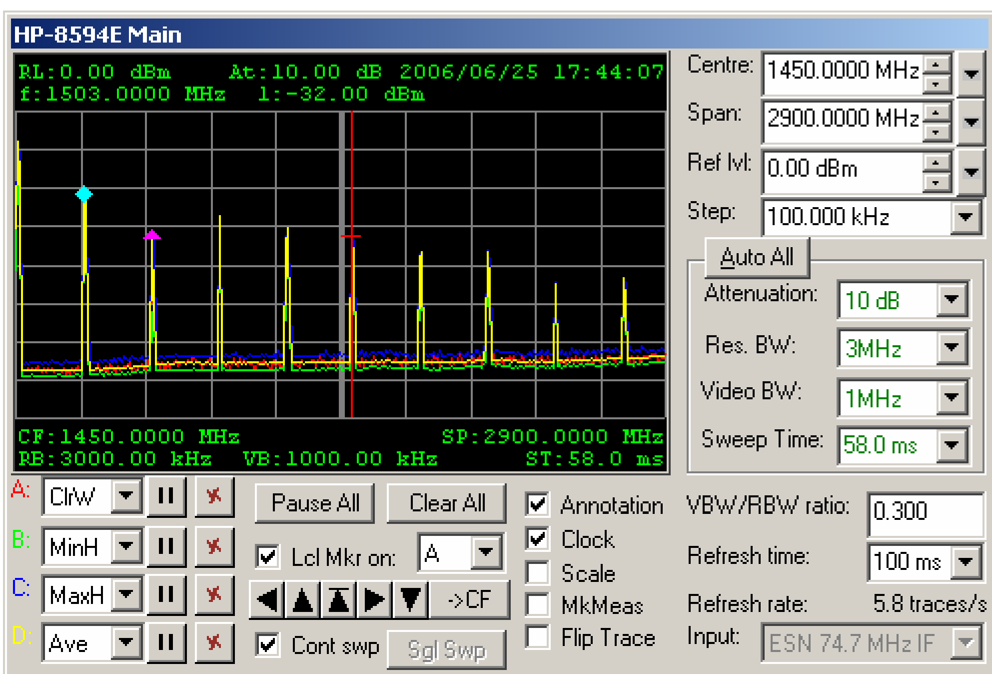
The spectrum analyser virtual instrument presents seven panels:



Of these seven panels, six can be removed from display using the button bar at the top of the window.

3.2.1.1.1. The Main panel

The panel that is always present is the Main panel, which contains most essential controls for the spectrum analyser:



The Main panel can be resized. Its minimum size is equal to the size of the initial trace display (i.e., all controls are hidden). Its maximum size is limited only by the available screen area.

The most prominent feature of the Main panel is the trace display, occupying the upper left portion of the panel. The trace display provides both graphical and text information, and can also be used to control the spectrum analyser.

The primary function of the trace display is graphical presentation of up to four traces. Each of these traces, labelled individually using the letters **A**, **B**, **C**, and **D**, can be controlled individually by using the corresponding dropdown control in the lower left area. By default, trace A is set to ClrW (Clear Write), while the other three traces are off. Other options include Min (Minimum), Max (Maximum), and Avg (Average).

> **Tip:** Regardless which trace options you choose, the virtual instrument gets only one "clear write" trace from the physical instrument. Minima, maxima, and averages are calculated locally on your workstation. For this reason, the possibility exists that the ISOC misses a very brief transient signal that may cause a spike to appear on the physical instrument's minimum or maximum display.

In addition to traces, the trace area displays a grid, optional text, a line marker, and markers. The presence or absence, and appearance of all these display elements are controlled through the various panels of the virtual instrument, as it is explained shortly.

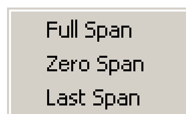
The trace display is also interactive. Clicking and dragging the mouse in the trace display causes the line marker to appear temporarily (if not already present), following the mouse position; the frequency and signal level at the mouse position are displayed. Clicking and dragging the mouse while holding down the Shift key on the keyboard allows you to measure a span on the display; the span width corresponding with the mouse position is displayed. Holding down the Ctrl key while dragging the mouse and then releasing the mouse button causes the instrument to tune to the frequency at the mouse position (for this reason, the line marker is shown in a different colour while the Ctrl key is depressed). Lastly, holding down both the Shift and Ctrl keys while dragging and then releasing the mouse changes the instrument's span setting to the value corresponding with the mouse position.

The instrument's primary controls are the centre frequency and span. These can be adjusted using the **Centre** and **Span** fields in the upper right area. The fields accept frequency values with an optional unit string; e.g., entering 1.25g in the **Centre** field and hitting the Enter key tunes the instrument to 1,250 MHz.

Next to the Centre field is a small button marked with a down-pointing arrow; clicking this button invokes a menu. This menu can be used to switch between **Centre & Span** mode (the default) vs. **Start & Stop** mode:

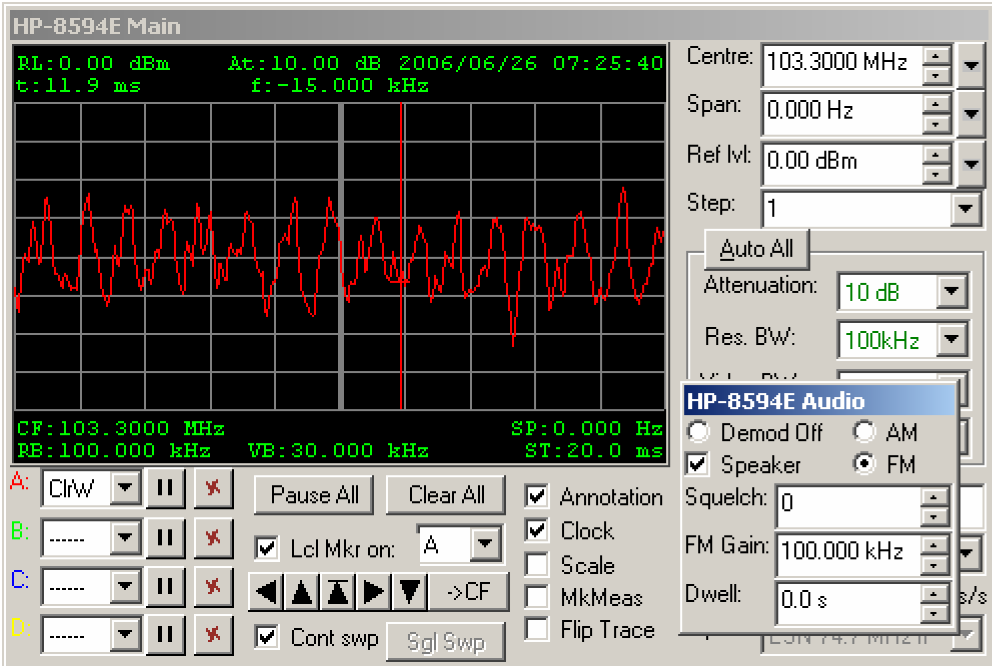
In **Start & Stop** mode, the **Centre** and **Span** fields are replaced with fields labelled **Start** and **Stop**. The combined functionality of these two fields is the same as that of the Centre and Span fields.

Next to the **Span** field, there's another dropdown menu. This menu allows you to switch the instrument to specific span settings:



The **Full Span** command switches the instrument to its default centre frequency and maximum span. The **Last Span** command resets the instrument to the previously used span value; this may not always work as you expect, however, as that span value may not be compatible with the current centre frequency and may be automatically reduced.

The **Zero Span** command leaves the centre frequency alone but switches the span to 0 Hz. The trace display changes in functionality: the horizontal axis now represents time, from zero on the left to the **Sweep Time** value on the right. The vertical axis continues to represent the signal level unless the demodulator is set to **FM** in the Audio panel; in this case, the vertical axis now represents a frequency deviation value, with the centreline corresponding with 0 Hz, and the **FM Gain** value (also in the Audio panel) determining the maximum and minimum frequency deviation at the top and bottom of the trace display:



The third field on the right side of the Main panel is the **Ref lvl** (Reference Level) field that determines the scale along the vertical axis of the trace display. The reference level setting determines the signal level at the top edge of the trace display; for instance, if the reference level is 0 dBm, the trace display will display signals between –80 and 0 dBm.

Next to the Ref lvl field, there is another dropdown menu. This menu controls the units of measurement used for level values; it also contains the option to switch between linear vs. logarithmic display:

The HP8594E can be used with either logarithmic units (dBm, dBmV, dBµV) or linear units (V, W) regardless of the Linear setting[7]. The Linear setting controls the appearance of the trace: if it is off (i.e., if the device is in logarithmic mode) the vertical scale of the trace window will span 80 dB; in linear mode, the vertical

[7] There is, however, some dependency between these settings. When you turn Linear mode on and the unit of measurement is a nonlinear unit (e.g., dBm), it is changed to V. When you turn off Linear mode, and the unit of measurement is a linear unit, it is changed to dBm.

scale will be linear with the bottom of the trace corresponding with 0 (Volts or Watts) and the top of the scale corresponding to the reference level.

For more information on these units of measure, consult Appendix B.

Beneath the **Ref lvl** setting is the **Step size** field; this field controls the step size used by the up-down controls that appear next to the **Centre**, **Span**, and **Ref lvl** fields.

Under the Step size field is an area reserved for secondary trace settings. By default, the **Attenuation**, **Res. BW** (resolution bandwidth), **Video BW** (video bandwidth) and **Sweep Time** fields are all set to **Auto**, meaning that the instrument's internal logic determines their values. The ISOC regularly queries these settings when communicating with the instrument, so the field are updated if the settings (automatically) change. Automatic values are always displayed in green. Alternatively, you can specify values manually, by either entering them (only possible in some fields, e.g., **Sweep Time**) or by selecting allowable values from the dropdown list. When a manual value is selected, it is displayed in red. You can always restore the automatic setting for each of these values individually by selecting Auto from the dropdown list; or, by clicking the **Auto All** button, you can restore all four values at once to automatic.

The area underneath the trace display controls the trace. Next to the four dropdown controls that control the four traces, there are four sets of buttons. Each of the four traces can be paused individually (), or its contents can be reset (i.e., previously collected maxima, minima, and averages can be cleared) by clicking .

Two more buttons, **Pause All** and **Clear All**, control all four traces simultaneously; as their labels suggest, the first pauses all four traces at once, the second clears all accumulated maxima, minima, and averages data from all four traces.

Below these buttons, there are several controls that manage the appearance of the local (line) marker. The local marker, when present, appears as a thin vertical line in the trace display, with a short horizontal line segment marking the signal level at the line marker position. The marker position and signal level are also shown in text, in the second line at the top of the trace display.

The local marker always appears temporarily if you click and drag the mouse in the trace area. To turn on the local marker permanently, make sure the **Lcl Mkr** checkbox is set. Next to it, the dropdown list labelled **on** controls which trace the local marker measures.

Five buttons underneath can be used to position the marker to signal peaks:

Next Left (◀): moves the line marker to the next peak found left of the marker's current position. If no more peaks appear to the left of the marker, the marker will not be moved. A peak is defined as a local maximum that is separated from nearby peaks by troughs of sufficient depth (the requisite depth being determined internally by the peak search algorithm).

Maximum (▲): moves the line marker to the highest signal level that appears anywhere in the trace.

Next Maximum (▲): moves the line marker to the highest peak (as defined above under Next Left) whose level is below the signal level at the current line marker position.

Next Right (▶): moves the line marker to the next peak (as defined above under Next Left) to the right of the marker's current position. If no further peaks are found to the right of the marker, the marker is not moved.

Minimum (▼): moves the line marker to the lowest signal level that appears anywhere in the trace.

The **->CF** button tunes the instrument's centre frequency to the current line marker position.

The **Cont swp** checkbox, set by default, controls whether the spectrum analyser sweeps continuously, or stops when it reaches the top frequency of its sweep range. If the device is in this single sweep mode (**Cont swp** is not set), the **Sgl Swp** (single sweep) button can be used to manually effect a sweep.

Four checkboxes control text decorations that may appear in the trace area. These are as follows:

Annotation determines whether or not the receiver's settings (reference level, centre frequency, etc.) are displayed in the trace area.

Clock determines whether a running clock is displayed in the upper right corner of the trace area. This can be helpful timestamping a trace that you decide to print or save through the Windows clipboard. Note however that the time displayed is the local time as known to your workstation, not the time on the server.

Scale determines whether or not a vertical scale is displayed on the left side of the trace area.

MkMeas determines if marker measurements are to be displayed next to markers that appear in the trace.

The **Flip Trace** checkbox can be used to flip the horizontal axis of the trace. This can be useful if the spectrum analyser is used, for instance, to display the IF output of a receiver; many receivers produce an IF output that is flipped in the frequency domain.

In the lower right, the **VBW/RBW ratio** control manages how the instrument determines the automatic values for the video bandwidth setting as a function of the resolution bandwidth.

The **Refresh time** controls how often a trace is sent by the ISOC server to your workstation. The actual **Refresh rate** is a function of several variables, including instrument and network latency; with the HP8594E, the maximum achievable refresh rate is in the vicinity of 6 traces per second, regardless of the **Refresh time** setting.

3.2.1.1.2. Input selection

The last control in the Main panel, in the lower right corner, selects a signal source for the spectrum analyser. This control is disabled unless an RF switch matrix is present at the ISOC server site, and signal sources are defined for the spectrum analyser instrument.

Some signal sources are special. As defined by the ISOC server administrator, these sources may be "associated" with another instrument. By way of example, a signal source named "ESN IF 10.7 MHz" may be associated with an ESN receiver.

This association, in practical terms, means the following: when such a signal source is selected as the spectrum analyser's input, and the associated instrument is also active, the spectrum analyser virtual instrument is placed in "tune-with association" mode. In this mode, the following are true:

- The spectrum analyser cannot be tuned; it is set to the fixed frequency associated with the signal source. An attempt to change the analyser's centre frequency results instead in a command sent to the associated instrument. In particular, if you click and drag the mouse in the trace display while holding down the Ctrl key, you will tune not the spectrum analyser, but the instrument (e.g., the ESN receiver) associated with the signal source;

- Frequencies displayed by the spectrum analyser (e.g., marker frequencies) will be relative to the associated instrument. For instance, the spectrum analyser may be tuned to the 10.7 MHz IF of the associated instrument (receiver), whereas the receiver is tuned to 160.55 MHz; if you place a line marker in the middle of the spectrum analyser trace display, the marker frequency will be shown as 160.55 MHz, not as 10.7 MHz;

- Some controls in the spectrum analyser user interface are disabled;

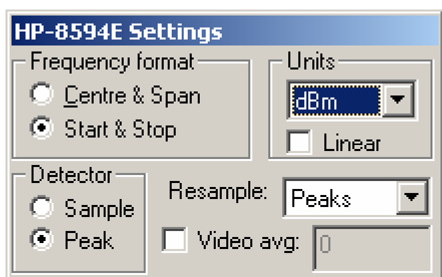
- The trace may be flipped automatically depending on how the associated instrument has been configured by the ISOC server administrator.

If you close the associated instrument, or select another signal source that does not have an associated instrument presently open in ISOC for Windows, the function of the spectrum analyser instrument returns to normal.

3.2.1.1.3. Additional panels

Lesser used functions of the spectrum analyser are organized into panels that are separate from the main panel. These panels can be hidden using the appropriate toolbar button if they are not required, thus freeing up valuable real estate on the screen.

The first of these panels is the Settings panel:



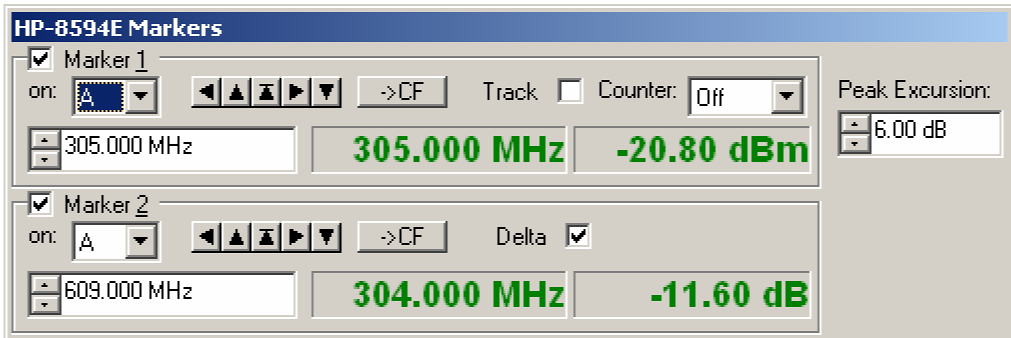
The **Centre & Span** and **Start & Stop** radio buttons perform the same function as the dropdown menu next to the **Centre** field in the Main panel. Similarly, the **Units** dropdown box and the **Linear** checkbox perform the same function as the dropdown menu next to the **Span** field in the Main panel.

The **Detector** setting controls the detector of the physical instrument: as the instrument sweeps across different frequencies, it may either report a **Sample** value or the **Peak** value it detects at any given frequency.

The **Resample** dropdown controls how the ISOC server packages trace information, changing resolution from that of the instrument to that requested by the ISOC client program. For a detailed explanation of the various resampling algorithms the ISOC offers, please read Section 2.1.2.7. The recommended value is Peaks.

The **Video avg** field controls how the physical instrument averages traces. By default, this feature is off. If you turn it on and specify a positive integer value, the instrument will continue to average traces using a moving window algorithm.

The next panel is the Markers panel. Through this panel, up to two markers can be controlled:



Markers appear in the form of a small diamond on the trace display. To turn on either **Marker 1** or **Marker 2**, click the appropriate checkbox.

The marker can be attached to any one of the four traces by selecting the desired trace in the **on** dropdown box. The marker can be positioned by either explicitly entering a frequency, or using one of the marker positioning buttons:

Next Left ( ): moves the marker to the next peak found left of the marker's current position. If no more peaks appear to the left of the marker, the marker will not be moved. A peak is defined as a local maximum that is separated from nearby peaks by troughs of sufficient depth (the requisite depth being determined internally by the peak search algorithm).

Maximum ( ): moves the marker to the highest signal level that appears anywhere in the trace.

Next Maximum ( ): moves the marker to the highest peak (as defined above under Next Left) whose level is below the signal level at the current marker position.

Next Right ( ): moves the marker to the next peak (as defined above under Next Left) to the right of the marker's current position. If no further peaks are found to the right of the marker, the marker is not moved.

Minimum ( ): moves the marker to the lowest signal level that appears anywhere in the trace.

The **->CF** button can be used to tune the instrument to the marker frequency.

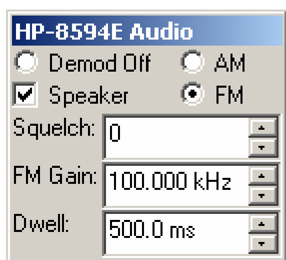
The **Track** option causes the centre frequency to follow the marker position.

The **Counter** option lets you select a marker counter resolution. If the marker counter is on, the marker will report not only the amplitude but also the frequency of the peak to which it is attached, and it will also follow that peak.

The **Peak Excursion** value determines how the instrument (also the virtual instrument) distinguishes peaks. So long as the signal remains within the peak excursion value of a detected peak, it is considered part of that peak and not treated as a separate peak, for the purposes of the **Next Left**, **Next Right**, and **Next Maximum** marker positioning functions, for instance.

The second marker can also be placed in Delta mode. The delta marker reports frequency and amplitude values that are relative to the first marker. To distinguish a delta marker from a regular marker, a small triangle symbol is used in place of the usual diamond symbol.

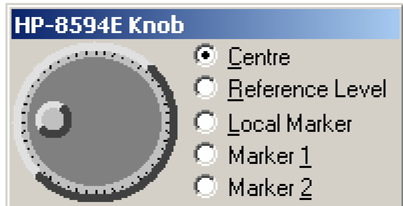
The Audio panel controls the spectrum analyser's demodulator and audio capabilities:



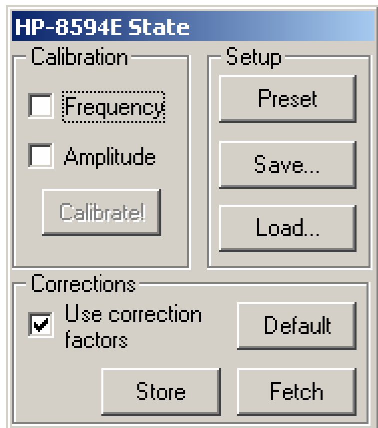
In order for audio to be heard from the instrument, the demodulator must be set to **AM** or **FM**; a **Dwell** time greater than zero must be specified; and the **Speaker** must be on. When these conditions are true, the instrument will pause during each trace at the marker frequency; during the pause, the demodulator will be turned on. (Note that this can result in an annoying clicking sound as the demodulator is turned off and on regularly).

Continuous audio can be heard if the instrument is in zero span mode.

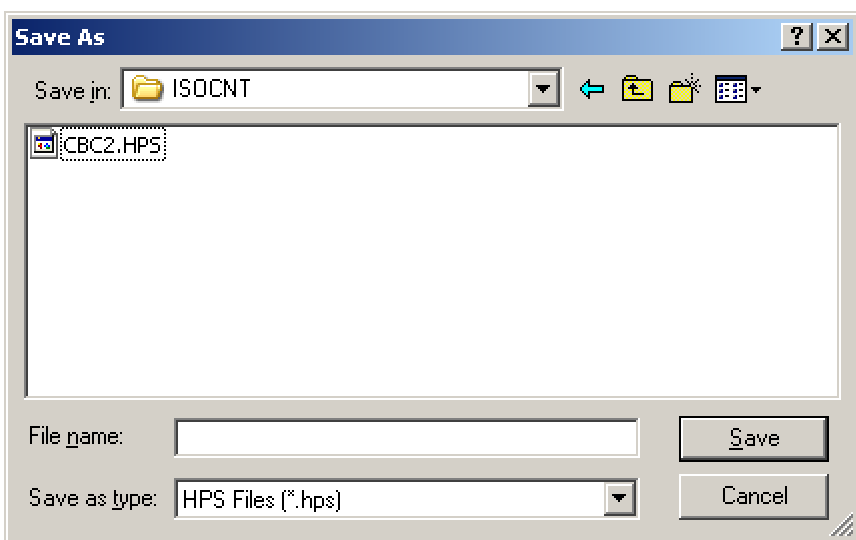
The Knob panel provides a tuning knob for convenience. The tuning knob can control the instrument's **Centre** frequency, **Reference Level**, the **Local Marker** position, or the positions of **Marker 1** and **Marker 2**:



The State panel can be used to load, save, and reset the instrument state, and also provides access to calibration functions:



The instrument's state can be saved on the local workstation and loaded later. To save the instrument state, click the **Save...** button. This displays the Save As dialog:

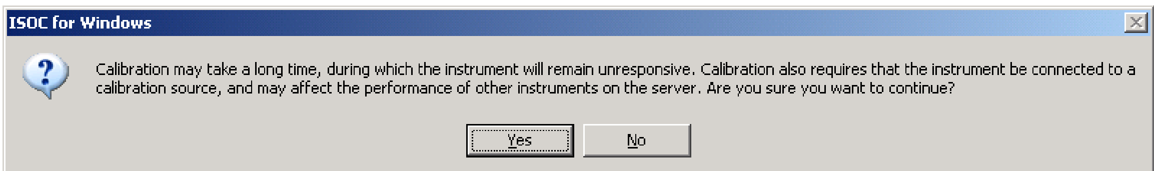


Files containing HP8594E spectrum analyser settings are saved by default using the `.HPS` extension.

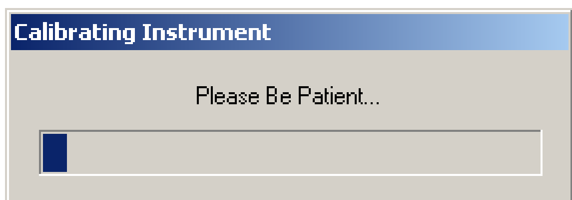
To reload saved settings to the instrument, use the **Load…** button. The instrument can also be reset to the factory preset state: to do so, click the **Preset** button.

The HP8594E spectrum analyser has a built-in calibration capability. Level measurements and frequency response can be calibrated either separately or together. To initiate calibration, make sure that the instrument is connected to its internal calibration source (either through a switch matrix or, preferably, using the short calibration cable that is provided with the instrument), select either the **Frequency** or **Amplitude** checkboxes (or both), and click the **Calibrate!** button.

Before calibration begins, a warning is displayed. As a general rule, it is best not to initiate calibration if you have more than one instrument open:



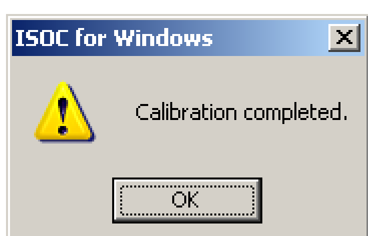
Calibration cannot be interrupted. During calibration, a progress dialog is shown that represents a rough estimate of the calibration process:



The estimate is rough by necessity, as calibration times vary, and during calibration, the instrument does not respond to commands, therefore its state and progress cannot be queried.

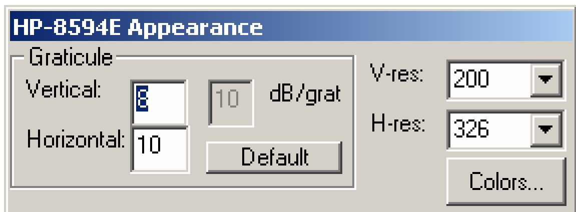
You may notice (especially if you have access to the ISOC server logs) that during calibration, the ISOC server will "throttle down". This is expected and harmless behaviour.

When calibration is completed, a message box appears:



To apply the corrections obtained during the calibration process, make sure that the **Use correction factors** checkbox is set. The current correction factors can be stored (in the instrument) by clicking the **Store** button; a previously stored set of calibration factors can be reloaded (causing the current set of calibration corrections to be discarded) by clicking **Fetch**. The **Default** button can be used to apply factory-preset calibration settings.

The last panel in the HP8594E virtual instrument is the Appearance panel. This panel controls the visual appearance of the trace display:



The **Graticule** area allows you to specify the number of **Vertical** and **Horizontal** graticules that are to appear in the trace display. The trace display resolution (**dB/grat**) is also displayed. Clicking the **Default** button resets the graticules to 8 horizontal, 10 vertical. The Colors… button controls trace colours; see Section 3.1.1.10.1 for details.

The **V-res** and **H-res** fields control the vertical and horizontal resolution of the trace display, respectively. By default, the resolution is set to 200 points vertically, while the horizontal resolution is set to the width of the trace display in pixels. You may change the resolution to a numeric value of your choice, or use one of the presets that appear in the dropdown boxes. When changing resolution, keep the following in mind:

If the horizontal resolution is not the same as the instrument's, resampling takes place. However, this "controlled" resampling may be preferable to the implicit resampling that takes place when the trace is drawn on the computer screen; therefore, it may be best to leave the **H-res** field at the screen resolution.

Although you can set the horizontal resolution to a value higher than the instrument resolution, this will not generate new information, only increase the required bandwidth to transmit traces from the server to the instrument.

On connections with limited bandwidth, it is best to leave the vertical resolution at a value smaller than the 1-byte limit, i.e., 255. That is because as soon as this value is above 255, each trace data point requires two bytes during transmission, effectively doubling the required bandwidth.

3.2.1.1.4. Instrument command reference

As a reference to server administrators and developers, and as a troubleshooting aid, here are the commands that the HP8594E virtual instrument uses to communicate with the physical instrument. Note that this list is not necessarily complete:

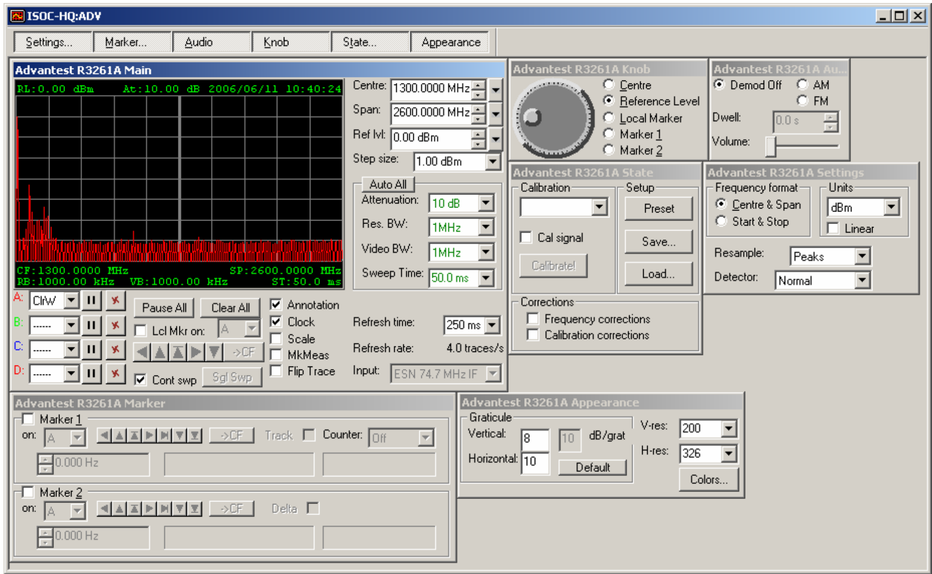
Command	***Description***
`CF`	Set/query centre frequency
`FA`	Set/query start frequency
`FB`	Set/query stop frequency
`SP`	Set/query span
`RL`	Set/query reference level
`AT`	Set/query attenuation, set auto attenuation
`RB`	Set/query resolution bandwidth, set auto RB
`VB`	Set/query video bandwidth, set auto VB
`ST`	Set/query sweep time, set auto sweep time
`VBR`	Set/query VBW/RBW ratio
`VAVG`	Set/clear/query video averaging
`MKPAUSE`	Set/query marker pause (dwell) value
`FMGAIN`	Set/query FM gain value
`SQLCH`	Set/query audio squelch value
`MKFCR`	Set/query marker frequency counter
`MKPX`	Control marker peaks function
`CORREK`	Set/query calibration correction settings
`DET`	Set/query detector setting
`AUNITS`	Set/query amplitude units

You may see these commands appear in the ISOC server log as the instrument is being utilized.

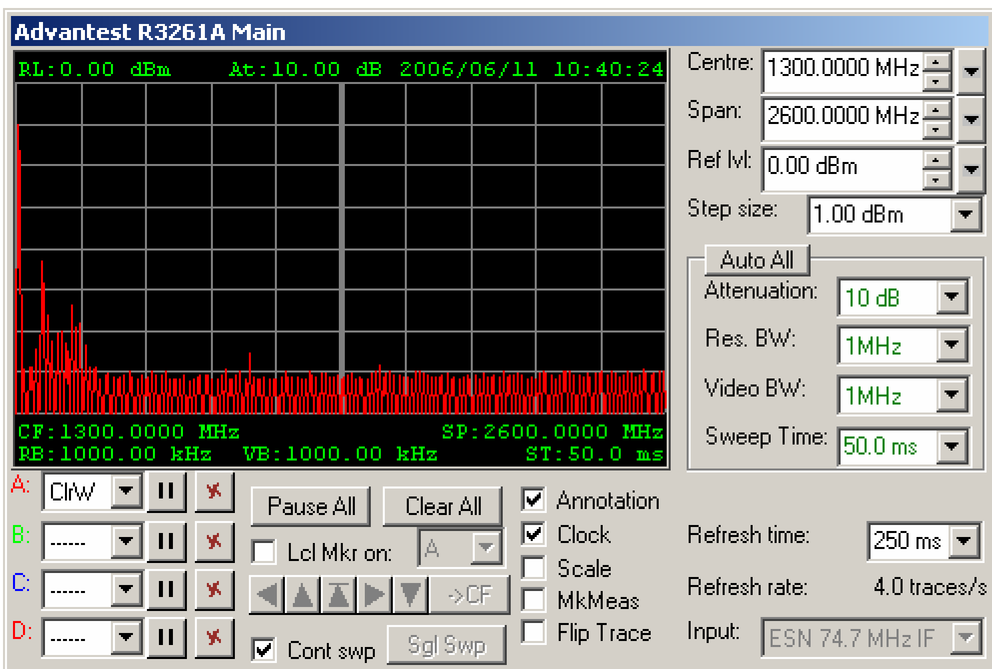
3.2.1.2. Advantest R3261A spectrum analyser

3.2.1.2.1. Interactive reference

The Advantest R3261A is very similar to the HP8594 spectrum analyser virtual instrument:



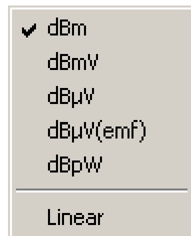
The appearance and functionality of the Main panel is nearly identical, with only some minor differences between the two units:



As can be seen, the controls are the same, except that the **VBW/RBW ratio** field is missing; the R3261A does not offer the ability to manually set this ratio.

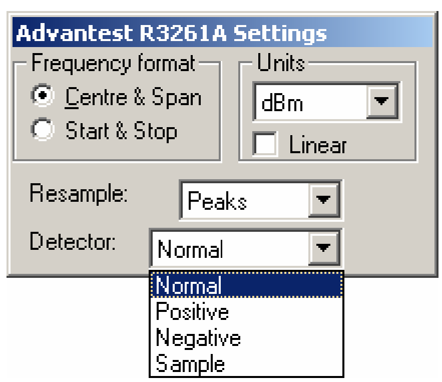
Another difference becomes evident when you invoke the dropdown menu next to the **Span** and **Ref lvl** fields. The span menu no longer has the Last Span option, as this option is not present on the R3261A:

The reference level menu appears quite different. The units of measure presented in this menu are all logarithmic units; in addition to the units available for the HP8594E, the settings dBµV(emf) and dBpW are also displayed:



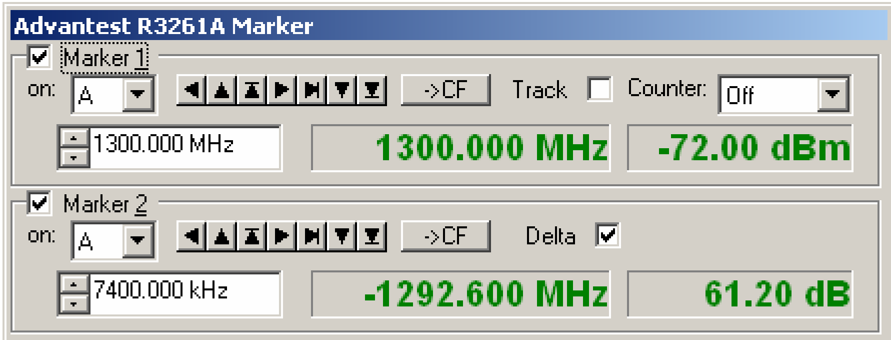
However, when you switch to linear mode, the unit settings are disabled; in linear mode, all level readings are expressed in units of Volts or multiples thereof (e.g., mV).

The Settings panel is also somewhat different. Absent is the video averaging option, as this option is not available on the R3261A. The **Detector** field, however, has several more options:



In addition to the Normal setting, the options of Positive (positive peak during the sample period), Negative (negative peak during the sample period) and Sample are presented.

The Marker panel is identical in functionality to the HP8594E Marker panel, with one exception. The Peak Excursion field is not present, as this value cannot be set on the R3261A:



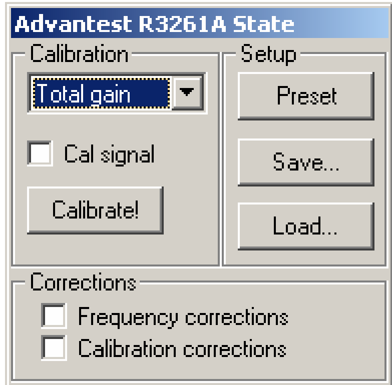
The Audio panel is somewhat simpler in appearance, as the **Squelch** and **FM Gain** settings are absent and the **Speaker** checkbox is replaced by a **Volume** control slider:

Note that the instrument's behaviour in zero span mode is somewhat different. The trace display continues to display the signal amplitude even if FM demodulation is selected. The effective IF bandwidth is controlled by adjusting the instrument's **RB** (resolution bandwidth) value.

The Knob panel is identical in appearance and functionality to the HP8594E's Knob panel.

The State control can be used to save and reload the instrument's state, reset the instrument to a factory preset state, to execute calibration, and to apply calibration corrections.

The calibration functionality of the R3261A differs significantly from that of the HP8594E. First, the instrument offers finer-grained control over the type of calibration to be performed:



The Calibration field can be used to select whether all calibration functions are to be performed, or if calibration is to be limited to Total gain, Input ATT (input attenuation), IF step Amptd (IF step amplitude), RBW switch, LOG linearity, or Amptd mag (amplitude magnitude).

The R3261A has a built-in switch for its calibration generator signal; there is no need to connect the calibration source externally. To turn on the calibration signal, make sure the **Cal signal** checkbox is set. This is a necessary step before a calibration can be successfully performed.

To execute the selected calibration option, click the **Calibrate!** button. As in the case of the HP8594E, a warning is first displayed letting you know that the calibration process may take some time to complete; this is followed by a progress dialog, and finally, a message box indicating that calibration has been completed.

You can selectively decide whether to apply **Frequency corrections**, amplitude and other **Calibration corrections**, or both sets of correction factors after a successful calibration.

The Appearance panel of the R3261A is identical in appearance and functionality to the Appearance panel of the HP8594E.

3.2.1.2.2. Instrument command reference

As a reference to server administrators and developers, and as a troubleshooting aid, here are the commands that the Advantest R3261A virtual instrument uses to communicate with the physical instrument. Note that this list is not necessarily complete:

Command	***Description***
`CF`	Set/query centre frequency
`FA`	Set/query start frequency
`FB`	Set/query stop frequency

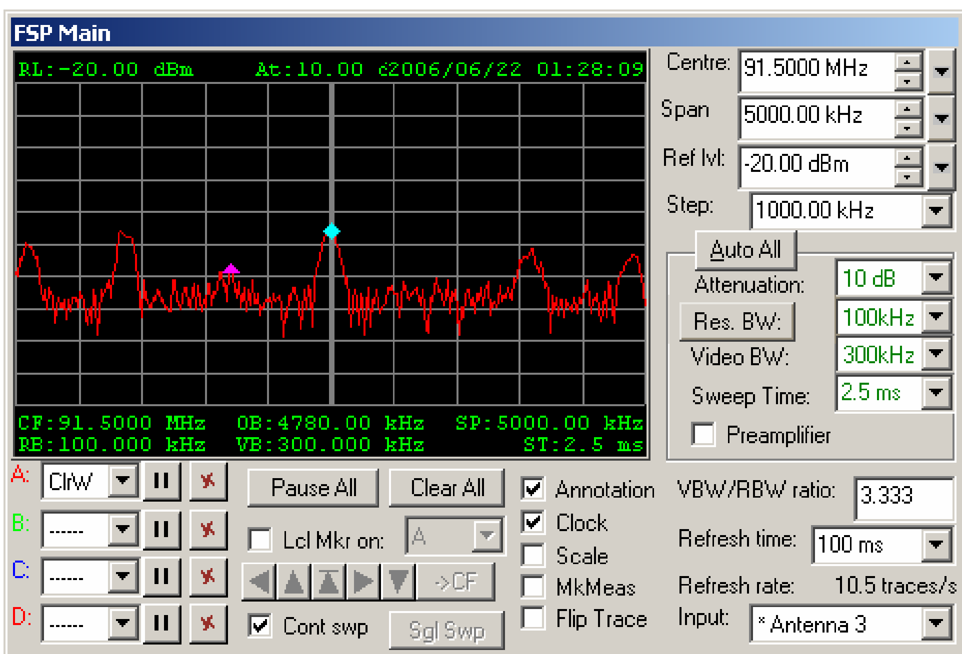
Command	Description
`SP`	Set/query span
`RL`	Set/query reference level
`AT`	Set/query attenuation, set auto attenuation
`RB`	Set/query resolution bandwidth, set auto RB
`VB`	Set/query video bandwidth, set auto VB
`SW`	Set/query sweep time, set auto sweep time
`DM`	Set/query detector setting
`PU`	Set/query marker dwell
`UN`	Set/query amplitude units

You may see these commands appear in the ISOC server log as the instrument is being utilized.

3.2.1.3. Rohde & Schwarz FSP/FSV spectrum analysers

3.2.1.3.1. Interactive reference

The Rohde & Schwarz FSP/FSV spectrum analyser virtual instrument offers a Main panel that is nearly identical to that of the HP8594E, with two exceptions. First, the FSP/FSV instrument has a **Preamplifier** option that can be turned on by checking the corresponding checkbox:

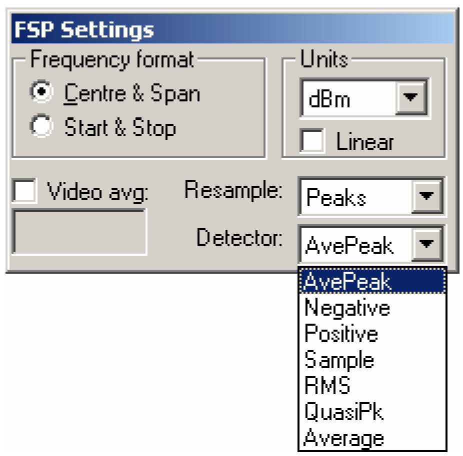


Second, the FSP instrument has multiple types of filters, which can be selected by clicking the Res BW button and making a choice from the dropdown menu that appears. In addition to the Normal (analog) filters, the instrument also has digital FFT filters, steep-edged channel filters, and filters with root-raised cosine (RRC) characteristic. The available filter frequencies vary depending on the filter type chosen. FFT filters are available only for frequencies at or below 30 kHz; if the FFT filter type is selected, but a filter frequency greater than 30 kHz is chosen, a normal (analog) filter is used.

Not all filter types are compatible with all operating modes of the instrument; for instance, if the tracking generator is used, the FFT filter type is not available.

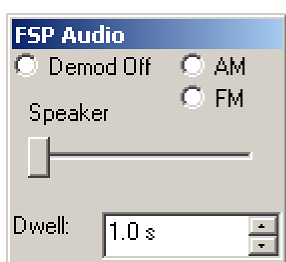
Of the spectrum analysers supported by the ISOC, the FSP is one of the most responsive. At a refresh rate of 100 ms, the FSP has been seen to deliver traces at a consistent rate of 10 traces per second.

The Settings panel of the FSP virtual instrument has the same functionality as its HP8594E counterpart; however, many more choices are offered for the **Detector** setting:



The functionality and appearance of the FSP Marker panel is the same as in the HP8594E virtual instrument.

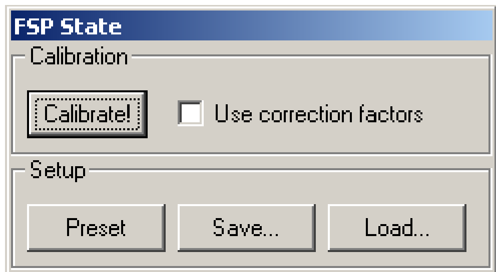
The FSP Audio panel offers demodulation settings, a volume control, and a field for dwell time:



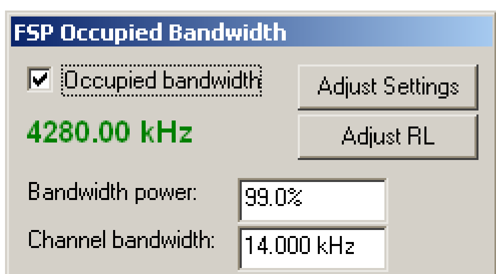
Unlike the HP8594E, the FSP instrument does not have a separate **FM Gain** field. The IF/demodulator bandwidth is controlled by setting the resolution bandwidth. In zero span mode, the instrument continues to display amplitudes, even if the FM demodulator is selected.

The Knob panel is the same in the FSP virtual instrument as it is in the HP8594E.

The FSP State panel offers a simpler design, reflecting the fact that the FSP instrument has only one calibration function:

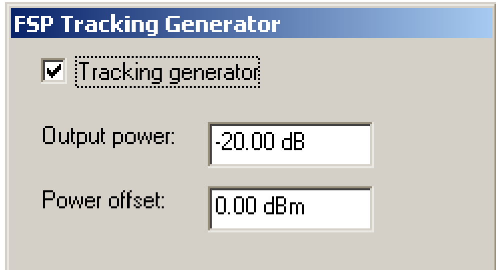


The FSP Occupied Bandwidth panel makes it possible to carry out occupied bandwidth measurements. Clicking the **Occupied bandwidth** checkbox turns on the measurement, repeatedly querying the instrument for the OBW value. Two user-adjustable parameters, the occupied bandwidth power level and channel bandwidth, control the measurement.



The **Adjust Settings** button sets the instrument's resolution bandwidth, video bandwidth, span, and detector settings to best match the current occupied bandwidth measurement. The **Adjust RL** button sets the instrument's reference level.

Another panel, the FSP Tracking Generator panel controls the built-in tracking generator of the FSP instrument. The tracking generator is turned on by clicking the **Tracking generator** checkbox. The output power and offset of the tracking generator can be adjusted. The tracking generator is turned off automatically when disconnecting from the instrument.



Lastly, the Appearance panel of the FSP instrument is the same as it is in the HP8594E virtual instrument.

3.2.1.3.2. Instrument command reference

As a reference to server administrators and developers, and as a troubleshooting aid, here are the commands that the Rohde & Schwarz virtual instrument uses to communicate with the physical instrument. Note that this list is not necessarily complete:

Command	***Description***
`SENS:FREQ:CENT`	Set/query centre frequency
`SENS:FREQ:START`	Set/query start frequency
`SENS:FREQ:STOP`	Set/query stop frequency
`SENS:FREQ:SPAN`	Set/query span
`DISP:TRAC:Y:RLEV`	Set/query reference level
`INP:ATT`	Set/query attenuation, set auto attenuation
`SENS:BAND:RES`	Set/query resolution bandwidth, set auto RB
`SENS:BWID:VID`	Set/query video bandwidth, set auto VB
`SENS:SWE:TIME`	Set/query sweep time, set auto sweep time
`SENS:BWID:VID:RAT`	Set/query VBW/RBW ratio
`SENS:AVER:COUN`	Set/clear/query video averaging
`CALC:MARK:FUNC:DEM:HOLD`	Set/query marker pause (dwell) value
`CALC:MARK:PEXC`	Control marker peaks function
`CAL:STAT`	Set/query calibration correction settings
`SENS:DET:FUNC`	Set/query detector setting
`UNIT:POW`	Set/query amplitude units
`SENS:BAND:RES:TYPE`	Set/query resolution bandwidth filter type
`CALC:MARK:FUNC:POW`	Set up OBW measurement
`SENS:POW`	Control OBW measurement options
`CALC:MARK:FUNC:POW:RES?`	Query OBW measurement
`OUTP`	Set/query tracking generator state
`SOUR:POW`	Set/query tracking generator settings
`STAT:QUES?`	Query measurement calibration nstatus

You may see these commands appear in the ISOC server log as the instrument is being utilized.

3.2.2. Receivers

Receivers supported by the ISOC fall into two broad categories: test receivers that support calibrated measurements, and communications receivers.

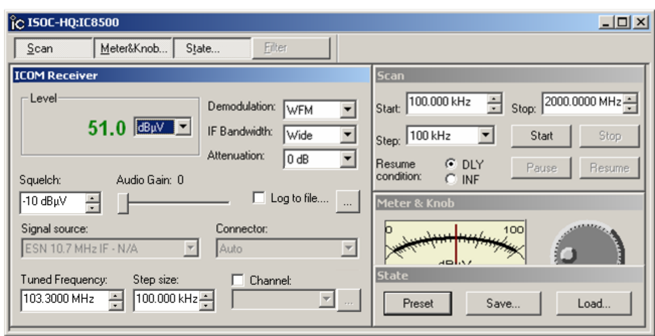
3.2.2.1. ICOM R-8500 and R-9000 receivers

The ISOC provides support for two types of ICOM communication receivers: the ICOM R8500 and the ICOM R9000. (Other receivers, such as the IC-R7100, may work with the "generic" ICOM driver but are not officially supported, except for DF operations).

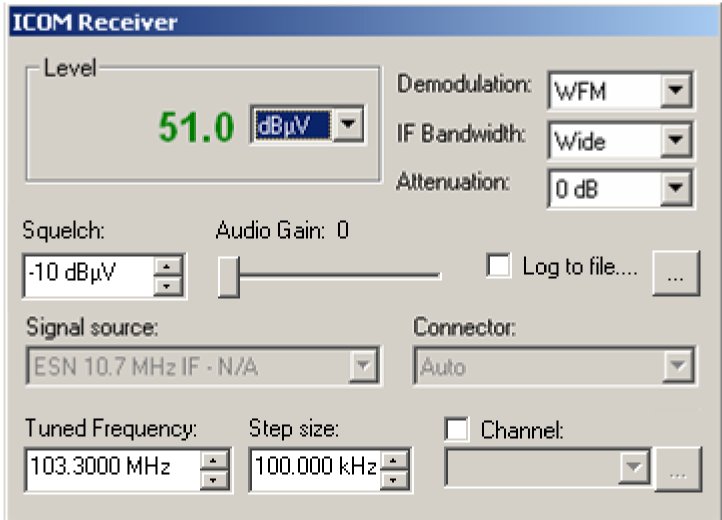
As the two receivers are effectively identical from the perspective of the virtual instrument user, they are discussed here together.

3.2.2.1.1. Interactive reference

Perhaps the most notable difference between the ICOM virtual instrument and other, more sophisticated virtual instruments such as the ESN receiver is the absence of a graphical trace:



The ICOM virtual instrument presents four panels, three of which can be removed in order to reduce the amount of screen space used by the instrument. The main panel of this instrument is the ICOM Receiver panel:



This panel provides basic receiver controls and also offers a level readback.

The instrument's frequency can be tuned by entering the desired value in the **Tuned Frequency** field. The measured signal level appears in the **Level** area. Level readings are reported in either "S-meter" units or in dBm or dBµV.

S-meter units are the native amplitude units of the ICOM receiver. The receiver does not offer a calibrated level reading, only this uncalibrated value that runs from 0-255 and reflects the approximate position of the S-meter needle on the instrument's front panel. The ISOC suite includes a calibration program that can be run on the ISOC server where the ICOM receiver is installed; this program builds a set of calibration tables that can be used to translate S-meter readings into other units.

If these calibration tables do not exist for the currently selected demodulation and bandwidth setting, the word **uncalibrated** appears in parenthesis next to the **Level** label.

The ICOM Receiver dialog also offers drop-down fields where the Demodulation, IF Bandwidth, and Attenuation settings of the receiver can be set. The Squelch field can be used to specify audio squelch; if the received signal level is below the squelch value, the instrument's audio output is suppressed. Note that in the current version of the ISOC, this squelch functionality is actually implemented in software, as the built-in squelch capability of the receiver interferes with level measurements.

The **Audio Gain** (volume) can be adjusted using the slider.

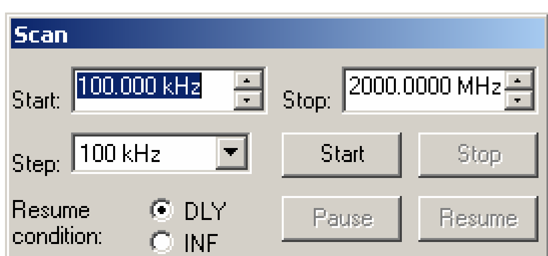
ICOM instruments are unique in that they have multiple signal connectors for different bands. The R-8500 has two connectors, one for 100 kHz – 30 MHz, the other for 30 MHz – 2 GHz. The R-9000 has three connectors: 100 kHz – 30 MHz, 30 MHz – 1 GHz, and 1 GHz – 2 GHz. Because of this, when a switch matrix is used to connect signal sources to the receiver, two selections must be made: the **Signal source** must be selected, as well as the input **Connector** to which that source is connected.

The **Connector** setting can also be left on **Auto**. In Auto mode, the ISOC server always selects the appropriate connector based on the receiver's tuned frequency. The selected connector is then displayed in the Connector field in green. In contrast, when a manual connector selection is made, it is displayed in red text.

The ICOM receiver can log its measurements to a human-readable text file. When you click the **Log to file** checkbox for the first time, or if you click the ... button, a standard Windows file selection dialog is displayed where you can specify the log file.

The **Channel** checkbox and field are used for channel tuning. In this mode, the receiver frequency is adjusted not by the set amount in the Step size field, but to discrete frequency values stored in a file. The file can be a `.SST` or `.LST` format file (see Appendices A.2 and A.3 below). When the checkbox is first checked, or when the button ... next to this checkbox is clicked, the Open dialog is displayed allowing you to select a `.SST` or `.LST` format file. So long as the **Channel** checkbox is set, the Step size field remains disabled.

ICOM receivers have a built-in scan capability. This capability is controlled through the **Scan** panel. To initiate a scan, specify the **Start** and **Stop** frequencies, and the **Step**. A running scan can be paused by clicking the **Pause** button. A scan also pauses if a signal level is encountered that exceeds the Squelch level, set in the ICOM Receiver panel. In this case, the scan may resume automatically, or may require you to click **Resume**, depending on the setting of the **Resume condition** radio buttons: **DLY** or **INF**.

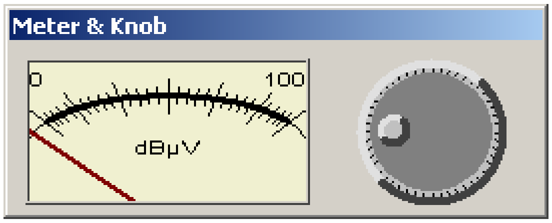


Tip: The scheduled scan capabilities offered by the ISOC Task Manager are probably much more suitable for most uses than use of the built-in scan capability of the ICOM receiver through the Scan panel.

The State panel lets you save the state of an ICOM receiver to a file on the local file system (click **Save…**), or load a state from a previously saved file (click **Load…**):

The receiver can also be reset to a factory preset state by clicking the **Preset** button.

The Meter & Knob panel offers a graphical meter and a tuning knob. The tuning knob tunes the receiver frequency, using the **Step size** value specified in the ICOM Receiver panel:

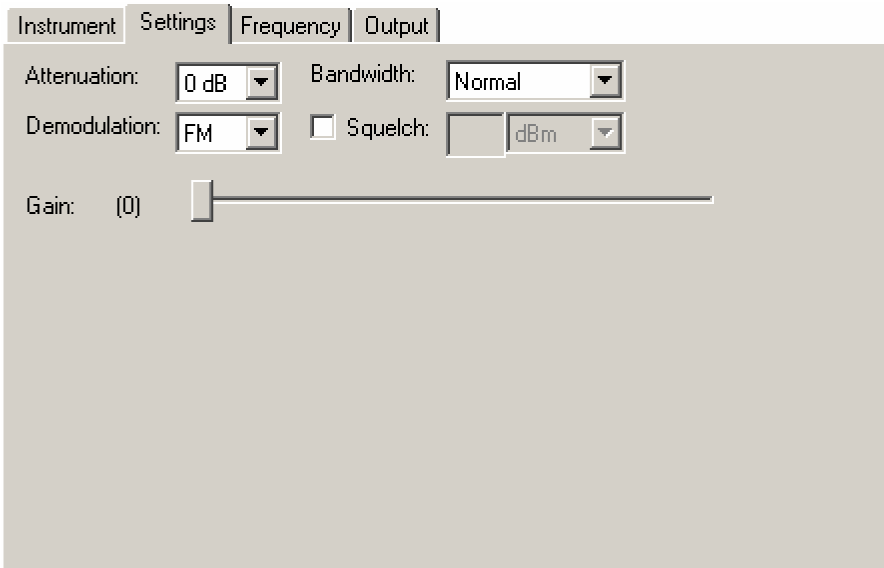


3.2.2.1.2. Background tasks reference

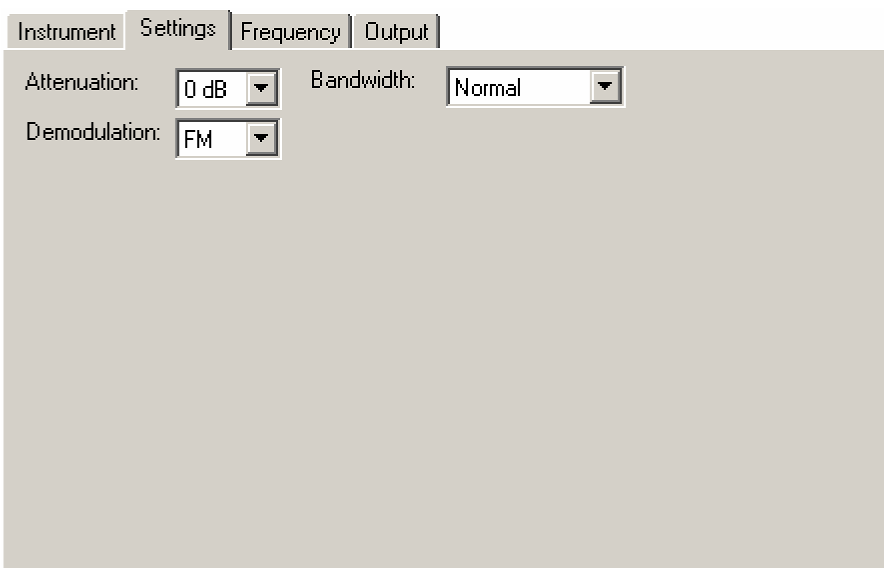
ICOM receivers can also be used in scheduled tasks.

Two task types are supported: in instrument control tasks, the receiver is continuously controlled by the software, and an optional human-readable log file is being generated, while in frequency scan mode, a high-speed scan of a set of frequencies is performed.

The ICOM interface in the ISOC Task Manager appears under the Settings tab. It offers a means to set the receiver's **Attenuation**, **Bandwidth**, **Demodulation**, and **Squelch**. An audio **Gain** can also be specified, which is especially useful if the receiver is used, for instance, for scheduled audio recordings:



When the receiver is used for a frequency scan task, a more limited user interface is presented, in which only the **Attenuation**, **Bandwidth**, and **Demodulation** settings are available:



3.2.2.1.3. Instrument command reference

ICOM receivers utilize a proprietary binary protocol over the serial port, the so-called CI-V protocol. CI-V commands are numerical commands, typically consisting of a 2-digit command code followed by a fixed number of digits representing the command's arguments.

Here is a list of a few select CI-V commands often used by the ISOC software:

Command	Description
`05`*nnnnnnnnnn*	Set receiver frequency
`06`*nnnn*	Set IF bandwidth and demodulator
`1401`*nnnn*	Set AF gain
`1403`*nnnn*	Set squelch
`1502`	Query S-meter level
`1800`	Power off
`1801`	Power on

The ISOC instrument driver also implements an extension to the `1502` command listed above:

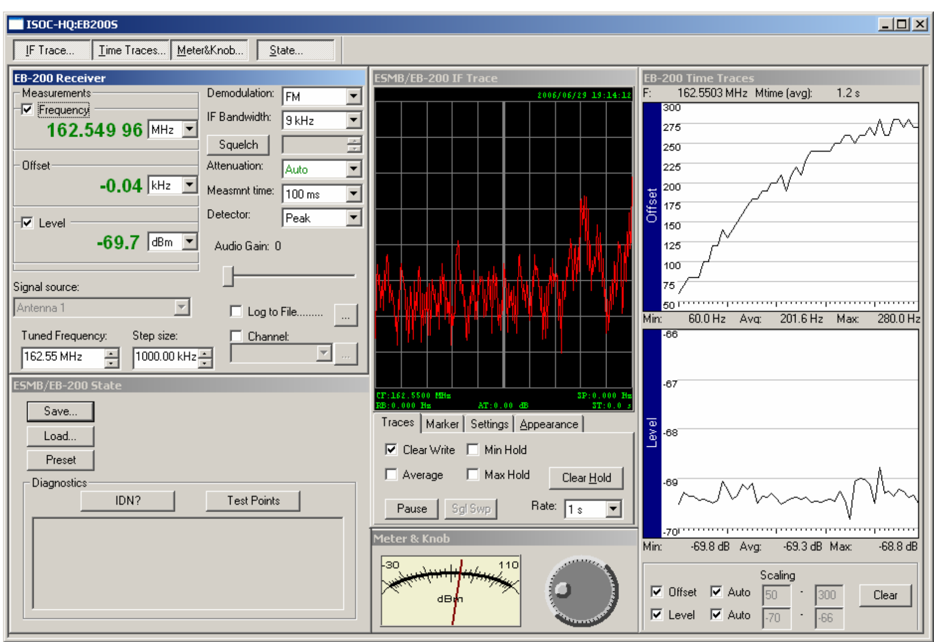
Command	Description
`1502`*nnnn*	Query S-meter level; last reading was *nnnn*, wait for reading to settle

3.2.2.2. Rohde & Schwarz EB-200 and ESMB receivers

Although very different physically, from a programming and remote operation perspective, the Rohde & Schwarz EB-200 and ESMB receivers are nearly identical. The ISOC system provides support for both receivers for interactive operation and for background tasks.

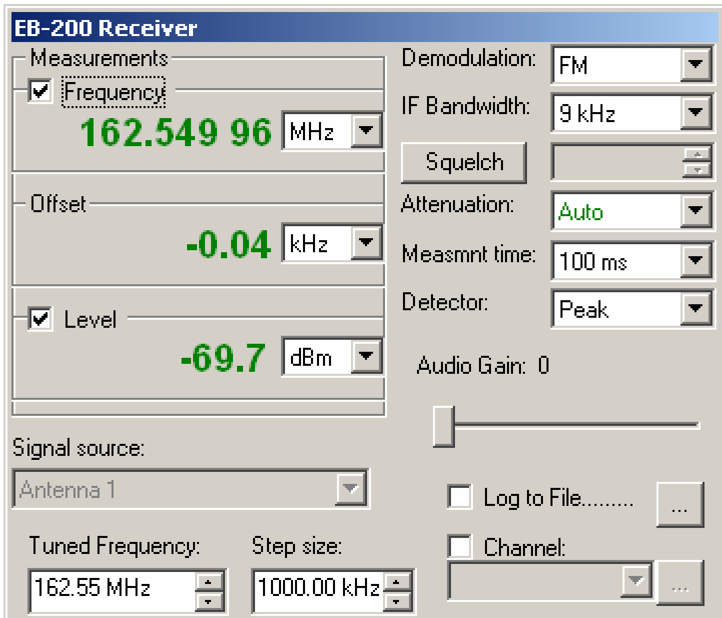
3.2.2.2.1. Interactive reference

The EB-200/ESMB virtual instrument uses five panels:



All of these panels can be turned off using the button bar at the top with the exception of the Receiver panel that provides the primary control interface for the instrument.

The Receiver panel has some differences between the two radios. For the EB-200, the Receiver panel has the following appearance:



On the left, **Frequency** and **Level** measurements can be selected. The receiver's state can be set using the Demodulation and IF Bandwidth levels. If squelch is desired, click the **Squelch** button, then enter the desired squelch level and hit the Enter key.

The receiver's frequency is set by entering the desired value in the **Tuned Frequency** field. The up-down control on the right of this field can also be used to adjust the frequency; its step size is controlled by the **Step size** field.

Attenuation can be set to **Auto**, or a manual level can be selected from the dropdown list. A manually set attenuation value is displayed in red; automatic attenuation values are displayed in green.

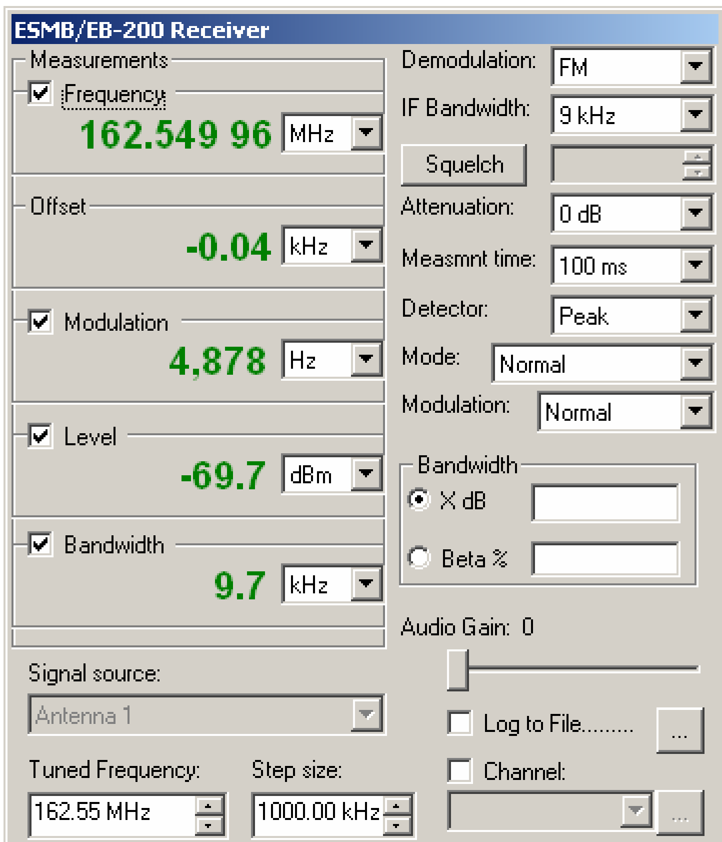
The receiver's measurement performance can be adjusted by changing the **Measmnt time** (measurement time) field; you can also choose the **Average**, **Peak**, **Fast**, or the **RMS** setting from the **Detector** dropdown list.

The **Audio Gain** slider controls the receiver's audio volume.

The EB-200/ESMB receiver can log its measurements to a human-readable text file. When you click the **Log to file** checkbox for the first time, or if you click the ... button, a standard Windows file selection dialog is displayed where you can specify the log file.

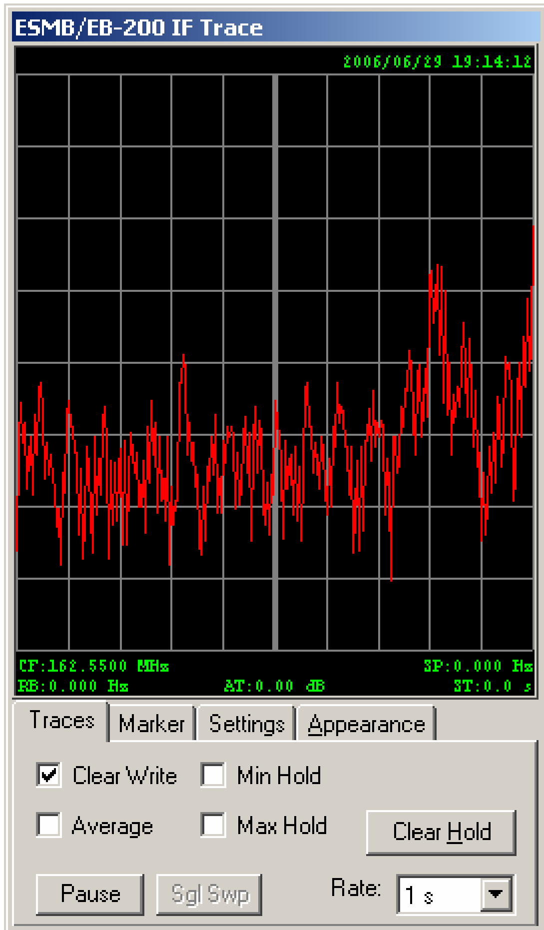
The **Channel** checkbox and field are used for channel tuning. In this mode, the receiver frequency is adjusted not by the set amount in the Step size field, but to discrete frequency values stored in a file. The file can be a `.SST` or `.LST` format file (see Appendices A.2 and A.3 below). When the checkbox is first checked, or when the button ... next to this checkbox is clicked, the Open dialog is displayed allowing you to select a `.SST` or `.LST` format file. So long as the **Channel** checkbox is set, the Step size field remains disabled.

The ESMB receiver's Receiver panel is slightly larger, as it contains several fields in addition to those present in the EB-200 Receiver panel:



The ESMB can measure **Modulation**. It can also perform **Bandwidth** measurement using one of two methods to determine what constitutes a signal: the **X dB** and the **Beta %** methods. The virtual instrument can also be used to specify the receiver's operating **Mode** (**Normal**, **Low Noise**, or **Low Distortion**) and configure how **Modulation** is measured (**Normal**, **Positive**, **Negative**).

The next panel in the ESMB/EB-200 virtual instrument is the IF Trace panel. It provides a graphical trace display at the top, and a tab control at the bottom:



You can interact with the trace display in several ways. By clicking and dragging the mouse, you can temporarily cause the line marker to appear, and read the frequency at the line marker, appearing in the upper left corner. By holding down the Ctrl key while dragging and then releasing the line marker, you can tune the receiver to the line marker frequency. Lastly, by holding down the shift key while dragging the mouse, you can view a span at the mouse position.

The first of several tabs beneath the trace display is the Traces tab. In this tab, you control the trace(s) that appear in the trace display. The trace display can show up to four traces, which can be selectively turned on and off using the checkboxes in this tab:

The **Clear Write** checkbox turns on the first trace, which is a clear write trace (no averaging or minimum/maximum hold calculations are performed on this trace).

The **Average** checkbox turns on the second trace, which is an averaging trace.

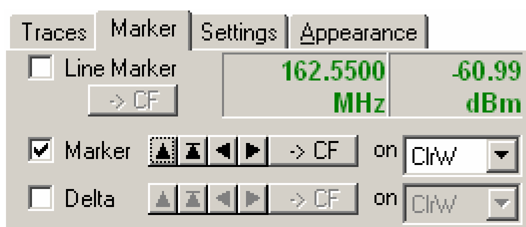
The **Min Hold** checkbox turns on the third trace, which is a minimum hold trace.

The **Max Hold** checkbox turns on the fourth trace, which is a maximum hold trace.

The **Clear Hold** button can be used to clear accumulated minimum, maximum, and average data. The **Pause** button can temporarily pause the trace. The traces can be restarted by clicking **Pause** a second time. While the traces are paused, the **Sgl Swp** button can be used to perform a single sweep.

The **Rate** field allows you to control the refresh rate of the trace display. The shortest refresh rate is 1 second.

The second tab in the IF Trace panel is the Marker tab. Through this tab, a line marker, a regular marker, and a delta marker can be controlled.



To turn on the line marker, click the **Line Marker** checkbox. The line marker can be positioned in the trace display by the mouse. While the line marker is visible, clicking the **-> CF** button tunes the instrument to the line marker frequency.

A normal marker appears as a small diamond placed on the signal trace. To turn on the marker, make sure the **Marker** checkbox is checked. When a marker is displayed, the marker frequency and the signal level at the marker appear in large green letters in the upper right portion of the Markers tab. The marker can be positioned by clicking one of the four marker positioning buttons:

Maximum ( ): positions the marker at the top signal level (highest peak).

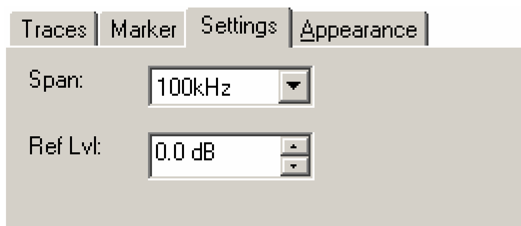
Next maximum ( ): positions the marker at the next highest peak relative to the current position. What constitutes a distinct peak is determined internally using a peak excursion algorithm.

Next left ( ): positions the marker at the next peak left of the current marker position.

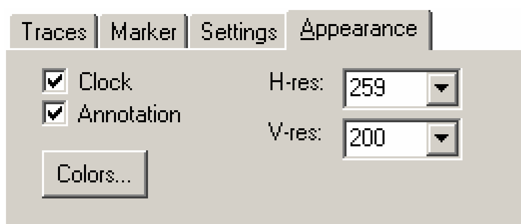
Next right (▶): positions the marker at the next peak right of the current marker position.

Of these marker positioning functions, the first (Maximum) is executed using the physical instrument. The other marker positioning functions are calculated by the ISOC software.

The Settings tab controls the trace. The **Span** field controls the trace width; the signal level at the top of the trace is controlled by the **Ref Lvl** field:



The last tab in the IF Trace panel is the Appearance tab. This tab controls the appearance of the trace display.



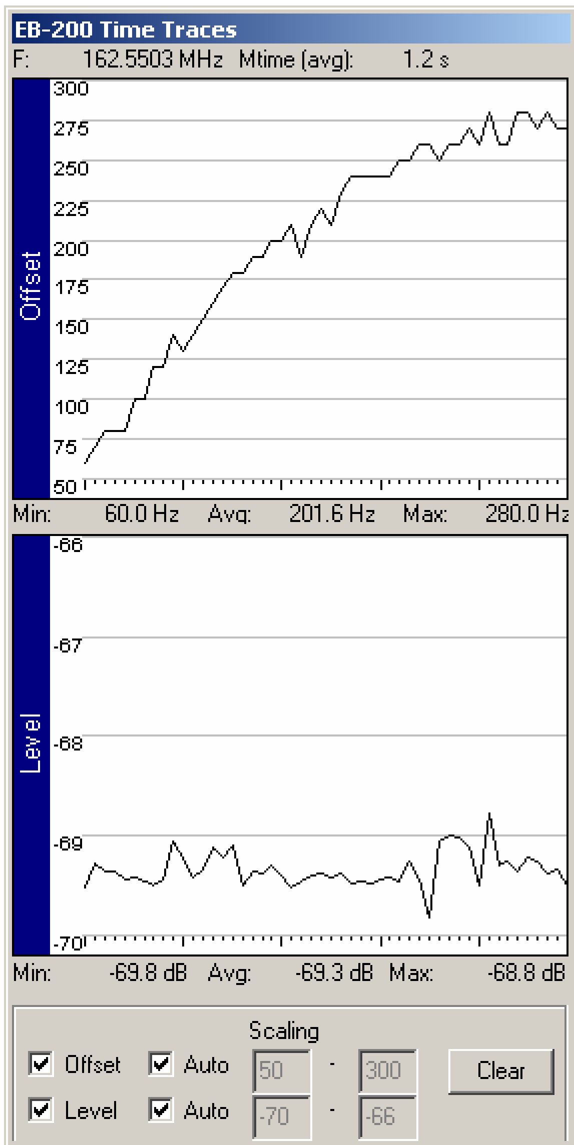
Two checkboxes, marked **Clock** and **Annotation**, determine which text decorations are to be displayed in the trace window. By turning all text decorations off, more of the area of the trace display can be used for the actual trace.

The **H-res** and **V-res** fields control the horizontal and vertical resolution of the trace as transmitted by the ISOC server to the ISOC client computer. By default, these fields are set to values that are most appropriate to the current visible size of the trace display. In addition to entering numeric values, it is also possible to use one of several presets when altering this field. The **Instrument** preset sets the trace width to the native value of the physical instrument. Setting the resolution higher than the instrument resolution is not a good idea: while increasing the amount of data to be transmitted per trace, it does not improve the trace quality, and may even introduce resampling artefacts. The **Screen** value is the recommended value, as this setting causes the trace to be resampled at the server using the actual resolution that corresponds with the present size of the trace display on the client computer. The resampling takes place in a controlled manner using a well tested algorithm, as opposed to the *ad-hoc* resampling that occurs when a trace of a different resolution is drawn on the computer screen using the built-in graphics primitives of the operating system.

For the vertical resolution, the **Byte** setting provides the optimal compromise between trace quality and bandwidth; it offers the maximum vertical resolution while still transmitting trace readings using single-byte values. This is especially important when using the instrument over a low-bandwidth connection, for instance.

The **Colors** button is used to change the colours used by the trace display. Pressing this button invokes the Colors dialog (see Section 3.1.1.10.1).

The next panel in the ESMB/EB-200 virtual instrument is the Time Traces panel:

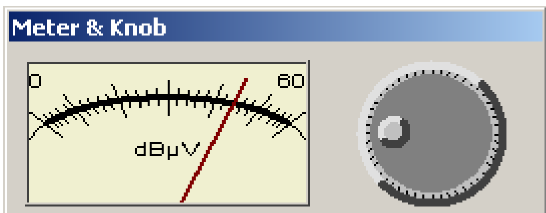


This panel provides a graphical history of the receiver's measurements.

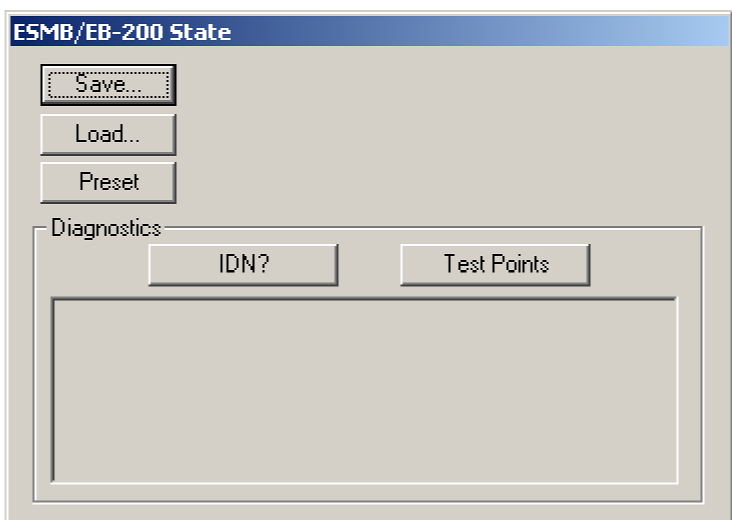
For the EB-200, two measurements are provided: **Offset** and **Level**. Both of these can be turned on and off selectively. By default, the vertical range of the graphs is set to **Auto**, but you can unset the corresponding checkboxes and enter Scaling values manually to achieve the desired graph appearance. The **Clear** button clears accumulated graph data.

For the ESMB, two additional readings: **Modulation** and **Bandwidth**, are also available in the Time Traces panel.

The Meter & Knob panel provides a VU-meter style analog level display and an analog knob for controlling the instrument frequency:



The final panel in the EB-200/ESMB virtual instrument is the State panel:



Through this panel, the instrument's current state can be saved. Clicking **Save…** invokes the standard Windows Save As dialog, where you can select a save file. The filename extension used for EB-200/ESMB state files is `.ESR`. The saved state of a receiver can be reloaded from a save file by clicking the **Load…** button, which in turn invokes the standard Windows File Open dialog.

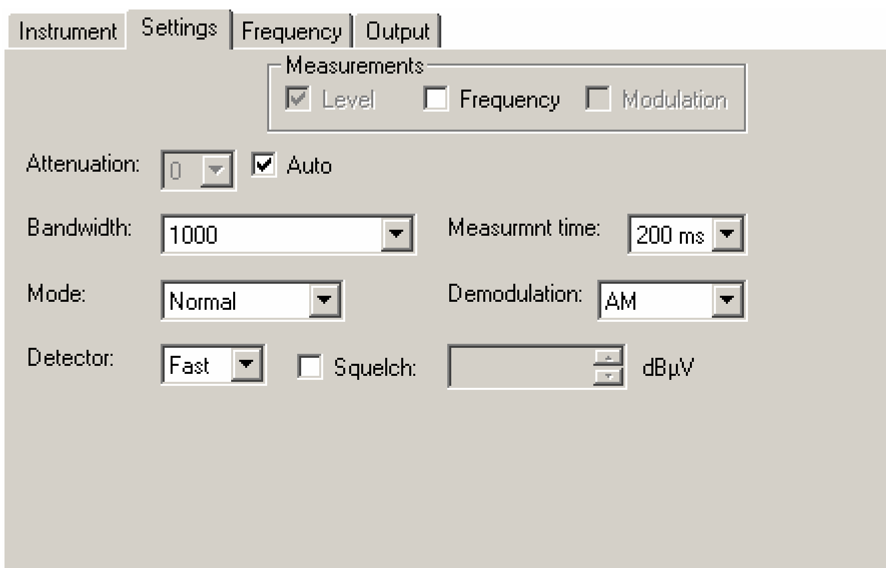
The instrument can be reset to a factory preset state by clicking **Preset**.

Two additional controls provide limited diagnostic functionality. The **IDN?** button queries the instrument's identification string; indeed, the same command is used internally by the ISOC software to determine if the receiver in question is an EB-200 or an ESMB. The **Test Points** button can be used to retrieve internal diagnostic information from the receiver, which is then displayed in the field below.

3.2.2.2.2. Background tasks reference

The EB-200/ESMB receivers can be used for both Instrument Control and Frequency Scan background tasks.

When used for an Instrument Control task, the driver presents the following user interface:

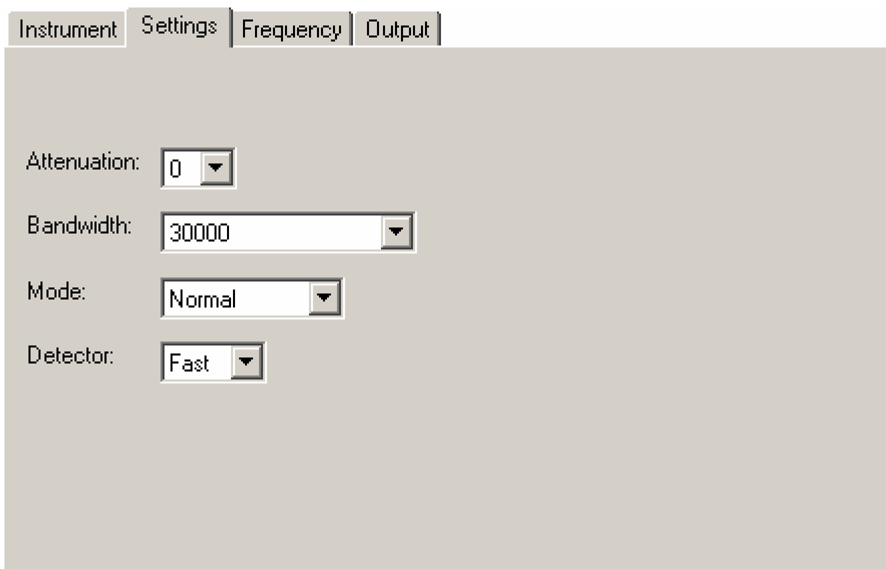


The **Measurements** area controls which measurements are to be performed. Note that if all measurements are turned off, **Level** measurement is turned on automatically. The **Modulation** measurement is available only for ESMB receivers.

The **Attenuation** can be set to **Auto** or to a specific value. You can also adjust the **Bandwidth**, **Mode**, **Detector**, **Measurmnt time**, and **Demodulation** values. The **Squelch** checkbox can be set if RF squelch is desired; the squelch value then can be entered in units of dBµV.

Tip: Choosing different **Detector** settings can have a significant impact on the scanning speed. For best results (and fastest scanning speed) the **Detector** should be set to “Fast”.

For Frequency Scan tasks, only a small subset of these controls is available:



3.2.2.2.3. Instrument command reference

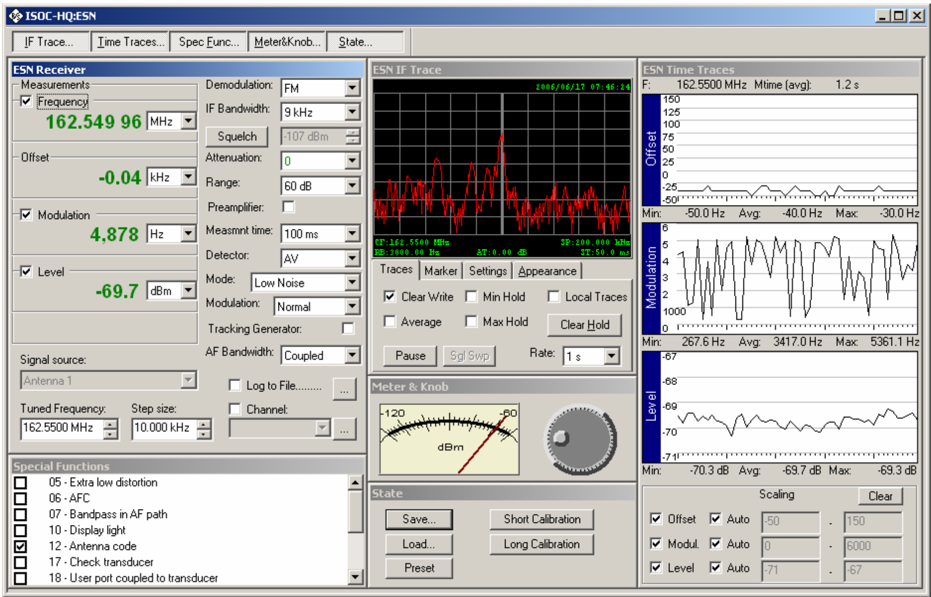
Some commands used more frequently by the ISOC system to control EB-200/ESMB receivers are as follows:

Command	***Description***
`FREQ`	Set/query receiver frequency
`BAND`	Set/query IF bandwidth
`MEAS:TIME`	Set/query measurement time
`DET`	Set/query detector setting
`MEAS:BAND:MODE`	Set/query bandwidth measurement method
`MEAS:BAND:XDB`	Set/query BW measurement XDB value
`MEAS:BAND:BETA`	Set/query BW measurement beta value
`INP:ATT:AUTO`	Set auto attenuation state
`INP:ATT:STAT`	Query attenuation state
`INP:ATT:MODE`	Query attenuation mode
`DEM`	Set/query demodulator setting
`FREQ:SPAN`	Set/query span
`OUTP:SQU:THR`	Set/query squelch level
`SYST:AUD:VOL`	Set/query audio volume
`OUTP:SQU:STAT`	Query squelch state

3.2.2.3. Rohde & Schwarz ESN receiver

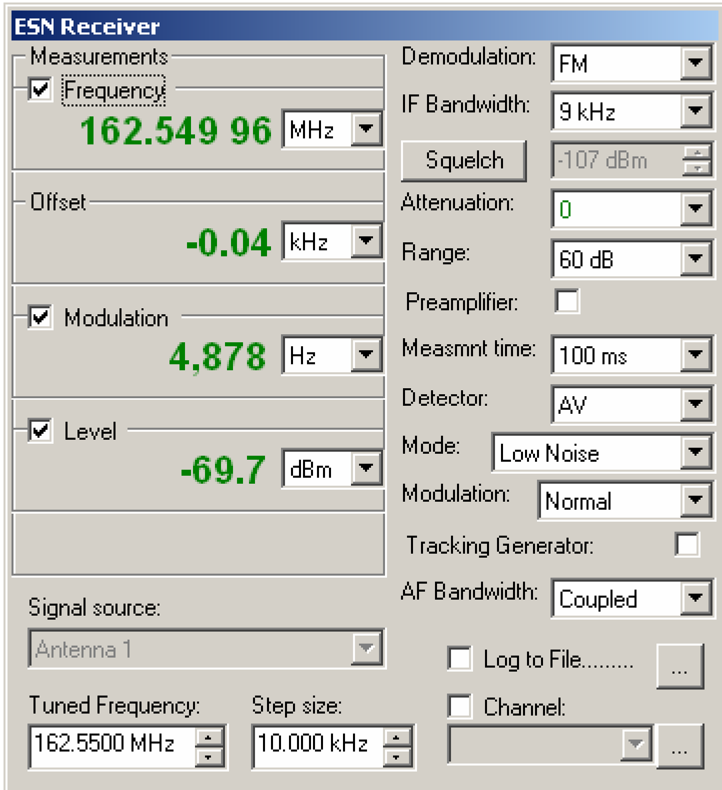
3.2.2.3.1. Interactive reference

The Rohde & Schwarz ESN receiver is one of the most complex instruments that the ISOC can control. Correspondingly, its user interface has a large number of controls divided into six panels:



Of the six panels, five can be hidden by clicking the corresponding button in the virtual instrument’s toolbar.

Primary control of the receiver is through the Receiver panel:



This panel controls the receiver's basic functions and displays its measurements. Specifically:

The **Frequency** field displays the received frequency. This measurement can be turned off by clearing the checkbox. The unit of measurement is user selectable.

The **Offset** field displays the current offset. This is a calculated value, the difference between the tuned and measured frequency. The unit of measurement for the offset is user selectable, and is independent of the unit of measurement used for the **Frequency** field.

The **Modulation** field measures the current modulation level. This measurement can be turned on or off using the checkbox. Obviously, this measurement can only be made if a **Demodulation** setting has been selected. When FM demodulation is used, modulation is measured as a frequency value, with a unit of measure that is user selectable. When AM demodulation is used, the modulation value is measured as a percentage value. (Note that frequency and level measurements are always performed even if their display is turned off, as the measured values are required internally by the ISOC).

The **Level** field measures the received signal level. This measurement can be turned off by clearing the checkbox. The unit of measurement is user selectable.

Underneath the **Level** field, an area of the ESN Receiver panel is reserved to inform the user of overrange/underrange and overload conditions. If the received signal level is such that it exceeds the receiver's capabilities (e.g., of a 30 dB receiver range is used along with manual attenuation), the words **OVERRANGE** or **UNDERRANGE** are displayed in this area in large red letters. The field may also display the word **OVERLOAD** if any of the receiver's stages are overloaded (this may happen even when the level measurement appears valid, e.g., when measuring a weak signal with a very strong signal lying just outside the IF bandwidth).

The **Demodulation** combo box lets you select the receiver demodulation.

The **IF Bandwidth** setting controls the receiver IF bandwidth. The actual values that appear in this combo box depend on the installed options in the specific receiver in use. When the ISOC connects to an ESN receiver, it always queries the receiver for the current set of IF filters available.

The **Squelch** button turns on squelch control. Next to the button, a numeric field controls the squelch value. If the received (RF) signal strength is below the squelch value and squelch is on, the receiver's AF output is suppressed.

The **Attenuation** field controls the receiver's attenuator. When set to **Auto**, the receiver automatically selects the attenuator most applicable to the presently received signal. The field is updated accordingly, displaying the automatically selected attenuation value in green. You can also select a specific attenuation setting manually, from the range of 0–70 dB, with a step size of 10 dB. A manually selected attenuation value is displayed in red.

The **Range** setting controls the range of the receiver's analog VU-meter style level meter. The level meter in the Meter & Knob panel of the virtual instrument mimics this behaviour. Two ranges are available: 30 dB and 60 dB.

The **Preamplifier** checkbox can be used to turn on the receiver's internal preamplifier. When the preamplifier is on, the signal level is boosted by 10 dB at the first mixer, and noise is reduced by 4-6 dB. As a result, the receiver's dynamic range is reduced by 4-6 dB (a decrease of 10 dB due to the lower maximum level, combined with an increase of 4-6 dB due to reduced noise).

The **Measurement Time** field controls the time for which the measured signal is monitored in order to obtain a measured value. For peak measurements, the reported signal level is the maximum value during the measurement period. For average measurements, the reported signal level is the average during the measurement period. The measurement time setting also influences the measured frequency reading; the longer the measurement time, the more significant (decimal) digits appear in this field.

Tip: If a very long measurement time is selected, the virtual instrument's behaviour may appear sluggish, as it has to wait a long time before the physical receiver responds to a query.

The **Detector** field controls how signal levels are obtained during the measurement time period. PK stands for peak: the signal level obtained is the maximum level during the measurement time period. QP is quasy-peak: the received signal is weighted using a peak detector with defined charge and discharge times. AV means average; the signal level is averaged during the measurement time period. Lastly, RMS performs root mean square averaging.

The **Mode** field provides a means to switch between low noise and low distortion modes. In low distortion mode, the receiver IF gain is adjusted so that the noise indication remains at or below the zero scale deflection. In low noise mode the IF gain is 10 dB lower, increasing the signal-to-noise ratio by 10 dB.

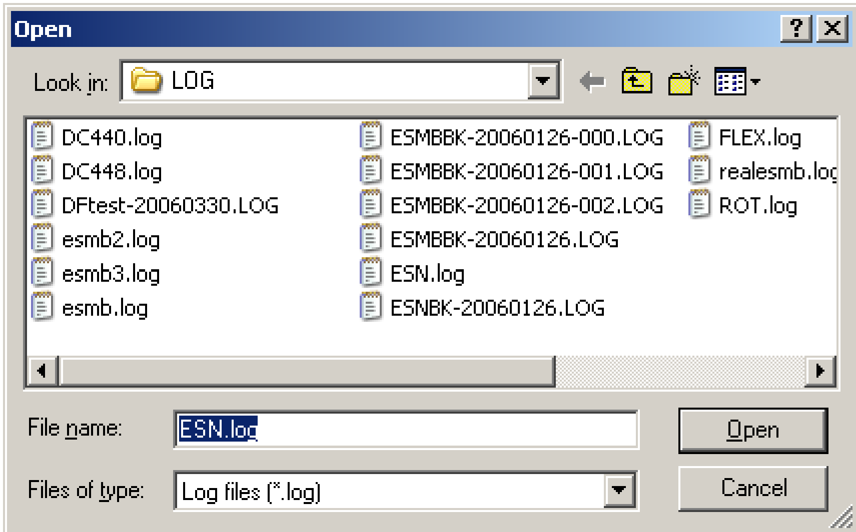
The **Modulation** field controls modulation measurements. This field is only effective when the **Modulation** measurement on the left side of the Receiver panel has been selected. The Normal, Positive, and Negative settings control the selection of normal, positive, and negative modulation depth measurements (for AM demodulation), or normal, positive, and negative frequency deviation measurements (for FM demodulation).

The **Tracking Generator** checkbox can be used to turn on or off the receiver's tracking generator.

The **AF Bandwidth** combo box controls the bandwidth of the AF stage of the receiver. When set to Coupled, the AF bandwidth follows the IF bandwidth in accordance with an algorithm internal to the receiver.

The **Signal Source** field provides control for the switch matrix. This field is inactive if no switch matrix is present at the server site (although even in this case, it may display a permanently connected, i.e., "hardwired" signal source). Clicking the combo box causes it to be populated with the list of signal sources that can be connected to this receiver. Any signal sources presently in use are marked by an asterisk (*); this also includes signal sources that are not presently connected to any device, but cannot be used because of a conflict in the way sources are wired at the switch matrix. When you select a signal source from this list, an appropriate command is sent to the ISOC server which, in turn, sends the necessary commands to the switch matrix.

The **Log to File** checkbox provides a means to record receiver measurements in a human-readable (ASCII) text file. When the checkbox is checked for the first time, or when the ... button next to the checkbox is clicked, the Open dialog is displayed, allowing you to select a log file:



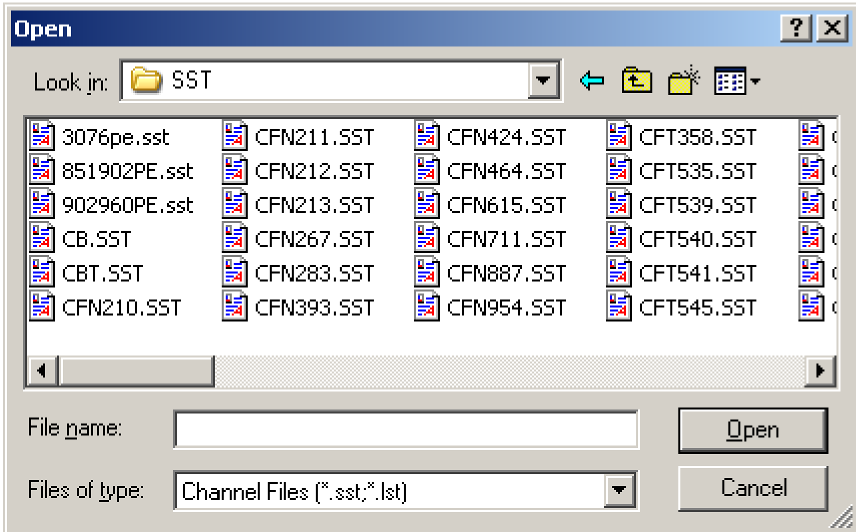
Log files are always appended to, never overwritten. The log file format is described in detail in Section 2.1.3.3.

The **Tuned Frequency** field is where the receiver frequency can be entered. The most straightforward way to enter a frequency is by selecting the contents of this field using the mouse, and then entering a new value from the keyboard. Unit abbreviations can be used; for instance, to enter a frequency of 2.1 GHz, you may type `2.1g`. When you're done entering a new frequency, hit the Enter key.

Another way to change the receiver frequency is by using the up-down control situated at the right edge of this field. The up-down step size is controlled by the **Step Size** field. Lastly, the knob on the Meter & Knob panel can also be used to adjust the receiver frequency.

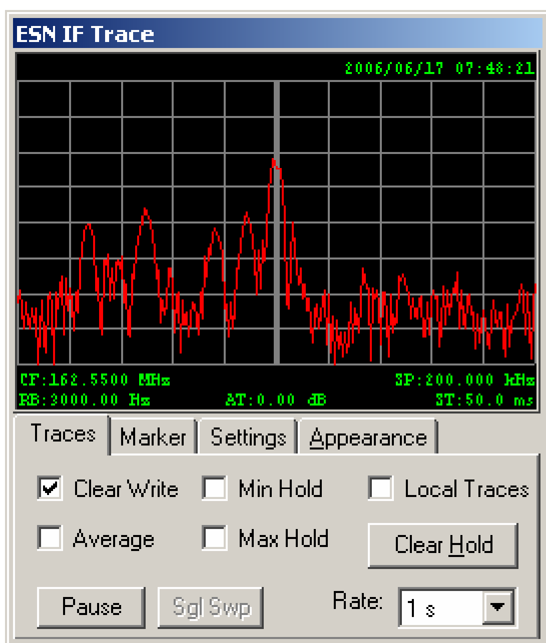
The value displayed in the **Tuned Frequency** field may change, especially if the receiver is configured for AFC (special function 06). The software is designed not to adjust the value displayed in this field if you are already editing it.

The **Channel** checkbox and field are used for channel tuning. In this mode, the receiver frequency is adjusted not by the set amount in the Step size field, but to discrete frequency values stored in a file. The file can be a `.SST` or `.LST` format file (see Appendices A.2 and A.3 below). When the checkbox is first checked, or when the button ... next to this checkbox is clicked, the Open dialog is displayed allowing you to select a `.SST` or `.LST` format file:



Note that so long as the **Channel** checkbox remains checked, the Step size field remains disabled. If you wish to end channel tuning mode and you wish the up-down control and tuning knob functionality to return to normal, clear this checkbox.

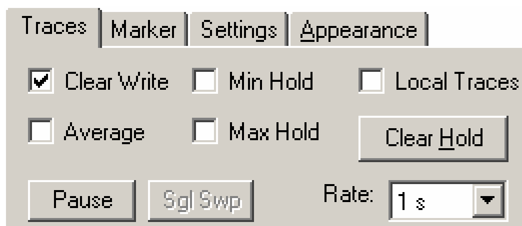
The next panel in the ESN receiver virtual instrument is the IF Trace panel, whose main function is to provide a visual representation of the instrument's trace display:



The IF Trace window is divided into two areas. The top part contains the trace display, while the bottom part contains a tab control with several tabs.

You can interact with the trace display in several ways. By clicking and dragging the mouse, you can temporarily cause the line marker to appear, and read the frequency at the line marker, appearing in the upper left corner. By holding down the Ctrl key while dragging and then releasing the line marker, you can tune the receiver to the line marker frequency. Lastly, by holding down the shift key while dragging the mouse, you can view a span at the mouse position.

The first of several tabs beneath the trace display is the Traces tab. In this tab, you control the trace(s) that appear in the trace display:



The **Local Traces** checkbox has a rather significant effect on the virtual instrument's behaviour. When this checkbox is checked, average, minimum hold, and maximum hold traces are generated "locally", i.e., on your workstation; when the checkbox is off, these traces are obtained from the instrument, which in turn does the necessary calculations for average, minimum hold, and maximum hold.

The main difference between the two methods is that the workstation can only perform signal level calculations on traces it receives. For instance, if the instrument receives two traces about one second apart, any signal levels observed between these two traces will be lost; this will have an obvious affect, especially on minimum/maximum hold values.

Unfortunately, the instrument can only handle two traces simultaneously, and when two traces are used, transmitting the traces to the workstation takes longer. It is for this reason that the **Local Traces** option is presented, improving software efficiency at the cost of sacrificing sensitivity to short duration transient signals.

The **Clear Write** checkbox turns on the first trace, which is a clear write trace (no averaging or minimum/maximum hold calculations are performed on this trace).

The **Average** checkbox turns on the second trace, which is an averaging trace.

The **Min Hold** checkbox turns on the third trace, which is a minimum hold trace.

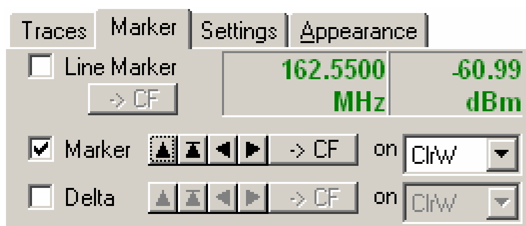
The **Max Hold** checkbox turns on the fourth trace, with is a maximum hold trace.

Note that unless **Local Traces** is set, only two of the four traces can be displayed simultaneously. Traces on the physical instrument are controlled by sending `SW:M` commands.

The **Pause** button can temporarily pause the trace. The traces can be restarted by clicking **Pause** a second time. While the traces are paused, the **Sgl Swp** button can be used to perform a single sweep.

The **Rate** field allows you to control the refresh rate of the trace display. The shortest refresh rate is 1 second (this is an instrument limitation, as the instrument cannot transmit IF traces faster to the controlling computer).

The second tab in the IF Trace panel is the Marker tab. Through this tab, a line marker, a regular marker, and a delta marker can be controlled.



To turn on the line marker, click the **Line Marker** checkbox. The line marker can be positioned in the trace display by the mouse. While the line marker is visible, clicking the **-> CF** button tunes the instrument to the line marker frequency.

A normal marker appears as a small diamond placed on the signal trace. To turn on the marker, make sure the **Marker** checkbox is checked. When a marker is displayed, the marker frequency and the signal level at the marker appear in large green letters in the upper right portion of the Markers tab. The marker can be positioned by clicking one of the four marker positioning buttons:

Maximum ( ): positions the marker at the top signal level (highest peak).

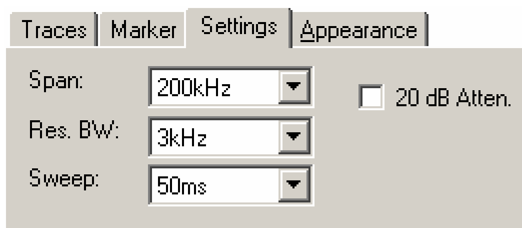
Next maximum ( ): positions the marker at the next highest peak relative to the current position. What constitutes a distinct peak is determined internally using a peak excursion algorithm.

Next left ( ): positions the marker at the next peak left of the current marker position.

Next right ( ): positions the marker at the next peak right of the current marker position.

Of these marker positioning functions, the first (Maximum) is executed using the physical instrument. The other marker positioning functions are calculated by the ISOC software.

The third tab in the IF Trace panel is the Settings panel. Through this panel, the main parameters of the IF trace are controlled:



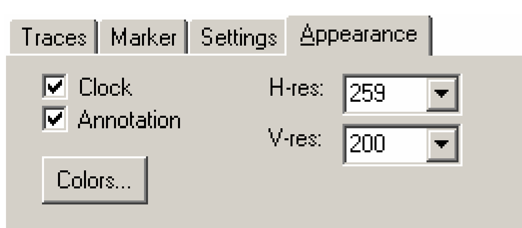
The **Span** is the width of the trace, in Hertz. The combo box contains values that the ESN receiver accepts as valid.

The **Res. BW** field controls the resolution bandwidth of the trace. A large span and a low resolution bandwidth value can cause the trace to be updated very slowly.

The **Sweep** field controls the sweep rate of the trace display. Unfortunately, it is of limited utility as the actual refresh rate on the virtual instrument is limited by the rate at which the instrument can transfer trace data to the ISOC software.

The IF trace feature of the ESN receiver incorporates an extra attenuator that can bring the trace level down by 20 dB. This attenuator is turned on by checking the **20 dB Atten.** Checkbox. This attenuator does not affect the measured signal level, only the IF trace display.

The last tab in the IF Trace panel is the Appearance tab. This tab controls the appearance of the trace display.



Two checkboxes, marked **Clock** and **Annotation**, determine which text decorations are to be displayed in the trace window. By turning all text decorations off, more of the area of the trace display can be used for the actual trace.

The **H-res** and **V-res** fields control the horizontal and vertical resolution of the trace as transmitted by the ISOC server to the ISOC client computer. By default, these fields are set to values that are most appropriate to the current visible size of the trace display. In addition to entering numeric values, it is also possible to use one of several presets when altering this field:

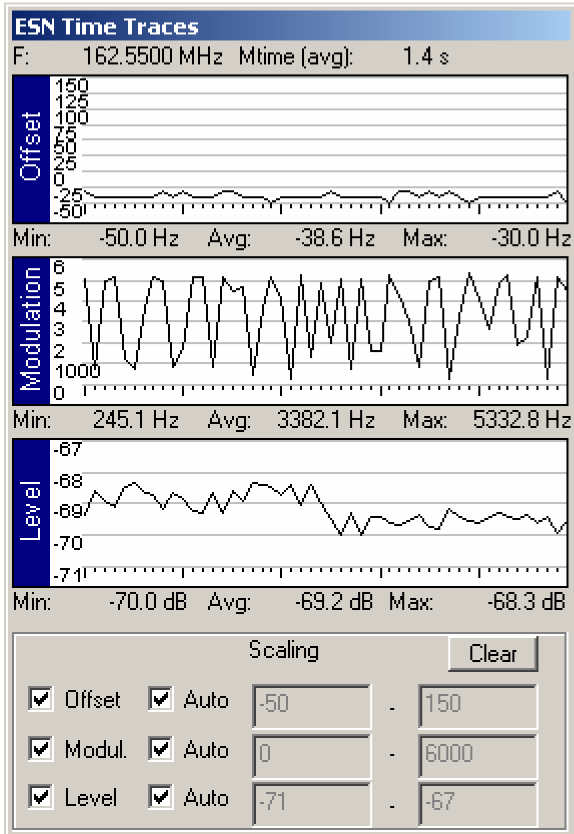
Instrument: The trace is sent at the native resolution of the physical instrument (i.e., no resampling takes place at the server). While this setting provides the best guarantee against resampling artefacts, it is usually unnecessary, as implicit resampling takes place on the client computer in any case when a trace is drawn in a (possibly small) trace display area. Setting the resolution higher than the instrument resolution is not a good idea: while increasing the amount of data to be transmitted per trace, it does not improve the trace quality, and may even introduce resampling artefacts.

Screen: This setting causes the trace to be resampled at the server using the actual resolution that corresponds with the present size of the trace display on the client computer. This setting is highly recommended, as the resampling takes place in a controlled manner using a well tested algorithm, as opposed to the *ad-hoc* resampling that occurs when a trace of a different resolution is drawn on the computer screen using the built-in graphics primitives of the operating system.

Byte: For the vertical resolution of the trace, this setting selects the highest resolution that can still be transmitted in the form of single-byte values. This is important when trying to achieve maximum trace quality while limiting the amount of data that is to be transmitted in each trace.

The **Colors** button is used to change the colours used by the trace display. Pressing this button invokes the Colors dialog (see Section 3.1.1.10.1).

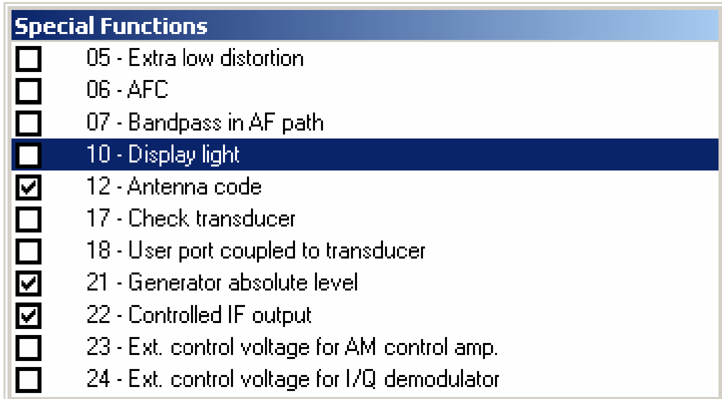
The next panel in the ESN virtual instrument is the Time Traces panel. This, largely non-interactive panel provides a visual representation of the last 50 measurements taken by the receiver. Specifically, the measured values for the receiver offset, modulation, and signal level are displayed in the form of continuously updated, moving graphs:



At the top of this panel, the receiver frequency (**F**) and actual measurement time (**Mtime (avg)**; the time interval between subsequent measurements as they arrive at your workstation) are displayed. This is followed by three panels, for the Offset, Modulation, and Level readings, respectively. Underneath each panel, the minimum, average, and maximum value for that measurement are shown.

At the bottom part of the Time Traces panel there exist several controls that alter the behaviour of this panel. Each of the Offset, Modulation, and Level readings can be turned off by clearing the appropriate checkbox. The vertical ranges for these measurements can be changed by first clearing the Auto checkbox in the appropriate row, and then entering the desired lower and upper limits for that value. Lastly, the **Clear** button can be used to clear all existing data from this panel.

The Special Functions panel provides access to several internal functions of the ESN receiver:



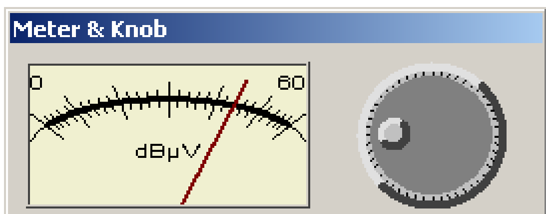
Special functions include the following:

- The special function **05 - Extra low distortion** inserts a 10-dB attenuator pad in the frequency range below 1000 MHz at the first intermediate frequency in order to reduce receiver-internal spurious products due to its intermodulation rejection in densely occupied frequency bands.
- The special function **06 - AFC** can be used to turn on AFC. When the AFC is on, the receiver frequency is adjusted by a measured frequency offset. To reduce the effects of inherent noise, the adjustment is made only if the received signal exceeds the inherent noise by at least 20 dB.
- The special function **07 - Bandpass** in AF path connects a 300 Hz to 3.3 kHz bandpass filter in the AF path to improve the signal-to-noise ratio. With SSB demodulation, to bandpass filter is always on regardless of this setting.
- The special function **10 - Display light** switches on and off the display illumination. To extend the life of the receiver, the ISOC turns off display illumination as it is not usually needed when the receiver is operated remotely.
- The special function **12 - Antenna code** allows the receiver to obtain a transducer factor for active antennas that are compatible with the ESN receiver's coded socket.
- The special function **17 - Check transducer** allows the transducer value, calculated at the receiver frequency, to replace the level measurement value.
- The special function **18 - User port coupled to transducer** causes pins on the ESN receiver's user port to become active corresponding with the active transducer range. This may be useful in setups where the ESN receiver controls a switch matrix.
- The special function **21 - Generator absolute level** controls, when a tracking generator is used, whether the level displayed is relative to 96 $dB\mu V_{emf}$ or absolute.
- The special function **22 - Controlled IF output** controls whether the 10.7 MHz IF output of the receiver is levelled or uncontrolled.

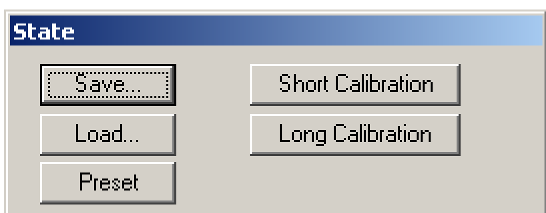
- The special function **23 - Ext. control voltage for AM control amp.** determines whether the gain of the IF amplifier is controlled internally or by an external source.
- The special function **24 - Ext. control voltage for I/Q demodulator** opens the control of the intermediate frequency for I/Q outputs so that a control voltage can be fed through the user interface at the rear of the instrument.

The ESN receiver has other special functions. Access to these is not implemented through the ISOC user interface because either a) the special function is used internally by the ISOC software, or b) the special function was deemed unnecessary/unneeded for the ISOC.

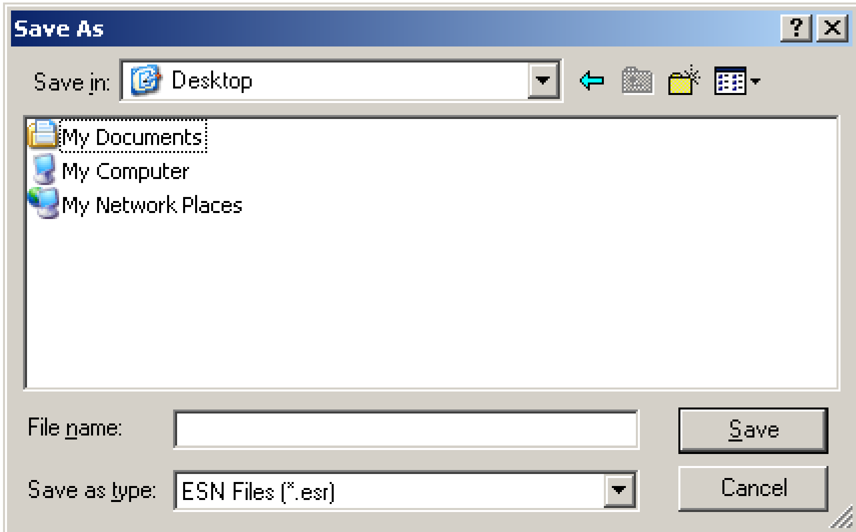
The Meter & Knob panel provides a VU-meter style analog level display and an analog knob for controlling the instrument frequency:



The State panel controls the overall instrument state:



The instrument state can be saved. By clicking the **Save...** button, you can invoke the standard Save As dialog:



The ESN virtual instrument uses the filename extension `.esr` to distinguish its files. (The `.esn` extension is used for something else, binary-format scan results files).

A saved instrument state can be loaded again by clicking the **Load...** button, which invokes the Windows standard Load dialog.

The instrument can also be reset to its factory default state by clicking the **Preset** button.

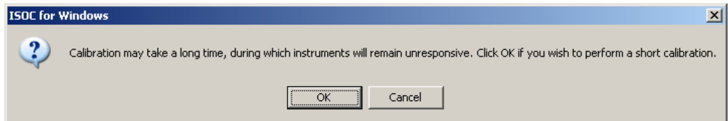
The ESN receiver can be calibrated under program control. Two calibration procedures are available: short and long calibration.

Short calibration takes several seconds, and measures the receiver gain at different frequencies. Short calibration is achieved by sending the commands `C:S` and `CAL?` to the receiver.

Long calibration (also known as total calibration) takes several minutes, and characterizes the receiver's frequency response, gain, bandwidth, weighting, and linearity. Long calibration is achieved by sending the commands `C:T` and `CAL?` to the receiver.

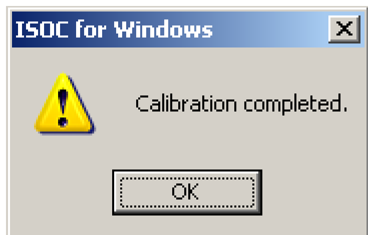
> **Tip:** The ESN manual recommends that long calibration be performed at least 30 minutes after the receiver was powered on. The calibration need not be performed daily; the correction values are expected to remain constant for long time.

Regardless which calibration method is used, the ESN virtual instrument displays a warning message before calibration is attempted, informing the user that the calibration may take a long time to complete:



Tip: It is highly recommended that calibration be performed when only the ESN receiver is being used.

When the calibration is completed, a dialog is displayed:



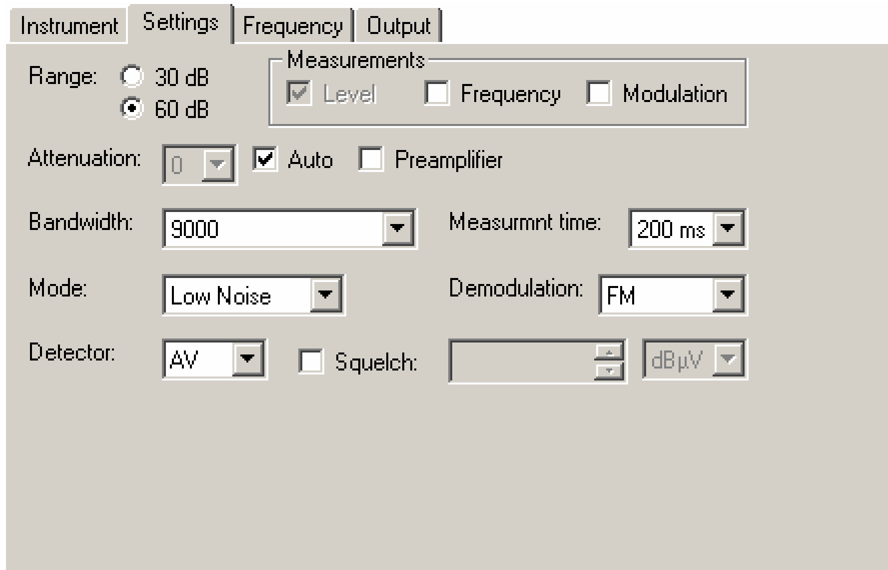
Tip: If after calibration, no trace is visible in the virtual instrument, try changing the settings of the Rate value under the Traces tab in the IF Trace panel.

3.2.2.3.2. Background tasks reference

The ESN receiver can be used for two types of background tasks: instrument control tasks and scanning tasks.

During an instrument control task, the receiver remains under the control of the ISOC software. The main intended purpose of such tasks is to provide a means to configure a receiver to work in conjunction with other equipment, e.g., audio recording. It is, however, also possible to capture measurement results during an instrument control task into a human-readable file.

When used in an instrument control task, many of the settings of the ESN receiver can be changed:



Range is the receiver's measurement range, corresponding with the range of the VU-meter on the receiver's front panel.

Attenuation can be set to **Auto** or to a specific value. Be careful not to specify an attenuation level that results in an overload/overrange/underrange condition, as these will not be corrected while the background task is running.

The **Preamplifier** checkbox turns on the receiver's preamplifier.

The **Bandwidth** field lets you select the IF bandwidth of the receiver. The actual set of available IF bandwidths varies depending on what options are installed in a specific receiver. As the ISOC scheduler works "off line", it does not know the current receiver settings; however, the list of IF bandwidths is always obtained when the receiver is online (e.g., when it is used interactively) and that list is used in this field. Therefore, the contents of this field are expected to be always correct, with the possible exception when, say, a receiver has just been replaced with one that has different IF bandwidth filters installed, and the new receiver has not yet been used by the ISOC in any way.

The **Measurmnt time** field controls the measurement time used by the receiver's detector when obtaining peak or averaging readings.

The **Mode** field determines whether the receiver operates in Low Noise mode (IF gain reduced by 10 dB) or Low Distortion mode.

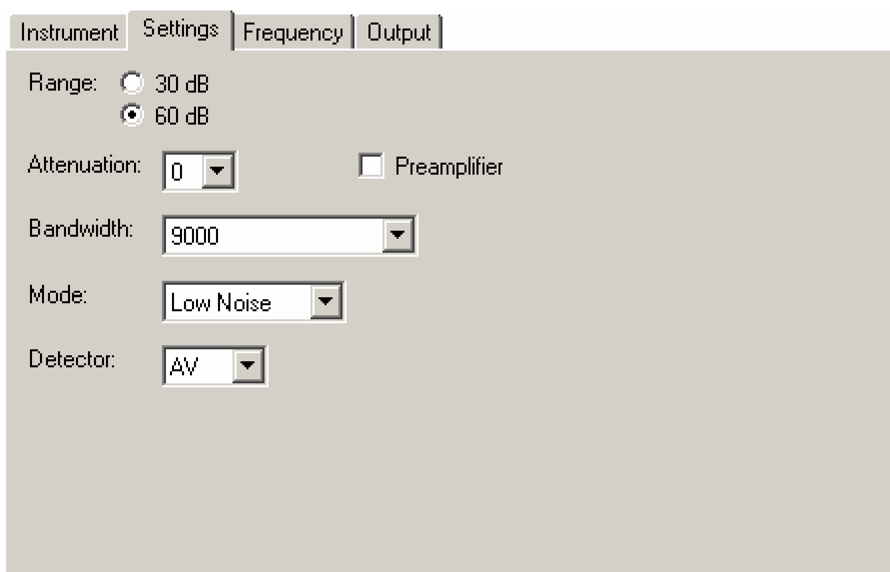
The **Demodulation** field can be used to select which (if any) demodulation to use to obtain an AF signal.

The **Detector** field selects whether the receiver is to obtain peaks, averages, quasi-peaks, or RMS averaging on the measured signal.

The **Squelch** field controls RF squelch. When activated, the receiver's AF output is suppressed if the received signal level does not exceed the squelch level. In addition, RF squelch may affect audio recordings.

Scanning tasks are used to obtain high speed measurements over a range or list of frequencies. The ESN receiver is capable of scanning (depending on receiver settings) several hundred to several thousand frequencies each second. To obtain such a high data rate, however, it is no longer possible for software to interactively control the receiver; instead, once the receiver is instructed to start the scan, it "takes over", performs the scan at a high rate, and "dumps" the measurement results for the ISOC software to read.

For this reason, only a subset of the instrument settings are available in this mode:



All other settings are either ineffective in this operating mode or are controlled by the instrument itself in order to deliver maximum performance.

3.2.2.3.3. Instrument command reference

The ESN virtual instrument driver uses many GPIB commands to control the instrument. Some of the more frequently used commands are provided here for reference:

Command	***Description***

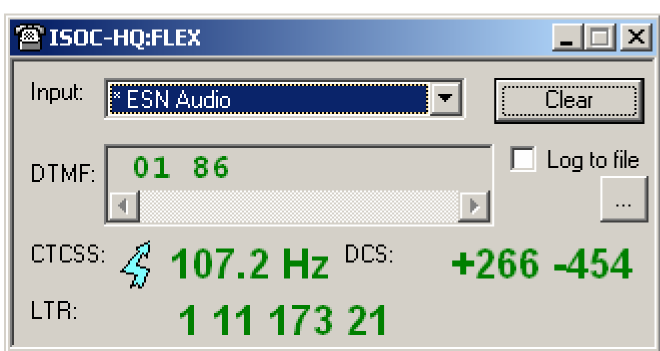
Command	Description
`FR`	Set/query receiver frequency
`B:I`	Set/query IF frequency
`ME:T`	Set/query measurement time
`DET`	Set/query detector setting
`RA`	Set/query range
`AT`	Set/query attenuation
`AT:M`	Set/query operating mode (`LOWN` or `LOWD`)
`B:A`	Set/query AF bandwidth
`DEM`	Set/query demodulator setting
`GE`	Set/query tracking generator
`PREA`	Turn preamplifier on/off, query state
`SPE`	Set/query special functions
`SPA`	Set/query span
`SPE:SQ`	Set/query squelch
`B:R`	Set/query resolution bandwidth
`SW:T`	Set/query sweep time
`AT:I`	Set/query 20 dB trace attenuation
`AT:A`	Set/query auto attenuation
`ME:C`	Set measurement values
`MA:PE`	Search for marker peak
`SY:S:B?`	Obtain list of installed IF filters

3.2.3. Tone decoders

3.2.3.1. FLEX Series Universal Controller

The FLEX Series Universal Controller is a multipurpose tone decoder that can decode DTMF, CTCSS, DCS, and LTR codes. The instrument has no user-configurable settings; when on, it continuously decodes the received AF signal and provides these readings to the control computer.

The interactive user interface for the FLEX decoder is simple:



The **Input** field provides a means to select a signal source through an audio switch matrix. The **Log to file** checkbox enables the logging of tone decoder measurements to a human-readable log file. When you first click the **Log to file** checkbox, or at any time when you click the ... button, the File Open dialog is presented, where you can select the desired file for logging. Details of the log file format can be found in Appendix A.5.5.

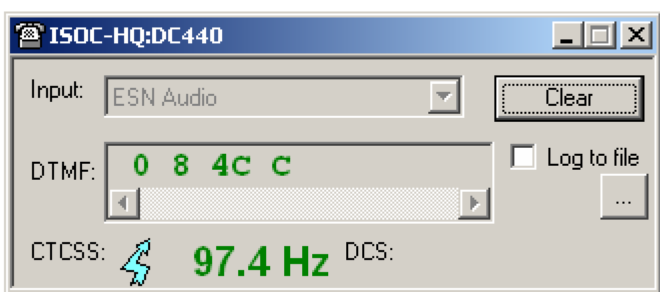
The remaining fields are all read-only. The **DTMF**, **CTCSS**, **DCS**, and **LTR** fields show the latest measurements from the instrument: DTMF characters received, last CTCSS value, and last DCS value, respectively. The **DTMF** field can contain a large number of characters; use the horizontal scrollbar to view them. The CTCSS and DCS fields also contain a small "lightning" symbol () that appears whenever the CTCSS, DCS, or LTR signal is active.

3.2.3.2. Optotrakker DC-440/DC-448 tone decoders

The ISOC recognizes two different types of tone decoders in the Optotrakker series. The main difference between the DC-440 and the DC-448 units is that the former uses a proprietary serial protocol, whereas the latter utilizes ICOM's CI-V protocol. The differences are almost completely transparent to the ISOC user, with one exception: the DC-440's proprietary protocol provides a "dump mode" in which the instrument autonomously sends results to the control computer without the need for it to be queried first. Dump mode lessens the possibility that a brief, transient signal is missed as the control computer may not be querying the instrument with sufficient frequency.

3.2.3.2.1. Interactive reference

The DC-440 and DC-448 user interfaces are identical. The instrument has no settings that are user adjustable. The virtual instrument interface provides a control for selecting an **Input** signal through an audio switch matrix:



The **Log to file** checkbox enables the logging of tone decoder measurements to a human-readable log file. When you first click the **Log to file** checkbox, or at any time when you click the ... button, the File Open dialog is presented, where you can select the desired file for logging. Details of the log file format can be found in Appendix A.5.5.

The remaining fields are all read-only. The **DTMF**, **CTCSS**, and **DCS** fields show the latest measurements from the instrument: DTMF characters received, last CTCSS value, and last DCS value, respectively. The **DTMF** field can contain a large number of characters; use the horizontal scrollbar to view them. The CTCSS and DCS fields also contain a small "lightning" symbol () that appears whenever the CTCSS or DCS signal is active.

3.2.3.2.2. Background tasks reference

The DC440/DC448 tone decoders can also be used in scheduled tasks. No user interface exists for background operation of these instruments; they have no user-configurable settings. Measurements from these instruments are recorded in a log file, the format of which is detailed in Appendix A.5.5.

3.2.4. DF processors

The ISOC can utilize several different types of DF processors, including:

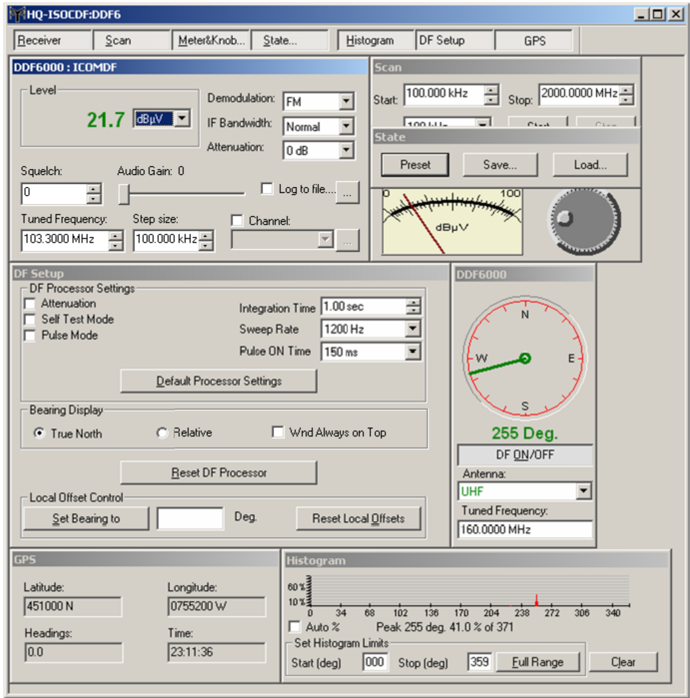
- Doppler Systems DDF6000D, 6100 and 7000 series
- Rohde & Schwarz PA025
- OAR 3001
- OAR 4*xxx* (OAR 4006 and OAR 4400)
- The CRC Spectrum Explorer application

Although the physical instruments can be very different, the user interface is essentially the same, with very minor differences. In the following, the Doppler 6000C processor is used to introduce the DF user interface elements; differences between this and other DF virtual instruments are pointed out.

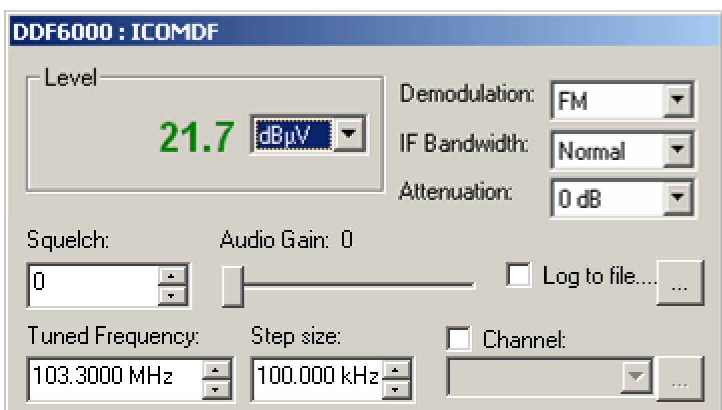
If an ISOC site is equipped with a OAR4*xxx* that has a built-in cubic LCR3000 or LCR2000, the DF processor controls the receiver automatically. In this case, the receiver remote control port is connected to the DF processor and not to one of the ISOC server's serial port. When the ISOC sees an instrument of type OAR4*xxx* and doesn't see any receiver of type DF*xxxx*R, then the DF is treated as an OAR4400 with a built-in receiver.

3.2.4.1. Interactive reference

The DF processor virtual instrument contains eight panels, seven of which can be removed in order to save space:



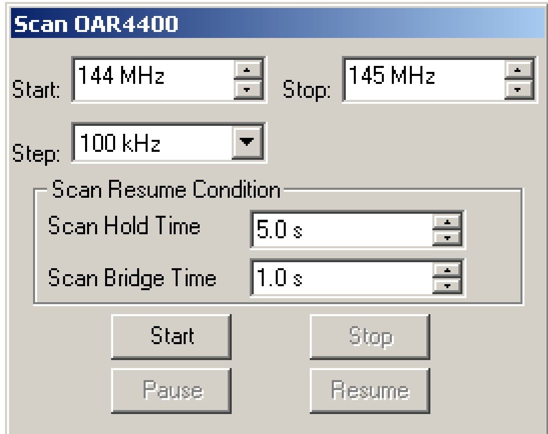
The first set of these panels control the DF receiver, which may be either an integrated part of the physical instrument or a separate receiver; however, in the virtual instrument, it is always treated as part of the same instrument. The receiver panel is nearly identical in appearance and functionality to the Main panel of ICOM receivers (section 3.2.2.1.1):



The one substantial difference is that signal source selection has been removed: the DF receiver always receives its signal from the DF processor.

Note that the Audio Gain slider also works differently, the minimum audio gain being 100 as opposed to 0. This is to ensure that the DF processor always receives a usable AF signal from the receiver.

The Scan panel is different for OAR processors that contain a built-in receiver:

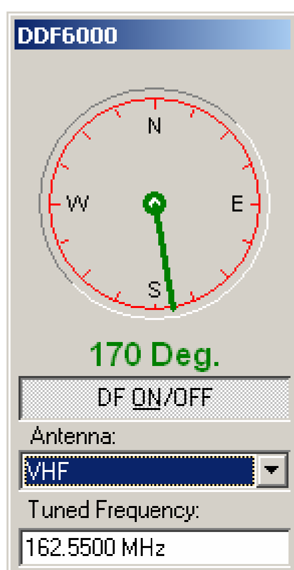


Scan frequencies are controlled by the **Start**, **Step**, and **Stop** fields. If a signal is present, the instrument will pause on that frequency for the time specified in the **Scan Hold Time** field. If the signal disappears during this time, the instrument waits for the time specified in the **Scan Bridge Time** field before abandoning that frequency and moving on to the next one.

Scanning can be started by clicking **Start**; a running scan can be stopped by clicking **Stop**. Clicking **Pause** pauses a running scan at the current frequency; the scan can be resumed by clicking **Resume**.

The Meter & Knob, and State panels are identical in appearance and functionality to their corresponding ICOM virtual instrument counterparts (section 3.2.2.1.1).

The main DF processor panel indicates the bearing of the DF signal:

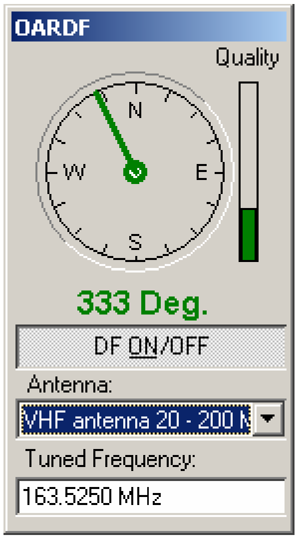


The bearings indicator is colour-coded. When the contour around the compass is black, the frequency is tuned to the frequency range of the selected antenna. A red contour means that it is not in the antenna range. You must then select another antenna from the **Antenna** field. Selecting **Auto** ensures that the antenna is always selected according to the frequency, thereby eliminating this problem.

A green needle indicates recent readings, there is a blinking white dot in the centre that indicates that new bearings are being received. A yellow needle means that the processor has not provided any readings in over six seconds, and a red needle means that the processor has not provided any readings in over 10 seconds.

In mobile configurations, the bearings are adjusted in regard to the front of the vehicle (based on the heading provided by the GPS). This way, it is easier for the driver to drive to the site where the signal is coming from.

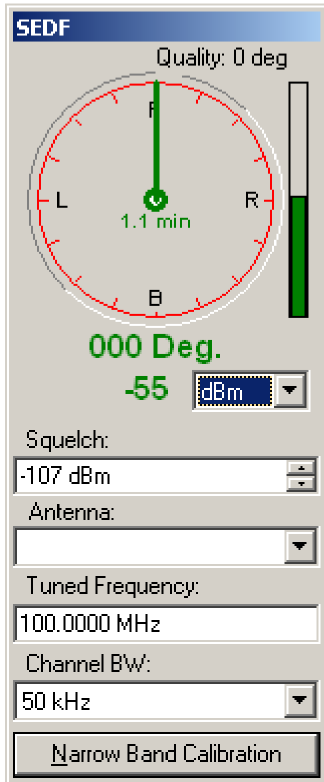
OAR DF processors also provide a signal quality indication:



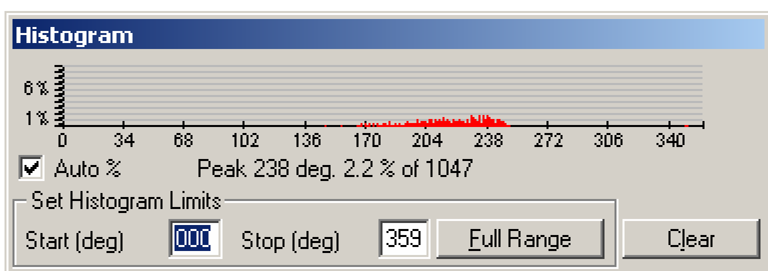
The **DF ON/OFF** button can be used to turn on and off the DF processor. Turning off the DF processor improves the quality of the audio signal, as it stops the electronic rotation of the antenna, and thus removes the DF tone otherwise present in the audio signal.

The **Tuned Frequency** control provides another means to set the DF frequency; the same value can also be controlled through the Receiver panel.

The bearing indicator for the SE DF instrument contains several additional controls to adjust Squelch, the Channel bandwidth, and initiate a narrow band calibration:

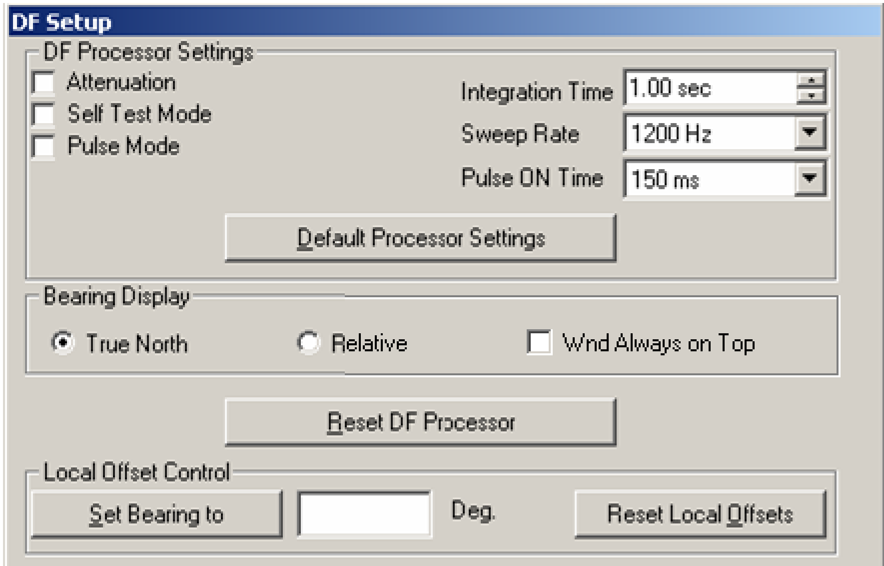


The Histogram panel provides a visual indication of the signal strength in various directions:



The vertical bars of the histogram indicate the relative signal strength in various directions, integrated over time. The horizontal and vertical scale of the histogram display can be controlled using the **Auto %**, **Start (deg)** and **Stop (deg)** fields, and reset by clicking **Full Range**. The **Clear** button clears accumulated data and restarts the integration.

The DF Setup panel provides a means to control the DF processor's operation. As such, this panel has the most differences between various DF processor types. The Doppler 6000C version of the DF Setup panel is perhaps the most complex:



The DF Processor Settings area contains several fields that control the DF processor's operation. The processor's **Attenuation** can be turned on by setting the corresponding checkbox. The processor can also be placed in **Self Test Mode**.

In **Pulse Mode**, the DF processor employs a pulse mode logic specifically aimed to locate transmitters used for tracking that employ pulse mode operation. The processor attempts to identify a pulse during each sweep, and if a pulse is located, the bearing towards that pulse is computed. The duration of the pulse that the processor is looking for is controlled by the **Pulse ON Time** field.

The **Integration Time** field controls the number of readings that the DF processor averages to compute a bearing. The minimum is 0.5 seconds, the maximum 10 seconds.

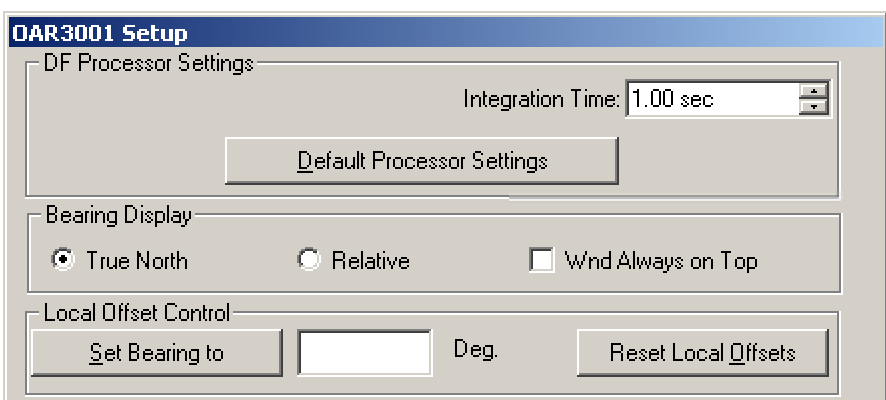
The **Sweep Rate** is selectable: 300 Hz, 600 Hz, 1200 Hz and 2400 Hz can be used to avoid signals that may already be present on the monitored frequency. Maximum sensitivity is obtained at higher sweep rates, but a sweep rate of 2400 Hz causes a peak deviation that exceeds the bandwidth of most narrowband FM receivers, resulting in sound distortion. Changing the sweep rate can also affect bearing accuracy. The optimal sweep rate is dependent on the DF site in question.

The **Default Processor Settings** button can be used to restore the DF processor to default operational settings.

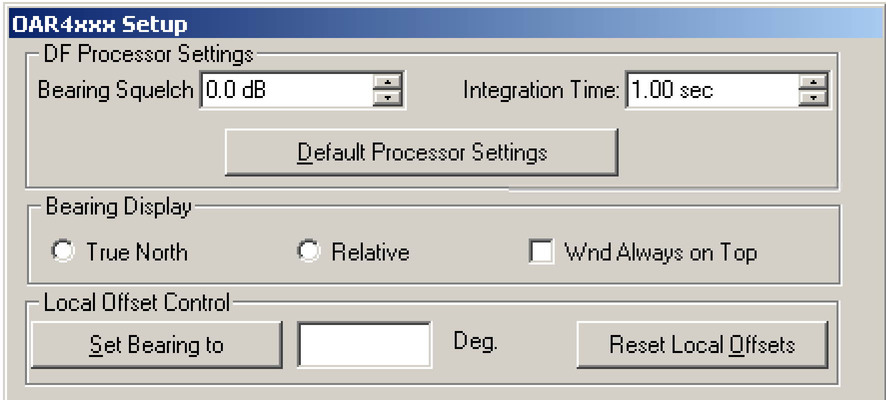
The second area of the Setup panel controls how the bearing indicator works. In **True North** mode, the bearing is absolute; in **Relative** mode, the bearing display will be relative to the GPS heading obtained from the GPS instrument (i.e., relative to the front of the vehicle). The **Wnd Always on Top** checkbox ensures that the bearing window always remains visible, even when the DF processor window is hidden or minimized.

The **Local Offset Control** area can be used to set the DF processor to report bearings relative to a known transmitter. This is intended as a means to fine tune the bearing. It is best to use a known transmitter in the same frequency band and, preferably in the same approximate direction of the transmitter of interest, in order to obtain a sufficiently accurate local offset value. To use a local offset, first make sure that the instrument is tuned to the known transmitter, and that the signal is strong and steady. Next, enter the bearing that this transmitter should appear at and click the **Set Bearing to** button. This will cause the bearing display to point in the indicated direction while still tuned to the strong transmitter. The offset thus calculated will be used when reporting the bearing towards other transmitters, until you either enter a new value and click the **Set Bearing to** button, clear this mode of operation by clicking **Reset Local Offsets**, or restart the application (the offset value is only temporary; it is not saved when the session ends.)

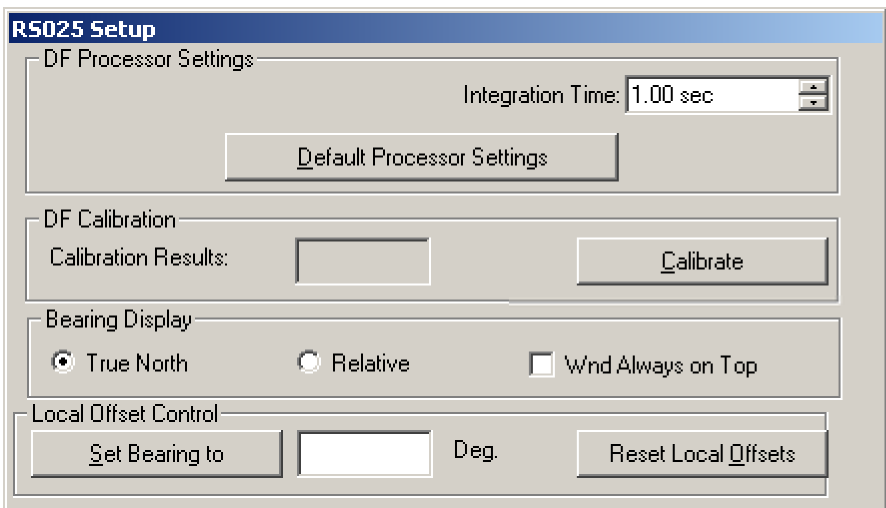
The Setup panel for OAR3001 DF processors contains a subset of the fields that are present in the Doppler 6000C virtual instrument. The functionality of the remaining controls is identical:



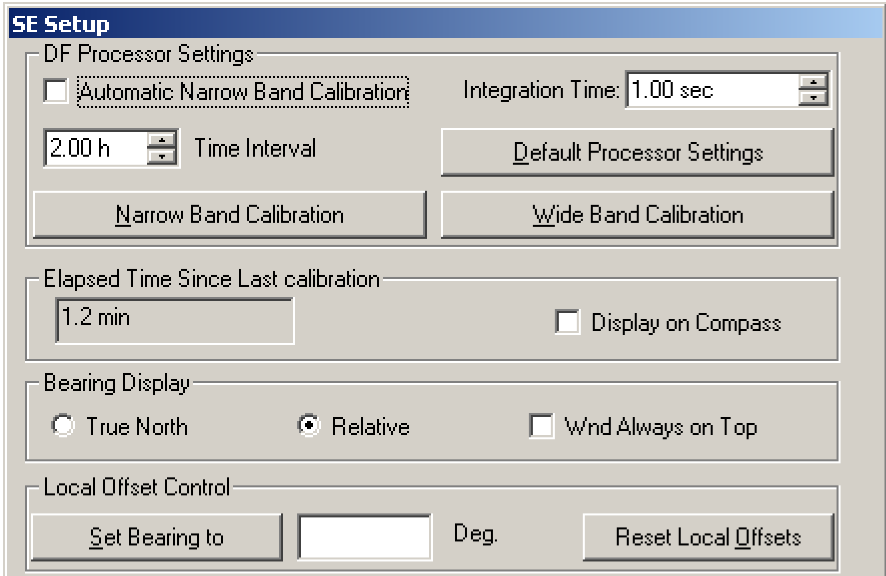
The OAR4xxx DF processor virtual instrument's Setup panel contains one extra field. The Bearing Squelch field can be used to suppress bearing calculations when the RF signal level is below the specified value:



The Rohde and Schwarz PA025 Setup panel contains an extra area for **DF Calibration**. Calibration can be initiated by clicking the Calibrate button; when calibration is completed, the Calibration Results field is filled in. This calibration corrects for the group delay of the associated DF receiver. It does not calibrate the DF bearing display:

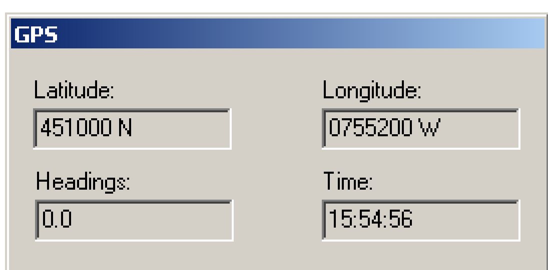


The SE Setup panel contains several additional controls:



The SE DF instrument requires frequent recalibration to compensate for temperature variations during the day. A full calibration can be accomplished by clicking the **Wide Band Calibration** button. However, a full calibration can be time consuming. Instead, a calibration over a narrow (~4 MHz) bandwidth can be performed much more rapidly by clicking the **Narrow Band Calibration** button. Recurring narrow-band calibration can be executed automatically if the **Automatic Narrow Band Calibration** checkbox is set, and the desired **Time Interval** is specified. The time since the last calibration is shown in the **Elapsed Time Since Last calibration** field, and can also be displayed on the compass display if the **Display on Compass** checkbox is set.

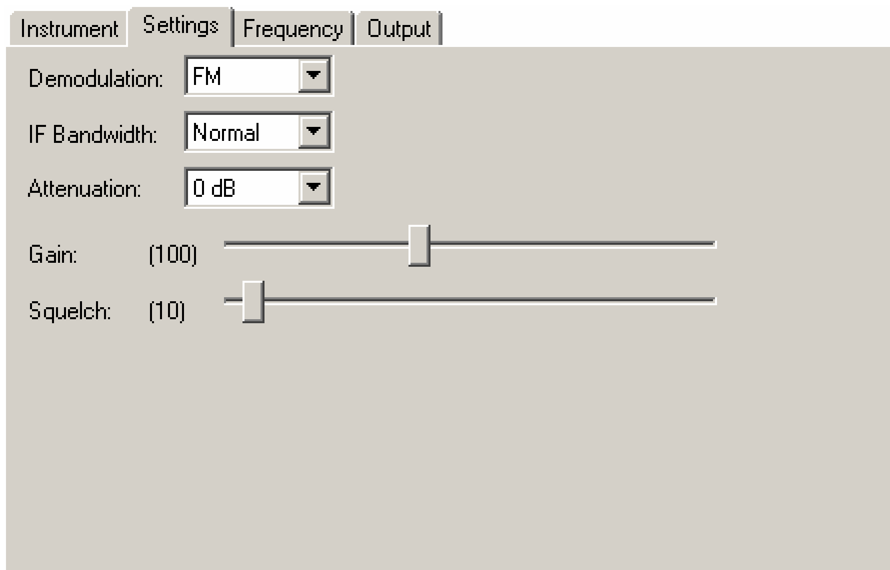
The GPS panel is informational. Fixed sites use the GPS instrument to synchronize the computer clock (important when using a DF network.) Mobile sites use GPS to determine the actual coordinates of the receiver. Either way, the GPS panel provides real-time display of current GPS information:



3.2.4.2. Background tasks reference

DF processors can be used with the ISOC Task Manager for background tasks. In background operation, the DF processor can continuously measure the bearing for the selected frequency or frequencies, and record results in a log file.

The DF processor user interface in the Task Manager is simple:



In addition to the **Demodulation**, **IF Bandwidth**, and **Attenuation** settings, you can also select the audio **Gain** and **Squelch**. Be careful not to select values that are too low (for audio gain) or high (for squelch) so as to prevent DF operation.

3.2.5. Signal generators

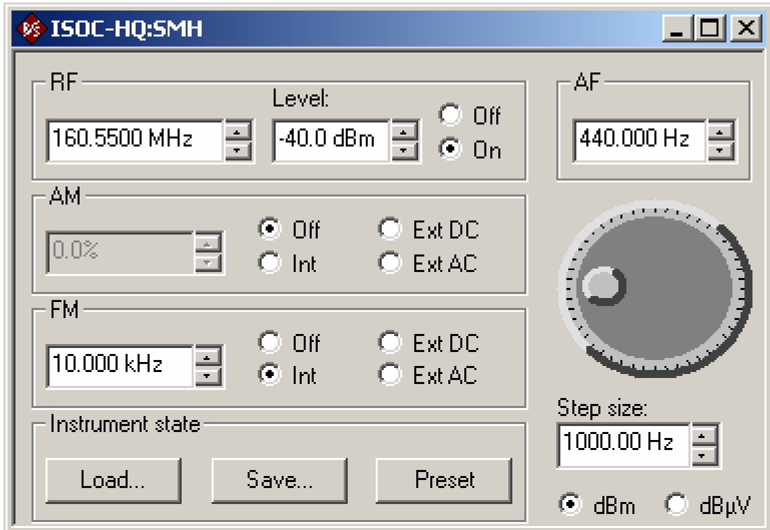
The ISOC supports the Rohde & Schwarz SMH Signal Generator.

3.2.5.1. Rohde & Schwarz SMH signal generator

The Rohde & Schwarz SMH signal generator is used to provide a reference signal, e.g., for calibration purposes or as part of a complex set of measurements. The SMH device can be used both interactively and in scheduled tasks.

3.2.5.1.1. Interactive reference

The interactive interface for the Rohde & Schwarz SMH signal generator consists of a single panel, divided into several areas:



Top left is the area controlling the RF output of the signal generator. The **RF** signal frequency and the signal **Level** can be set. A separate set of radio buttons control whether the signal generator is actually producing output. (NB: To avoid a spurious signal, the signal generator is turned off automatically by the ISOC software whenever the software stops controlling the instrument).

To the right of the RF area is an area where you can specify the **AF** modulating frequency for the emitted signal. If the necessary option is installed, the AF generator can be tuned continuously. Without this option, only a discrete set of AF frequencies are available; when the ISOC detects such an SMH, it replaces the edit control in the AF area with a dropdown list containing the available AF frequencies.

The second area on the left side of the SMH panel controls amplitude modulation. The modulating signal can originate from one of three sources: the **Int**ernal AF generator, or the instrument's **Ext DC** or **Ext AC** connectors. Once a signal source has been selected, you can adjust the **AM** modulation, a percentage value.

The frequency modulation area, which is the third area on the left side of the SMH virtual instrument panel, works very similarly. Once again, you may select from **Int**ernal, **Ext DC**, or **Ext AC** as the modulation source. The FM modulation depth is specified as a frequency value.

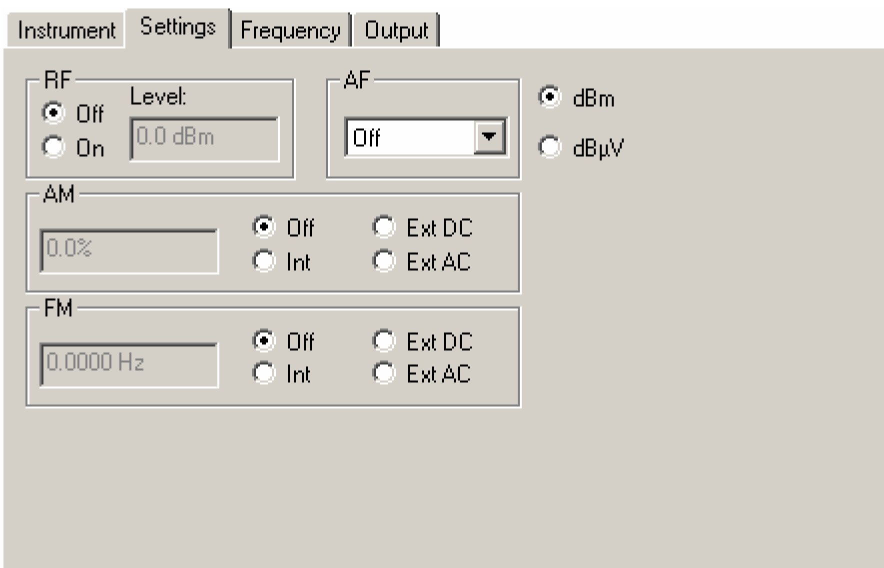
The SMH instrument's state can be saved to a file on the local workstation and reloaded. To save the instrument state, click the **Save…** button. To load a previously saved instrument state file, click the **Load…** button. By default, SMH state information is saved in files using the `.SMH` filename extension.

The RF frequency, AM and FM modulation fields, and the AF frequency field can all be tuned using the tuning knob that is present on the right-hand side of the virtual instrument panel. The tuning step can be adjusted using the **Step size** field.

Lastly, the unit of measurement used by the virtual instrument for level readings can be changed from **dBm** to **dBµV** by clicking the appropriate radio button in the lower right side.

3.2.5.1.2. Background tasks reference

The interface presented for the Rohde & Schwarz SMH signal generator by the ISOC Task Manager is a simplified version of the interactive virtual instrument:



The most notable missing field is the RF frequency field. This field is replaced by the controls of the Frequency tab.

The RF signal level can still be adjusted, using the **Level** field.

AM modulation is **Off** by default; alternatively, **Int**ernal, **Ext DC**, and **Ext AC** can be selected as the AM modulation source. If an AM modulation source has been selected, the **AM** modulation depth can be adjusted in percentage units.

FM modulation is also Off by default; again, the other choices are **Int**ernal, **Ext DC**, and **Ext AC**. Once a modulation source has been chosen, the **FM** modulation depth can be set using a frequency value.

As the Task Manager works "offline" (no instrument needs to be physically connected when the task is being set up, only when the task is run, days, possibly weeks later) it has no way of knowing whether or not the physical instrument has the AF generator option installed. For this reason, only a discrete set of AF frequencies are presented in the **AF** field; these frequencies are available on all SMH instruments, with or without the AF generator option.

Lastly, the **dBm**/**dBµV** radio buttons control the unit of measurement used for signal levels.

3.2.5.1.3. Instrument command reference

The SMH virtual instrument driver uses many GPIB commands to control the instrument. Some of the more frequently used commands are provided here for reference:

Command	***Description***
`AM`	Set/query AM modulation
`FM`	Set/query FM modulation
`AF`	Set/query AF generator
`L`	Set/query generator level
`L:OFF`	Turn off generator

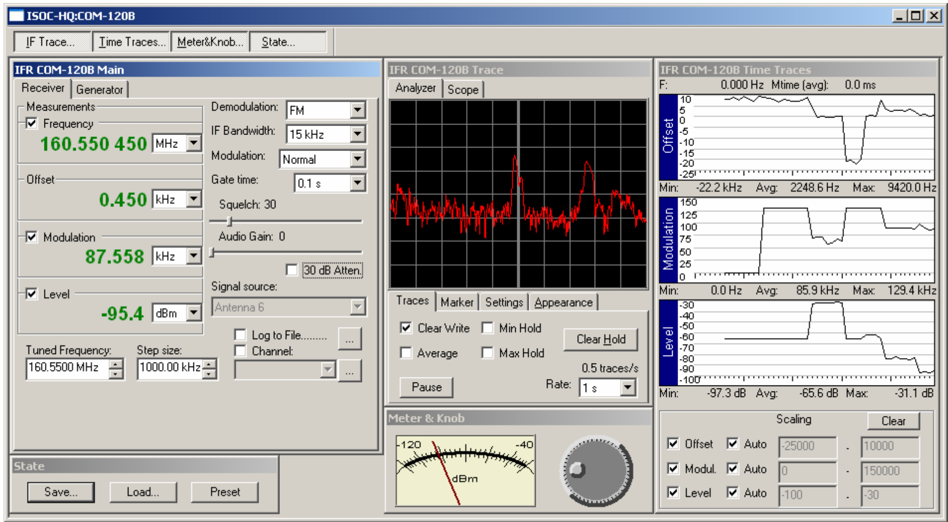
3.2.6. Multipurpose instruments

3.2.6.1. IFR COM-120B

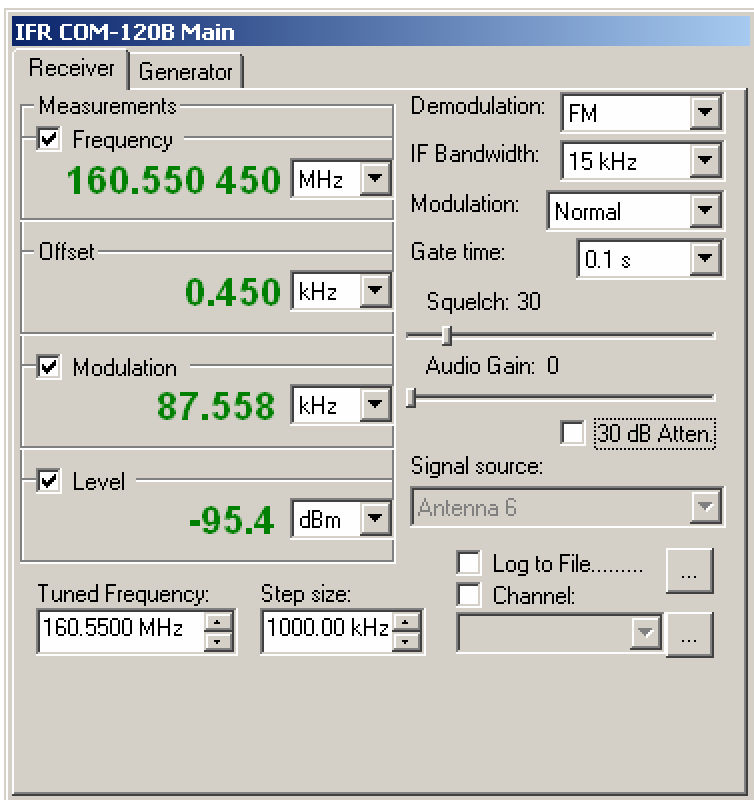
The IFR COM-120B is a multipurpose instrument that can act as a test receiver, spectrum analyser, and signal generator. Much of this instrument's functionality is supported through the ISOC IFR COM-120B virtual instrument.

3.2.6.1.1. Interactive reference

The initial appearance of the IFR COM-120B is not unlike that presented for receivers, such as the Rohde & Schwarz ESN:



Out of the five panels that constitute the user interface, four can be turned off using the button bar at the top. The once exception is the Main panel that provides basic control of the instrument:

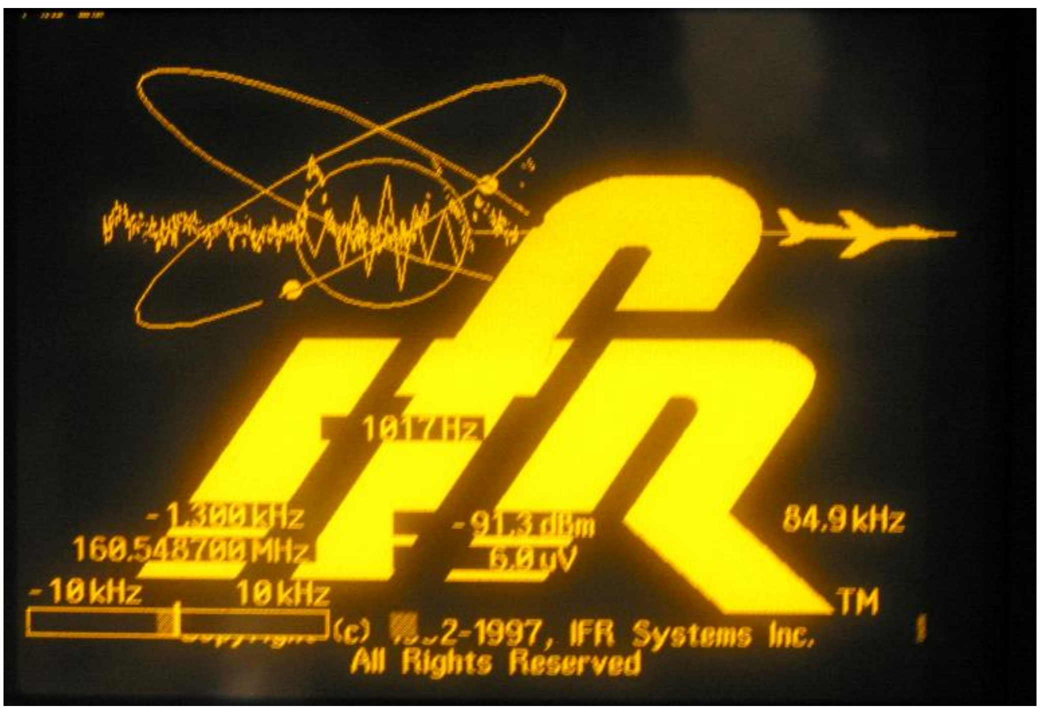


In receiver mode, as a test receiver, the COM-120B can measure the received signal's **Frequency** and **Offset**, **Modulation**, and **Level**. Unneeded measurements can be turned off using the appropriate checkboxes, with the exception of the **Offset** measurement.

The receiver's frequency can be set using the **Tuned Frequency** field. Up-down controls in this field can also be used; the step size is controlled by the **Step size** field.

The behaviour of the various stages of the receiver is controlled using the **Demodulation**, **IF Bandwidth**, and **Modulation** fields. The **Gate time** field controls the receiver's measurement time; two choices, 0.1 s and 1 s are presented. Note that in 1 s mode, the instrument may appear less responsive.

Indeed, during testing this instrument was found to be particularly prone to (thankfully, brief) lockups, especially when the Gate time setting was changed, or when the operating mode was changed from Receiver to Generator or vice versa. That these were genuine lockups of the physical instrument, not just a glitch in the ISOC software, can be seen clearly in the following photographic capture of the physical instrument's display, corrupted as measurements overlay the initial logo display during a lockup:



It is possible that newer versions of the COM-120B instrument firmware may have eliminated some or all of these problems. Just to be sure, the ISOC software has been fine tuned to a) avoid lockups whenever possible, and b) recover gracefully when a lockup occurs, maintaining control of the instrument.

In any case, keep this in mind when you manipulate the Gate time field; if the instrument appears nonresponsive, be patient, as it will probably recover after approximately 30 seconds or so.

The instrument's squelch and audio volume are controlled through the **Squelch** and **Audio gain** sliders. The receiver also has a built-in attenuator; if the **30 dB Atten.** checkbox is set, the attenuator is on.

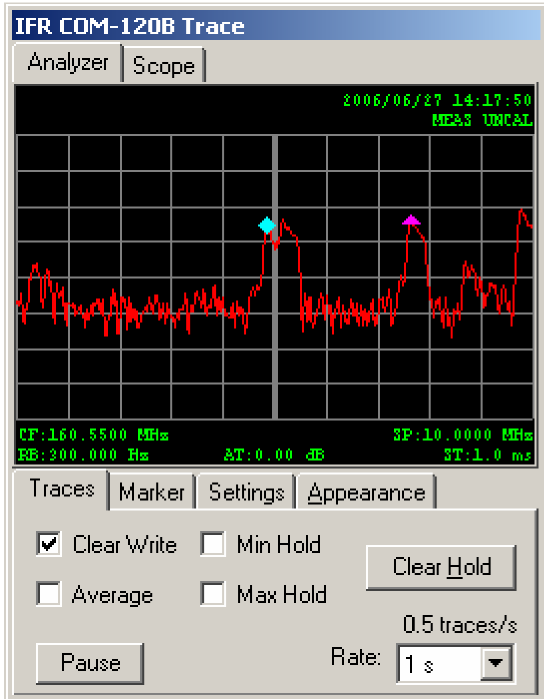
The **Signal Source** field controls the signal that is connected to the instrument's input via the switch matrix.

> **Tip:** The incoming signal for the COM-120B is always assumed to be connected to the instrument's Antenna connector. The "T/R connector" is reserved for output (generator) signals.

The COM-120B can log its measurements in a human-readable log file. The **Log to file** checkbox can be used to start logging. When you set this checkbox for the first time, or when you click the ... button, the File Open dialog is displayed, allowing you to select a log file.

The **Channel** checkbox and field are used for channel tuning. In this mode, the receiver frequency is adjusted not by the set amount in the Step size field, but to discrete frequency values stored in a file. The file can be a `.SST` or `.LST` format file (see Appendices A.2 and A.3 below). When the checkbox is first checked, or when the button ... next to this checkbox is clicked, the Open dialog is displayed allowing you to select a `.SST` or `.LST` format file.

The COM-120B's trace display can operate in one of two modes: Analyser and Scope. In Analyser mode, a spectrum display is provided, centred on the instrument's tuned frequency:



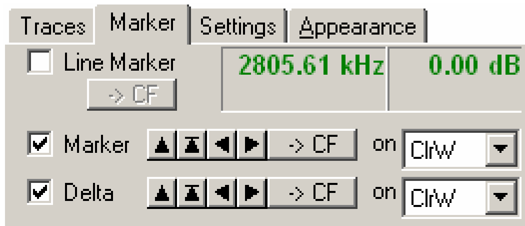
The upper portion of this panel contains the trace window. You can interact with the trace window using the mouse. Clicking and dragging the mouse in the trace area causes a line marker to appear, following the mouse position. Clicking and dragging the mouse while holding down the Ctrl key on the keyboard can be used to tune the instrument to the frequency at the mouse position as the mouse is released. Clicking and dragging the mouse while holding down the Shift key can be used to measure a span.

The lower portion of the Trace panel contains a set of tabs, the first of which is the Traces tab controlling trace appearance. The **Clear Write**, **Average**, **Min Hold**, and **Max Hold** checkboxes can be used to turn on up to four simultaneous traces. (NB: Averaging, minima, and maxima calculations are performed on the workstation; brief transient signals that appear and disappear between two traces do not figure in these calculations).

The **Clear Hold** button can be used to clear accumulated average, minimum, and maximum values.

The trace rate is controlled by the **Rate** dropdown; values of 1, 2, and 5 seconds can be selected. The actual trace rate is displayed above this field.

The second tab in the Trace panel is the Marker tab. The marker tab can be used to display a local marker, a normal marker, and a delta marker.



Clicking the Line Marker checkbox makes the line marker appear in the trace display. The line marker can be positioned using the mouse. Clicking the **->CF** button tunes the receiver to the current line marker frequency.

A regular marker can be turned on by clicking the **Marker** checkbox. The marker appears as a diamond symbol in the trace display. The frequency and signal level at the marker frequency are displayed in large green letters in the upper right portion of the Marker tab.

The marker can be positioned using the following four graphical buttons:

Maximum ( ): positions the marker at the top signal level (highest peak).

Next maximum ( ): positions the marker at the next highest peak relative to the current position. What constitutes a distinct peak is determined internally using a peak excursion algorithm.

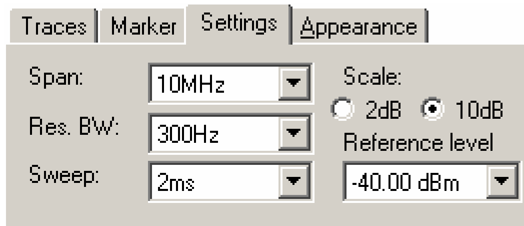
Next left ( ): positions the marker at the next peak left of the current marker position.

Next right ( ): positions the marker at the next peak right of the current marker position.

The marker can also be attached to any one of the four traces using the **on** dropdown field. The **->CF** button can be used to tune the instrument to the current marker frequency.

The **Delta** checkbox can be used to display a second marker, the frequency and signal level of which will be measured relative to the first. To distinguish the delta marker from a regular marker, it is represented by a small triangle (delta) symbol in the trace display. The delta marker can be positioned and attached to different traces the same way as the regular marker. While the delta marker is on, the upper-right portion of the Marker tab will display the (relative) delta marker signal level and frequency.

The third tab in the Trace panel is the Settings tab. The fields in this tab control many aspects of the trace:

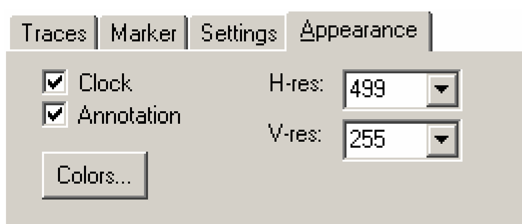


The trace's **Span**, resolution bandwidth (**Res. BW**) and **Sweep** time can be set using the corresponding dropdown fields. Like a true spectrum analyser, the COM-120B can display the trace using very large span values. Be aware, however, that an excessively large span (more than several hundred MHz) causes the instrument to respond very slowly, to the point of being almost nonresponsive. Similarly, a very high sweep time can also make the instrument function very slowly.

The **Scale** checkboxes can be used to change the vertical resolution of the trace display. The value is per graticule; in **2dB** mode, the total height of the trace is 16 dB, while in **10dB** mode, it is 80 dB.

The **Reference Level** field is used to adjust the signal level at the top of the trace display. The available values in this field depend on the **Scale** setting.

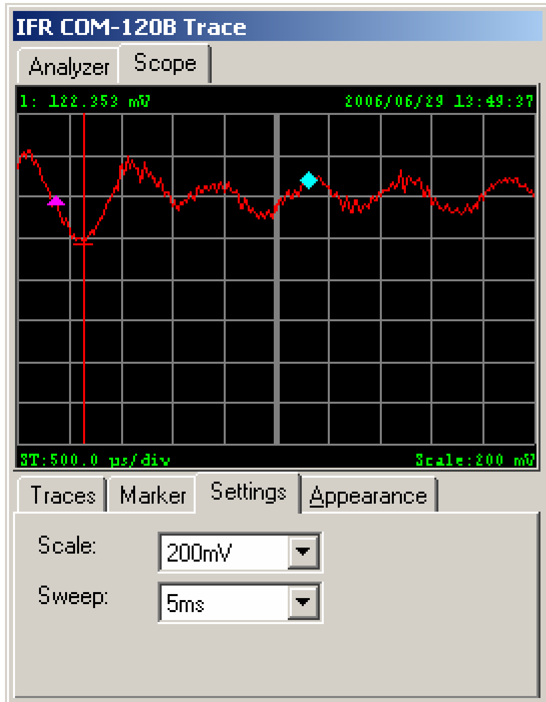
The last of four tabs in the Trace panel is the Appearance tab:



The **Clock** and **Annotation** checkboxes control the appearance of the clock display and annotations in the trace window. The **H-res** and **V-res** fields determine the horizontal and vertical resolution of the trace. The best values to use in these fields are the **Instrument** setting for the horizontal resolution and the **Byte** setting for the vertical resolution; the former minimizes any artefacts that may appear as a result of resolution changes, while the latter maximizes the trace quality without wasting bandwidth.

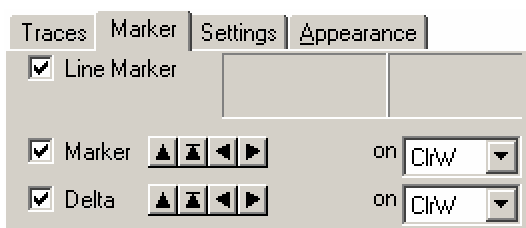
The **Colors…** button can be used to change the trace colours. See section 3.1.1.10.1 for details.

If you switch the Trace panel to Scope mode, its appearance changes slightly:

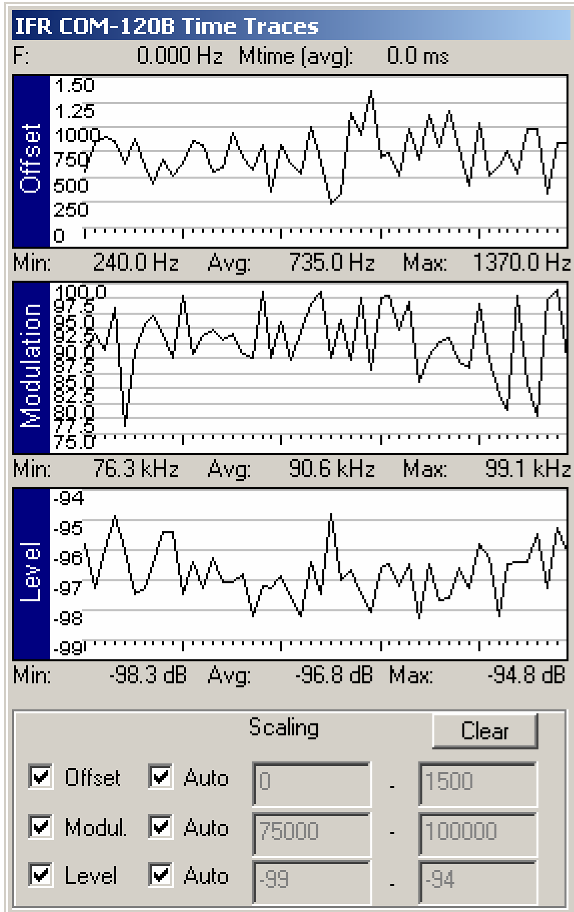


The vertical scale is now linear, representing a signal level in Volts or mV. The horizontal scale now represents time. The scale of these axes can be adjusted using the **Scale** and **Sweep** controls in the Settings tab.

The Marker tab also changes slightly in Scope mode. As markers are no longer measuring a signal frequency, the **->CF** buttons are no longer present. The marker level and frequency displays are also omitted:

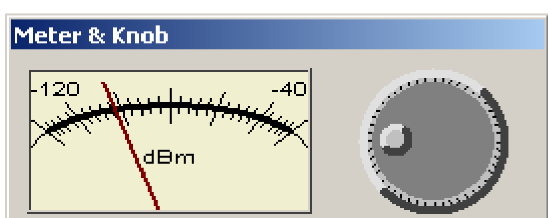


The next panel in the COM-120B virtual interface is the Time Traces panel. This panel provides a graphical presentation of the last 50 Offset, Modulation, and Level readings:



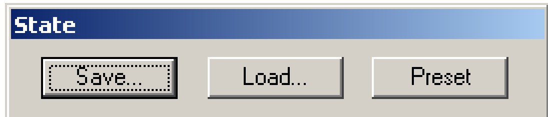
You can selectively turn on or off any of the graphs by clearing the **Offset**, **Modul.**, and **Level** checkboxes. The vertical scaling of these graphs is automatic by default; by clearing the corresponding **Auto** checkbox and entering suitable values in the Scaling fields, you can change the scaling to suit your specific needs. Lastly, the **Clear** button can be used to clear accumulated graph data.

The Meter & Knob panel provides a graphical signal level meter and a tuning knob. The tuning knob tunes the instrument's frequency, using a **Step size** specified in the Main panel:

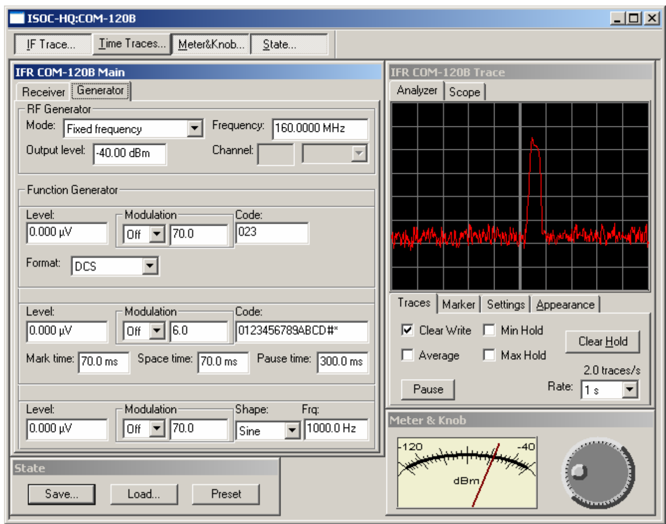


The State panel can be used to save the state of an IFR COM-120B instrument in a file in the local file system. To save the instrument's current state, click the

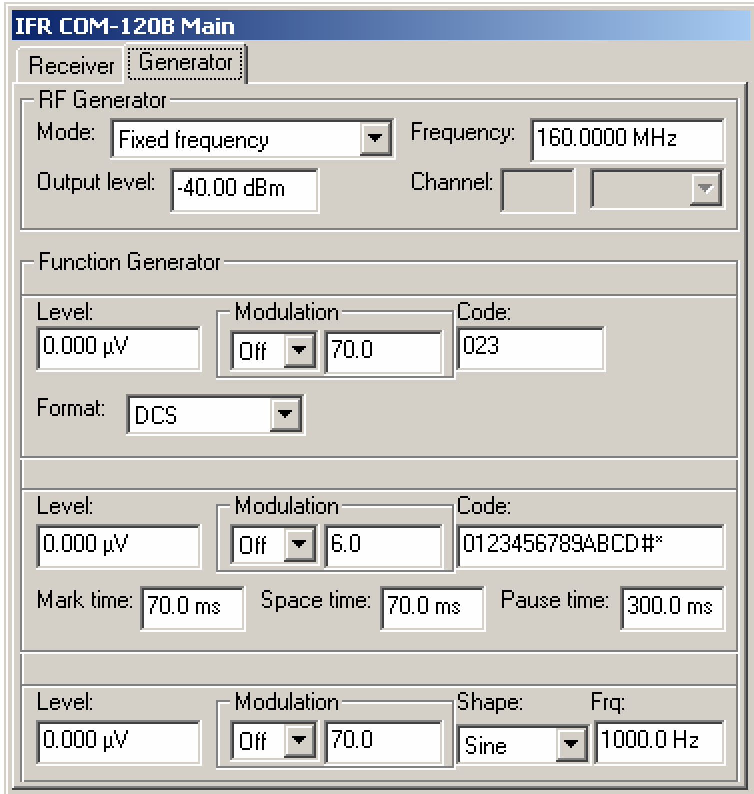
Save… button. To reload a previously saved state, click **Load…** The **Preset** button can be used to reset the instrument to a factory preset state:



Clicking the Generator tab in the Main panel changes the instrument's mode of operation from that of a receiver/spectrum analyser to a signal generator:



All signal generator functionality is controlled through the Generator tab. Specifically, this tab provides control for the RF generator, function generator, and modulation settings of the COM-120B instrument:



The **RF Generator** area lets you specify the **Frequency** and **Output level** of the RF generator. The generator can operate in one of several modes. In **Fixed frequency** mode, the generator frequency is entered by hand. The frequency can also be tuned to a specific **Channel** frequency if you select one of the **Cellular** or **Trunking** modes in the **Mode** dropdown. For cellular (forward and reverse) modes, the Channel field can be used to enter a channel number; for trunking (forward and reverse) modes, an additional field becomes active where you can specify 800 MHz or 900 MHz band operation.

The **Function Generator** can generate a **DCS** or **DCS Inverse** code. It can be used to modulate the RF signal by selecting **AM**, **FM**, or **PM** in the **Modulation** field; select **Off** if you do not wish the RF output to be modulated by this signal. The DCS code can be entered in the **Code** field. The signal's level is controlled by the **Level** field; the modulation depth can also be adjusted by changing the value of the numeric field in the **Modulation** area.

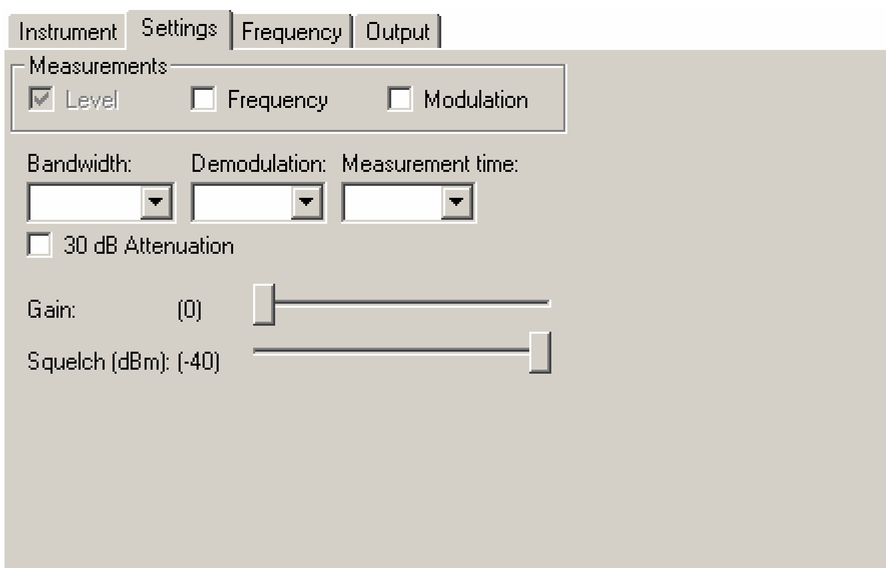
The output signal can also carry a DTMF code. The DTMF **Level**, **Modulation** (**Off**/**AM**/**FM**/**PM**) and modulation depth, and the DTMF **Code** to be transmitted can all be set through the appropriate fields. The duration (**Mark time**) of, and pause between (**Space time**) DTMF codes can also be set. The DTMF sequence you specify in the **Code** field is emitted repeatedly; the pause after the sequence ends can be set using the **Pause time** field.

The COM-120B also has a waveform generator that can produce a sine, square, ramp, or triangle audio waveform. This generator is controlled through the bottom area in the Generator tab. The signal **Level**, **Modulation**, and modulation depth can be adjusted through the appropriate fields. The waveform is selected through the **Shape** dropdown; the **Frq** field controls the audio frequency.

3.2.6.1.2. Background tasks reference

The IFR COM-120B can be used for scheduled background tasks. In this mode, the instrument is used as a receiver that can measure signal levels, frequencies, and modulation depth.

The IFR COM-120B driver only supports Instrument Control tasks that generate logs in a human-readable log file format. The user interface provides a means to select which values to measure and control basic receiver settings:



The **Frequency** and **Modulation** measurements are optional. The **Bandwidth**, **Demodulation**, and **Measurement time** values must be set to appropriate values; the **30 dB Attenuation** checkbox controls whether or not the receiver's built-in attenuator is used. The **Gain** slider controls the audio level; audio output can be suppressed using the **Squelch** control if the received RF signal does not reach the desired level.

3.2.6.1.3. Instrument command reference

Here is a list of a few select IFR COM-120B instrument commands used by the ISOC software:

Command	Description
REC:FREQ	Set/query receiver frequency
REC:BAND	Set/query receiver bandwidth
REC:DEMOD	Set/query demodulator
REC:SQU:LEV	Set/query squelch level
MET:RFER:GATE:TIME	Set/query measurement time
REC:VOL	Set/query audio volume
ANAL:SPAN	Set/query trace span
ANAL:INP:ATT	Set/query attenuation
ANAL:REF:LEV	Set/query trace reference level
ANAL:SCAL	Set/query trace vertical scale
ANAL:BAND	Set/query resolution bandwidth
ANAL:SWEEP	Set/query analyser sweep time
SCOP:SCAL	Set/query scope vertical scale
SCOP:SWE	Set/query scope sweep time
DISP:REC:ANAL	Set analyser to display received signal
REC:MET:ANAL	Set analyser to display received signal
REC:MET:SCOPE	Set scope to display received signal
DISP:GEN:ANAL	Set analyser to display generator signal
GEN:MET:ANAL	Set analyser to display generator signal
GEN:MET:SCOPE	Set scope to display generator signal
SCOP:INP DET	Set scope input to detector (receiver)
SCOP:INP INTMOD	Set scope input to internal modulator
GEN:FREQ:MODE	Set/query generator mode
GEN:FREQ	Set/query generator frequency
GEN:OUTP:LEV	Set/query generator level
FGEN:DATA:LEV	Set/query function generator level
GEN:OUTP:DATA:PM:DEV	Set/query function PM modulation level
GEN:OUTP:DATA:MOD	Set/query function modulator
FGEN:DATA:COD	Set/query DCS code
FGEN:DATA:FORM	Set/query DCS mode
FGEN:DTMF:LEV	Set/query DTMF level
GEN:OUTP:DTMF:PM:DEV	Set/query DTMF PM modulation level
GEN:OUTP:DTMF:MOD	Set/query DTMF modulator
FGEN:DTMF:COD	Set/query DTMF code
FGEN:DTMF:MARK	Set/query DTMF mark time
FGEN:DTMF:SPAC	Set/query DTMF space time
FGEN:DTMF:PAUS	Set/query DTMF pause time
FGEN:GEN1:LEV	Set/query waveform level
GEN:OUTP:GEN1:PM:DEV	Set/query waveform PM modulation level
GEN:OUTP:GEN1:MOD	Set/query waveform modulator
FGEN:GEN1:SHAP	Set/query waveform shape
FGEN:DATA:STAT	Set/query function generator state
FGEN:DTMF:STAT	Set/query DTMF generator state

Command	Description
`FGEN:GEN1:STAT`	Set/query waveform generator state
`FGEN:GEN1:FREQ`	Set/query waveform generator frequency

3.2.6.2. CRC Spectrum Explorer

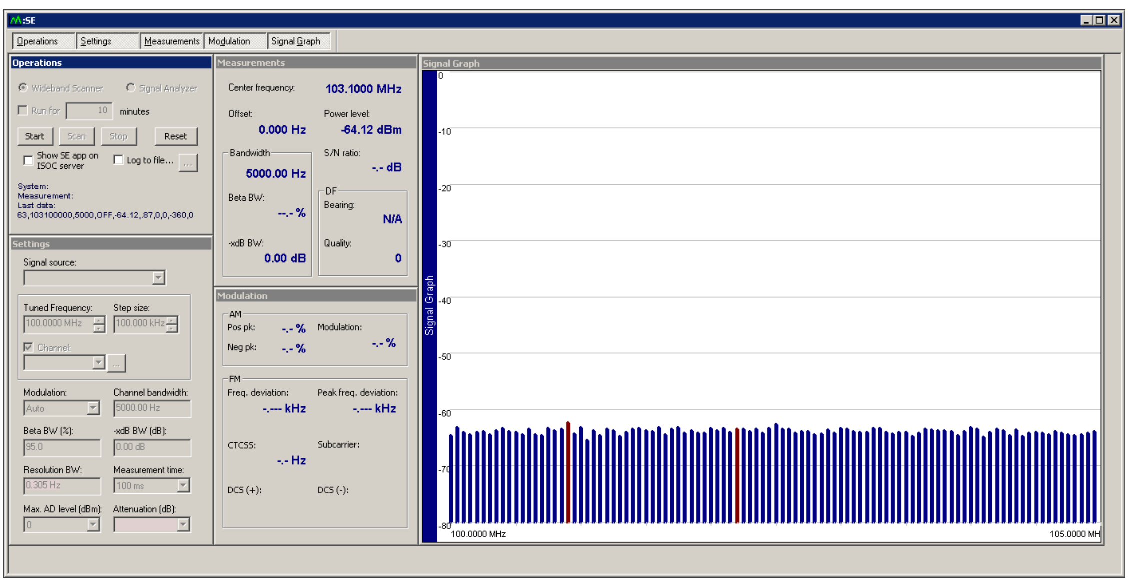
The CRC Spectrum Explorer is a "software instrument": it is an application suite developed by Communications Research Centre Canada that controls a selection of RF instruments and provides a software interface to them.

The ISOC can utilize the Spectrum Explorer for interactive operation as well as background tasks. Interactive control is achieved either using the new (as of Version 2.15) SE virtual instrument, or through Remote Desktop.

3.2.6.2.1. Interactive reference (virtual instrument)

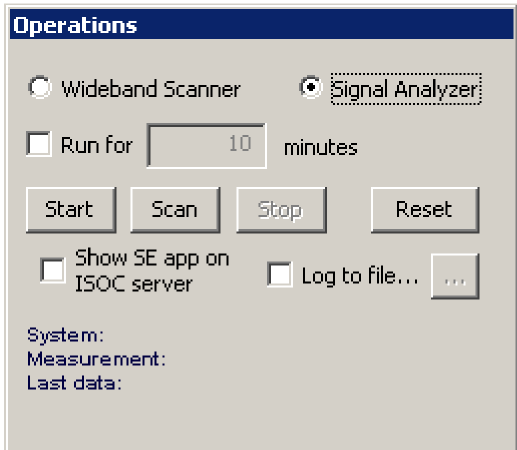
Starting with Version 2.15, the ISOC has built-in virtual instrument support for the Spectrum Explorer. The virtual instrument allows access to the Spectrum Explorer in wideband scanner or signal analyzer mode, allowing users to monitor a single frequency or a set of frequencies. Readings can be viewed in real time or saved to a file.

The Spectrum Explorer virtual instrument is illustrated below:



When the Spectrum Explorer virtual instrument is started, the ISOC connects to the Spectrum Explorer. Depending on the performance of the Spectrum Explorer host computer and its hardware configuration, the connection can take several seconds, during which the ISOC remains unresponsive. This is normal; please be patient.

The Spectrum Explorer is controlled through the Operations and Settings panels in the virtual instrument. The Operations panel can be used to select the Spectrum Explorer's mode of operation and start or stop scans:



The main operating mode of the Spectrum Explorer is controlled by the **Wideband Scanner** and **Signal Analyzer** radio buttons.

> **Tip:** Changing the operating mode of the Spectrum Explorer is a very time consuming operation, as the Spectrum Explorer software tears down and rebuilds its user interface. Please be patient when changing the Spectrum Explorer operating mode!

Measurements can be started or stopped using the **Start** and **Stop** buttons. The **Scan** button is available if a **Channel** file is selected in the Settings panel, to scan through all frequencies in that file, not just the selected frequency. Additionally, the **Run for** checkbox can be used to specify a predetermined amount of time for which a scan is to run; the default for this checkbox is to stay cleared, which means that the scan runs until the **Stop** button is pressed.

When no scan is running, the **Reset** button can be used to reset the settings of the Spectrum Explorer virtual instrument to defaults.

The **Show SE app on ISOC server** checkbox controls the visibility of the Spectrum Explorer user interface on the Spectrum Explorer host computer. When the Spectrum Explorer is initialized, its user interface is visible; this checkbox can be cleared to cause the user interface to be hidden.

The **Log to file** checkbox can be used to enable logging of Spectrum Explorer measurements. When it is clicked the first time, or when the  button is clicked, a file selection dialog appears where the name and location of the log file can be specified.

The log file contains three sections: a file header, a session header, and actual measurements. The file header contains the version number ("Version 1.0"), the name of the ISOC server host, and the district number. The file header appears only once, at the top of each file, followed by a blank line.

The session header contains several lines indicating the current Spectrum Explorer settings. These include the name of the instrument, the selected input (signal source), and all the settings from the Settings panel. This section is followed by another blank line.

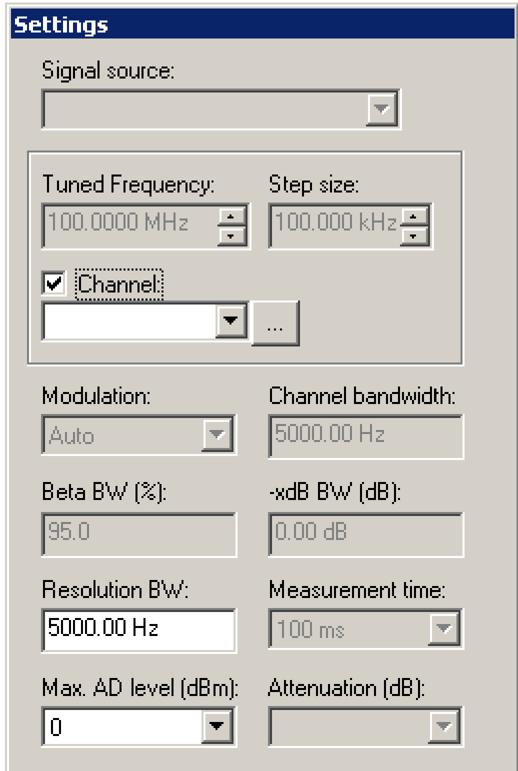
Finally, the individual measurements appear, one per line, containing the following columns:

- Date (yyyy/mm/dd)
- Time (hh:mms:ss)
- Longitude
- Latitude
- Index
- Centre Freq (Hz)
- Bandwidth (Hz)
- Status
- Power (dBm)
- C/N ratio (dB)
- Offset (Hz)
- -xDB bandwidth (Hz)
- DF Bearing
- DF error
- Modulation
- Modulation presence (%)
- Amplitude modulation depth (%)
- Positive modulation depth (%)
- Negative modulation depth (%)
- Frequency deviation (Hz)
- Peak frequency deviation (Hz)
- Symbol rate (sym/s)
- Signal format
- Sub-Carrier
- Tone frequency (Hz)
- Code #1
- Code #2
- Bandwidth (BETA%) (Hz)
- S/N ratio (dB)

Individual values within each line are comma delimited. When a value is missing (e.g., when it is not applicable in the Spectrum Explorer's current mode of operation) it is left blank.

Returning to the Spectrum Explorer virtual instrument user interface, the bottom area of the Operations panel displays the most recently received information from the Spectrum Explorer. It can be used to verify that the Spectrum Explorer is indeed operating as desired.

Before a scan is initiated, it is necessary to set up the Spectrum Explorer with appropriate parameters. This is accomplished using the Settings panel:



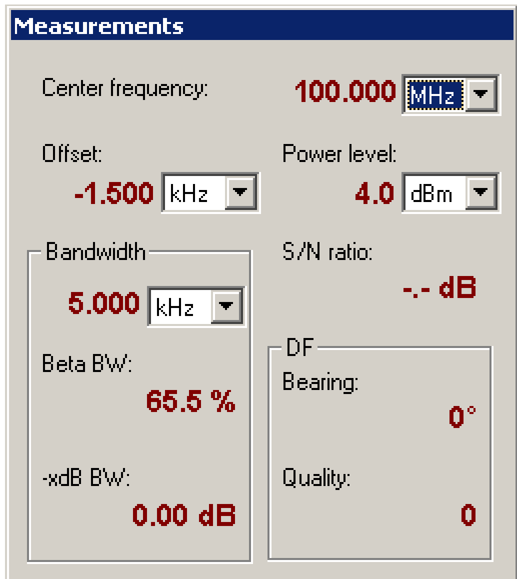
In the Settings panel, the **Signal source** field allows the selection of an appropriate input for the Spectrum Explorer at installations with a switch matrix present. The **Tuned Frequency** field is used to set a single frequency (this is most useful if the Spectrum Explorer is used in its Signal Analyzer mode) and can be adjusted using the up-down arrows. The magnitude of the adjustments is controlled by the **Step size** field.

As an alternative to single-frequency operation, the **Channel** checkbox can be used to select a frequency list file. When the Channel checkbox is first selected, or when the ... button is clicked, a file selection dialog appears where an LST or an SST file can be selected. The list of frequencies in that file can be viewed using the dropdown control.

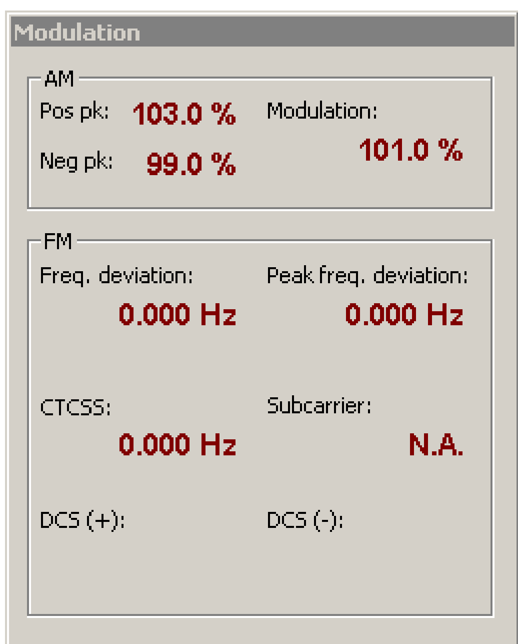
Eight additional controls can be used to set the receiver to the desired parameters. Not all these controls are available all the time. In particular, when the Spectrum Explorer is used in Wideband Scanner mode, only the **Resolution BW** and **Max. AD level** fields can be adjusted. The **Channel bandwidth**, **Beta BW**, **–xdB BW**, **Measurement time** and **Attenuation** fields are available only in Signal Analyzer mode.

When a scan is initiated by clicking the **Start** or **Scan** buttons in the Operations panel, these settings are first sent to the Spectrum Explorer and are read back for verification. If the Spectrum Explorer reports a value that is different from the value entered, the corresponding field will appear with a lightly shaded background. Most of the time, this will happen as the Spectrum Explorer rounds an input value to the nearest available value.

While a scan is running, readings provided by the Spectrum Explorer can be viewed in the Measurements panel:



Readings are displayed in red if the Spectrum Explorer indicates that the corresponding channel is “on”; otherwise, the readings are shown in blue. For certain readings such as the Center frequency, the units of measurement can be chosen by using the corresponding dropdown controls. Additional readings related to modulation are provided in the Modulation panel:



Lastly, a simple histogram style display of the signal spectrum is shown in the Histogram panel. This panel is most useful when the Spectrum Explorer is used to scan multiple frequencies.

> **Tip:** The version of the Spectrum Explorer used during ISOC development exhibited some peculiarities. In particular, it did not respond reliably when multiple frequencies were scanned in Signal Analyzer mode. Furthermore, at certain times the Spectrum Explorer displayed warning dialogs on the Spectrum Explorer host computer screen, which needed to be dismissed manually before the Spectrum Explorer responded to further interactive commands. It is highly recommended that you test and experiment with your Spectrum Explorer installation first to discover its most reliable modes of operation.

3.2.6.2.2. Interactive reference (Remote Desktop)

The ISOC also provides access to the CRC Spectrum Explorer via Microsoft Remote Desktop, a built-in facility of Microsoft Windows that allows remote control of one computer from another.

Access to the remote computer running the Spectrum Explorer is accomplished via a helper application. This application is invoked, with appropriate parameters, when the CRC Spectrum Explorer instrument is opened for interactive use.

> **Tip:** In order for the Remote Desktop connection to work properly, its parameters must be correctly set up on the ISOC server, and your workstation must be able to connect directly to the computer running CRC Spectrum Explorer.

Within the ISOC itself, the CRC Spectrum Explorer user interface is very simple: it provides only for the ability to select a signal source:

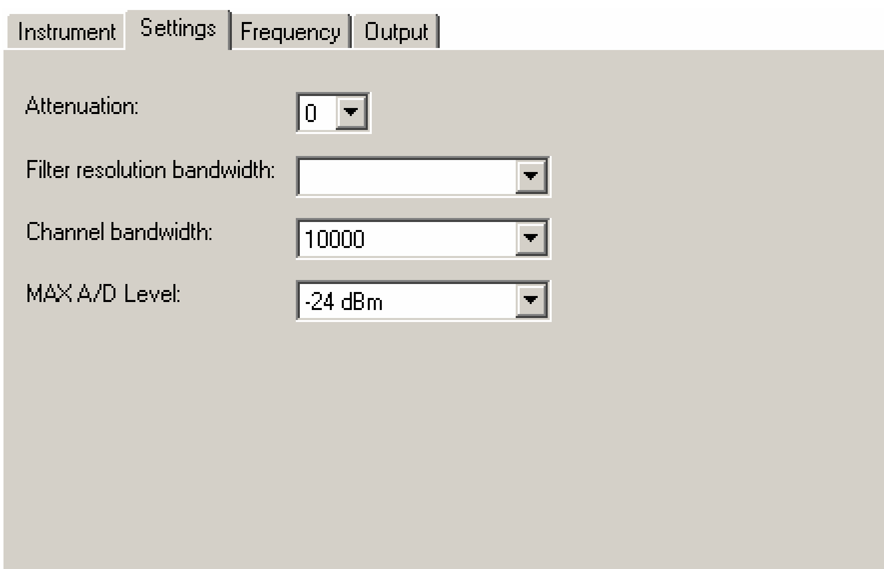
This window also serves as an indicator that a Remote Desktop connection to the designated instrument is open. If the Remote Desktop connection is closed (as indicated by the termination of the Remote Desktop program on your workstation), this window also closes. Conversely, if this window is closed manually, it causes termination of the Remote Desktop session.

> **Tip:** Recent versions (2.8.9 and later) of the ISOC suite warn you before letting you close the Remote Desktop session by closing the signal source window. Closing the session this way instead of properly shutting down the Spectrum Explorer application in the Remote Desktop window can render the Spectrum Explorer server inaccessible until a reboot.

The Spectrum Explorer instrument can also be used for interactive DF operation via the special instrument type, "Spectrum Explorer DF".

3.2.6.2.3. Background tasks reference

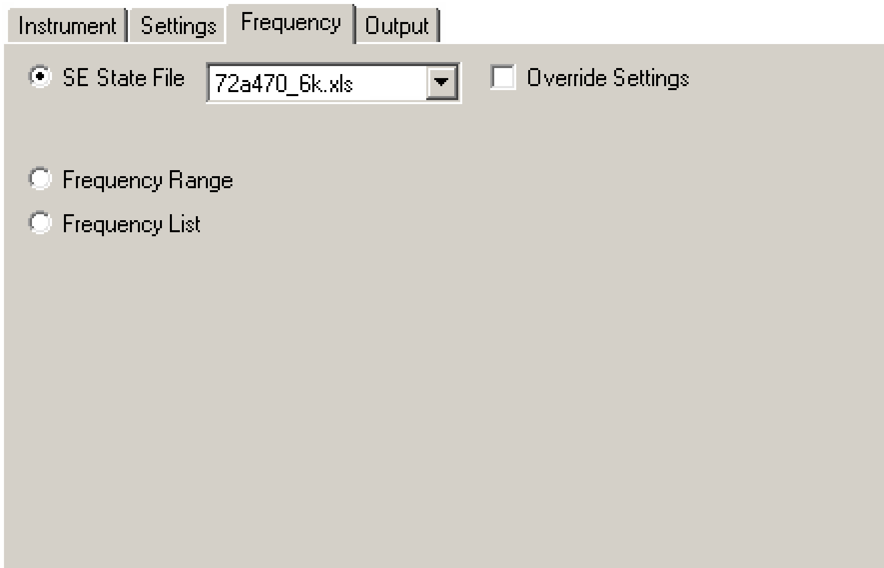
The Task Manager interface of the Spectrum Explorer contains a few instrument-specific controls:



The four values, **Attenuation**, **Filter resolution bandwidth**, **Channel bandwidth**, and **MAX A/D Level**, can be set individually, and these values are sent to the instrument when it is being initialized for a scanning task.

For the Spectrum Explorer instrument, a new option is available under the Frequency Tab. When the **SE State File** radio button is selected, a dropdown control appears containing a list of Microsoft Excel files that can be sent to the instrument. It is the user's responsibility to ensure that the selected file is an appropriately formatted file containing Spectrum Explorer state information.

When a state file is used, separately sending to the instrument the file resolution bandwidth, channel bandwidth, and maximum A/D level settings may not be desirable. The sending of these options can be suppressed by checking the **Override Settings** checkbox under the Frequency tab.



3.2.6.2.4. Instrument command reference

Here is a list of a few select Spectrum Explorer instrument commands used by the ISOC software:

Command	***Description***
`SYST:REMOVEALL`	Reset the Spectrum Explorer
`SYST:APP:ADD`	Invoke a Spectrum Explorer application
`SYST:APP:ITEM`	Select the default application
`SYST:COMMAND?`	List available commands
`SYST:RX:ATTPROFILE?`	List available attenuation settings
`SYST:AD:REFLPROFILE?`	List available max. A/D level settings
`SYST:AD:REFL`	Set max. A/D level
`SYST:AD:REFL?`	Query max. A/D level
`SYST:RX:ATT`	Set attenuation
`SYST:RX:ATT?`	Query attenuation
`MEAS:SETT:RESOLUTIONBANDWIDTH`	Set the resolution bandwidth
`MEAS:SETT:RESOLUTIONBANDWIDTH?`	Query the resolution bandwidth
`SYST:RX:BANDWIDTH`	Set the receiver bandwidth
`SYST:RX:BANDWIDTH?`	Query the receiver bandwidth
`MEAS:SETT:BANDWIDTH:XDB`	Set the –xDB bandwidth
`MEAS:SETT:BANDWIDTH:XDB?`	Query the –xDB bandwidth
`MEAS:SETT:BANDWIDTH:BETA`	Set the beta bandwidth
`MEAS:SETT:BANDWIDTH:BETA?`	Query the beta bandwidth
`MEAS:CHANNEL:CLEAR`	Clear all measurement channels

Command	***Description***
`MEAS:CHANNEL:ADD`	Add a measurement channel
`MEAS:START`	Start scanning
`MEAS:RUN?`	Verify that the scan is running
`MEAS:CHANNEL?`	Read measurements
`MEAS:STOP`	Stop a scan
`SYST:ERROR:MESSAGE?`	Query the system error message buffer
`SYST:ERROR:MESSAGE:CLEAR`	Clear the system error message buffer
`MEAS:ERROR:MESSAGE?`	Query the measurement error buffer
`MEAS:ERROR:MESSAGE:CLEAR`	Clear the measurement error buffer

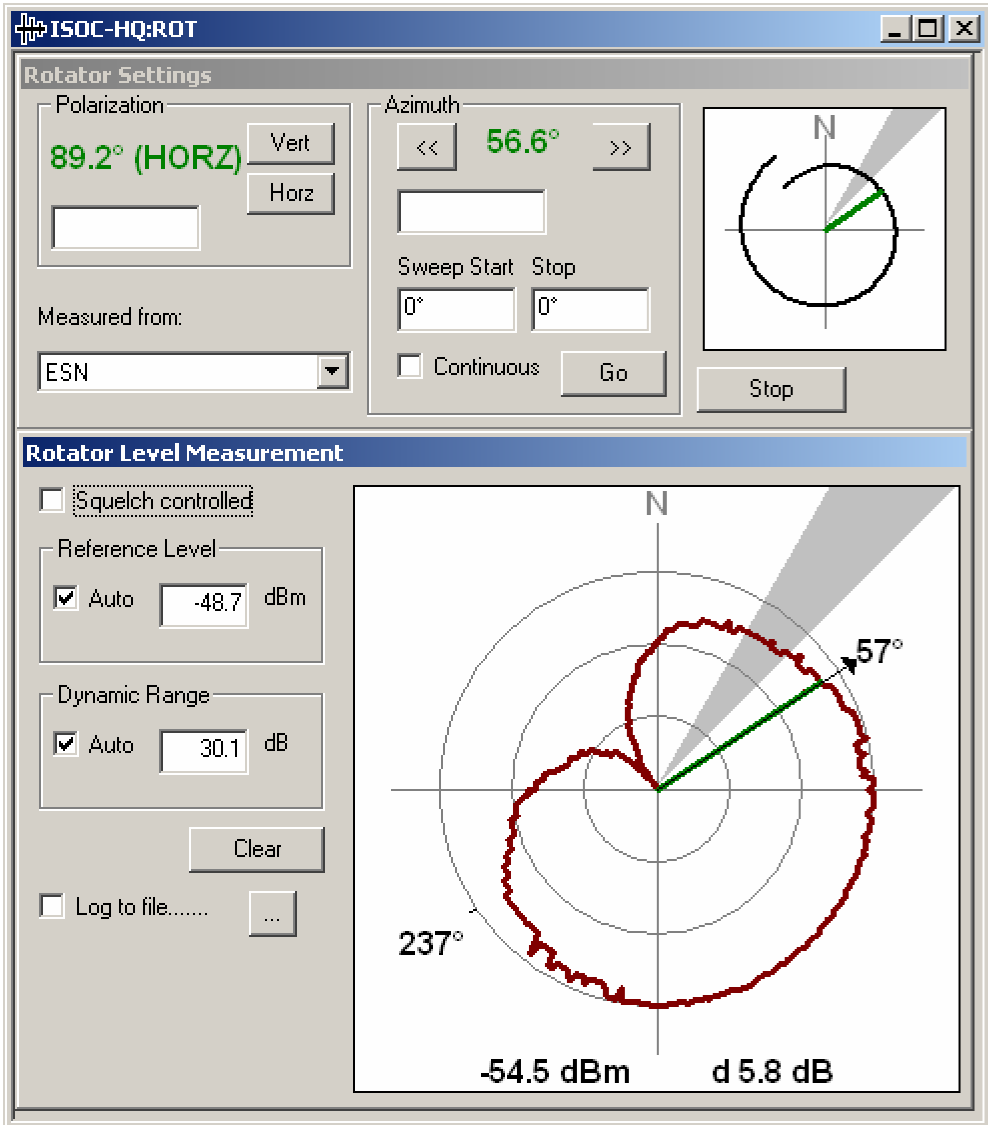
3.2.7. Miscellaneous instruments

3.2.7.1. Emotator EV-800D antenna rotator

The Emotator EV-800D consists of an antenna stub with motorized azimuth and elevation controls, and a control electronics box. The control electronics box is connected to the ISOC server computer using a B&B Electronics 232SDA10 data acquisition module. The data acquisition module receives commands from the ISOC server and sets logic states that control the operation of the rotator; it also accepts analog readings from the rotator and translates them into digital values that are transmitted to the ISOC server. These digital values are converted into azimuth and elevation readings by the ISOC server.

3.2.7.1.1. Interactive reference

The antenna rotator virtual instrument consists of two panels: the first panel controls the antenna rotator, while the second panel shows level measurements in various directions. Initially, only the first panel is visible. The second panel can appear when at least one additional instrument is open and uses an input signal that is associated with the antenna rotator. The **Measured from** field contains the list of all presently active virtual instruments that the antenna rotator can work with; selecting an instrument from this list causes the second panel to appear:



The antenna rotator is controlled through an RS-232 data acquisition module manufactured by B&B Electronics. This module accepts simple commands in the form of `!0RA`*n* (read analog channel *n*) and `!0SO`*n* (set binary output *n*); these commands are used to read the rotator position and control the rotator's motors, respectively.

To control the antenna rotator, use the controls in the Rotator Settings panel. To adjust the polarization (vertical position) of the antenna, use the **Vert** or **Horz** buttons, or enter the desired numeric value (in degrees) in the **Polarization** field and hit Enter. The actual polarization reading appears in green; if it is within ten percent of the horizontal or vertical position, the words HORZ, or VERT, respectively, also appear.

To adjust the azimuth (horizontal position) of the antenna, use the **<<** or **>>** buttons, or enter the desired value in degrees in the **Azimuth** field. Alternatively, you can use the small graphical area to the right, which shows the rotator position; by clicking and dragging the mouse in this area, you can set the new azimuth, and the rotator will move to that position. Note that the rotator's azimuth range may exceed 360°. The spiral shape of the line representing the rotator's horizontal range can help unambiguously position the rotator in the overlapping region.

The antenna rotator can also be configured to sweep horizontally. Enter the desired start and stop values, in degrees, in the **Sweep Start** and **Stop** fields, and click the **Go** button. If the **Continuous** checkbox is selected, the antenna rotator will sweep back and forth continuously; otherwise, it will stop when it reaches the end of the sweep range.

A sweep range can also be specified graphically, using the right mouse button. Click and hold the right mouse button as you drag the mouse in the graphical area to select the desired sweep range.

The **Stop** button can be used to immediately stop the rotator (both horizontal and vertical motion). The **Stop** button also cancels an ongoing sweep.

The Rotator Level Measurement panel provides a graphical readback of the level measurements made by the receiver that works in conjunction with the rotator. Received signal levels are displayed as a function of direction in the form of a polar graph. The measurements can be squelch controlled; if the **Squelch controlled** checkbox is set, no measurements are displayed in the graph if the RF level does not exceed the squelch level (as specified in the receiver virtual interface).

The appearance of the graph can be controlled through the **Reference Level** and **Dynamic Range** areas. The **Reference Level** controls the signal level that corresponds with the outermost concentric circle in the graph; the **Dynamic Range** corresponds with the range of signal levels from the centre of the graph to the outer circle. Leaving both settings on **Auto** allows the virtual instrument to select the best values based on the actual range of the received signal.

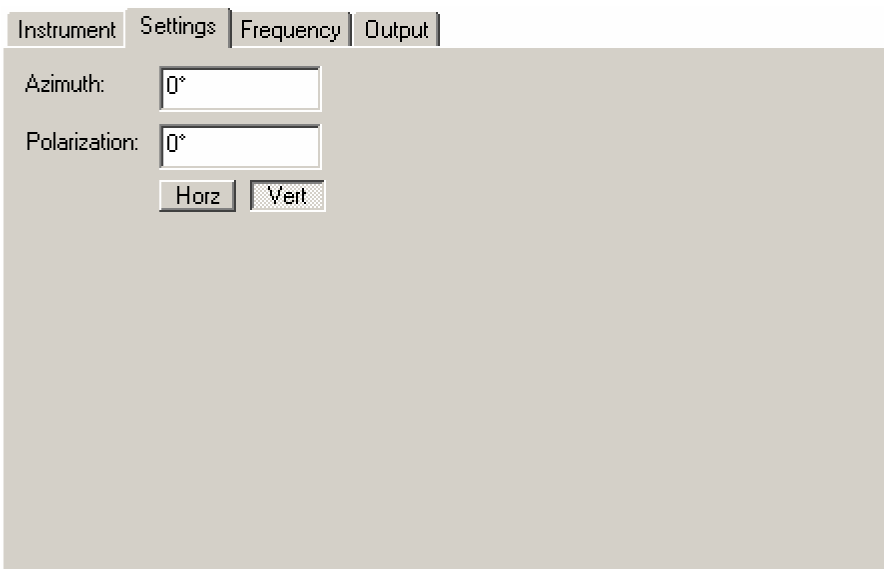
The **Clear** button can be used to clear the graph. The **Log to file** checkbox can be used to log measurements. When you set this checkbox for the first time, or when you click the ... button, the File Open dialog is displayed, allowing you to select a log file.

Areas marked as obstructions are shaded grey in the chart. The obstruction list is configured by the server administrator who sets up the rotator.

The chart can also be used interactively. Clicking and dragging the mouse shows the angle in the mouse direction and 180° opposite, and also the signal level. The difference between the signal level and the reference level is also displayed in the graph area.

3.2.7.1.2. Background tasks reference

The antenna rotator can also be used in scheduled tasks. No measurements are performed by the rotator; the functionality is limited to setting up the rotator with a given azimuth and polarization value. Correspondingly, the antenna rotator's user interface in the Task Manager is fairly simple:



Only two values can be entered: the **Azimuth** and **Polarization** values, in degrees. The **Horz** and **Vert** buttons provide convenient shortcuts for horizontal and vertical polarization, respectively.

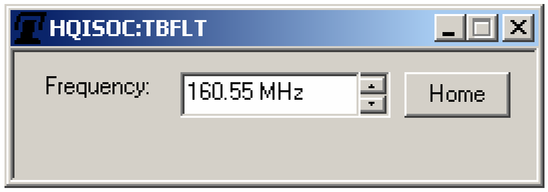
3.2.7.2. Telonic/Berkeley TCK programmable filter

The Telonic/Berkeley TCK programmable filter is a high-accuracy narrowband filter unit that is used in the ISOC in conjunction with certain receivers (notably ICOMs) to improve the receivers' selectivity.

The TCK instrument can be used both interactively and in scheduled tasks.

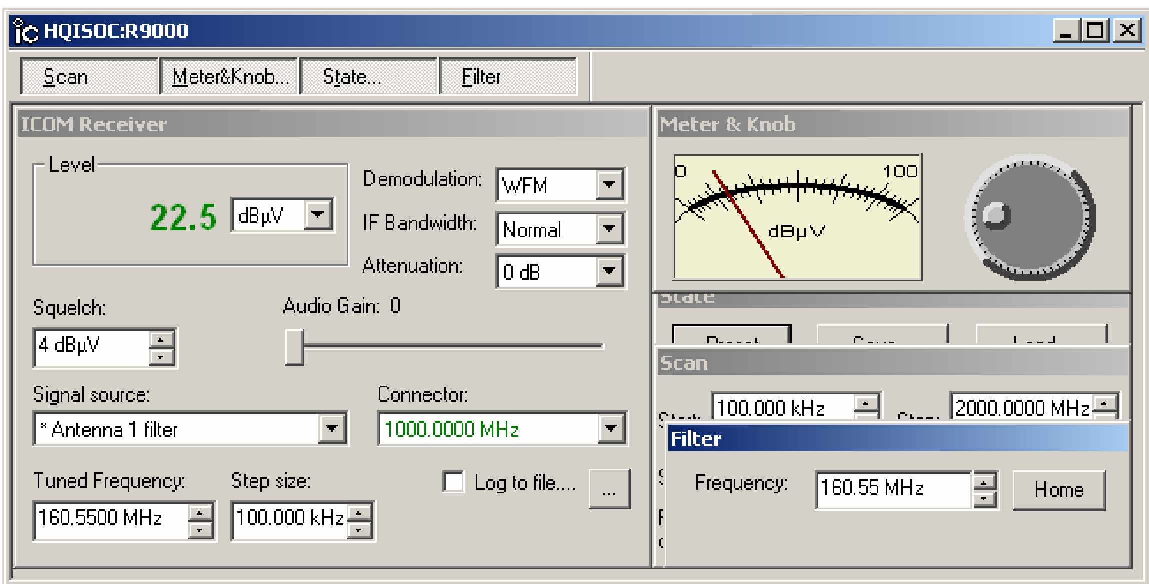
3.2.7.2.1. Interactive reference

Interactively, the filter can be operated in stand-alone mode. The virtual instrument is simple:



Only two controls are present: the filter **Frequency** and the **Home** button. To set the filter to a desired frequency, enter that frequency in the **Frequency** field and hit the Enter key (this sends an `F` command to the filter unit). The Home button can be used to reset the filter to its home (minimum) frequency (`H` command).

The TCK filter is used most typically in conjunction with a receiver. When using the ICOM virtual instrument, if you select a **Signal source** that is associated with a TCK filter unit, a new panel, the Filter panel appears in the ICOM virtual instrument. This panel has the exact same user interface as the standalone TCK filter virtual instrument:

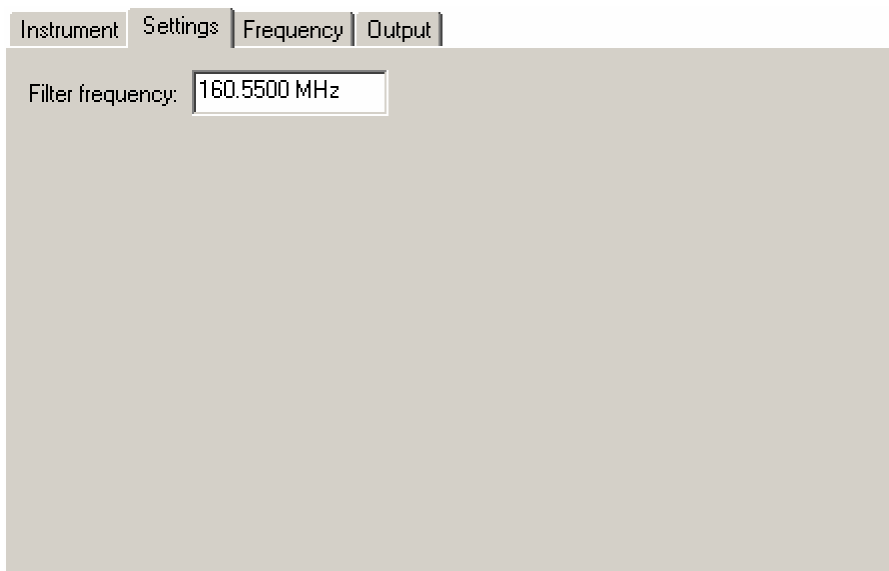


In this mode of operation, the filter is tuned automatically; it is set to follow the receiver's tuned frequency. (It is still possible to detune the filter if desired; however, the next time you change the receiver frequency, the filter will again be set to the new receiver frequency).

Tip: If the ICOM virtual instrument operates very sluggishly after the Filter panel is opened, it may be due to a communication problem with the filter.

3.2.7.2.2. Background tasks reference

The TCK filter can also be used in background tasks. If it is associated with a signal source, the Task Manager will offer to automatically set up a task for the filter. The filter's configuration interface contains only one control, for the **Filter frequency**:



Regardless of this setting, if the filter is used in conjunction with a tuneable instrument such as a receiver, the filter will be commanded to follow the receiver whenever the receiver frequency is changed.

3.2.7.3. Windows audio

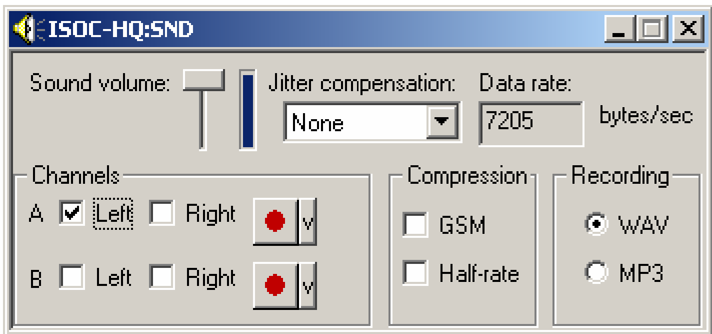
The Windows Audio virtual instrument corresponds with the audio capture capability of the ISOC server computer's sound hardware. The purpose of this virtual instrument is to provide a digital audio stream that can be transmitted efficiently even over narrowband network connections and can be listened to on client computers.

This virtual instrument is unique in that it is a "shared" instrument: multiple clients can listen to the same audio stream simultaneously. This is possible because on the client side, the Windows Audio virtual instrument is entirely passive; it does not control what happens on the server, it merely receives the audio stream provided by the server. Therefore, when multiple clients connect, there is no possibility for conflict.

Because of this architecture, the virtual instrument provides no means to select an audio signal source. At sites equipped with an audio switch matrix, selection of the audio signal source is accomplished through a separate virtual instrument, the Audio Input virtual instrument (see section 3.2.7.4 below). This means that if you wish to listen to audio and also control which signal is routed to the audio input, you may need to open two virtual instruments; a Windows Audio instrument to listen to the audio stream, and an Audio Input instrument to control the signal source for that stream.

3.2.7.3.1. Interactive reference

The Windows Audio instrument's interactive user interface has the following form:



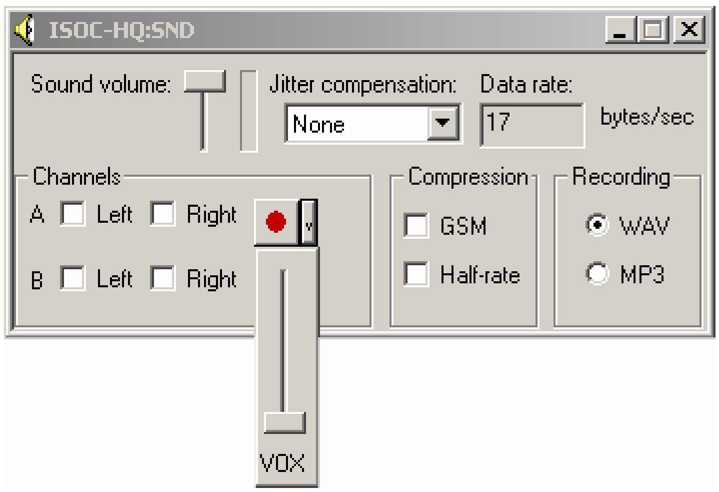
The settings in this panel are as follows:

The **Sound volume** slider controls the playback volume of the received audio stream. Next to the slider is a vertical bar display that shows the received audio signal level.

The **Jitter compensation** setting determines the amount of delay used in audio playback to compensate for any variations in the arrival time of streaming audio data packets.

The **Data rate** field shows the current data rate in bytes/sec. This may help you determine if interrupted or choppy audio is a result of trying to transmit too much data over a narrowband data connection. The data rate of an uncompressed monaural ISOC stream is ~8000 bytes/sec. This is also the maximum data rate of a single-channel ISDN data connection. A 33,600 bps modem's maximum data rate is ~4,200 bytes/sec (the actual data rate is less, due to the overhead of network headers and other data traffic). GSM compression reduces the data rate for a monaural radio stream by a factor of 5 at a minimal loss of quality. Half-rate compression further reduces the data rate by a factor of two, albeit at a significant loss of quality. The lowest data rate at which a single monaural audio stream can be transmitted is, therefore, approximately 800 bytes/sec, which is suitable for transmission even over a 9,600 bps modem connection.

The **Channels** area lets you select which audio channel (on the server) is heard on which speaker (on the client). For each of the server's two channels (marked **A** and **B**), you can select the speaker (**Left** on **Right**) on the client computer. If neither is selected, the audio stream is not transmitted at all, in order to save bandwidth. The Channels area also contains controls for recording audio. The  button starts the recording, or stops a recording that is in progress. Before you begin the recording, you can use the down-arrow button to view the VOX slider:



When the VOX value is set to something other than 0 (bottom end of the scale) audio recording is paused if the received audio level remains below this level for a period of time, and resumes instantly when an audio level higher than this level is detected.

You can also pause audio recording manually. As soon as you begin recording, the pause button () appears. Clicking this button pauses the recording; clicking it again resumes the recording.

> **Tip:** When you record audio through the Windows Audio virtual instrument, **the recording stays on the server**. This ensures good quality, uninterrupted recording. When the recording is completed, you can use a file transfer utility (e.g., the file transfer capability built into the ISOC Task Manager) to retrieve the resulting file.

Recorded audio is saved in a file named

`client-devid-ch-datetime.ext`

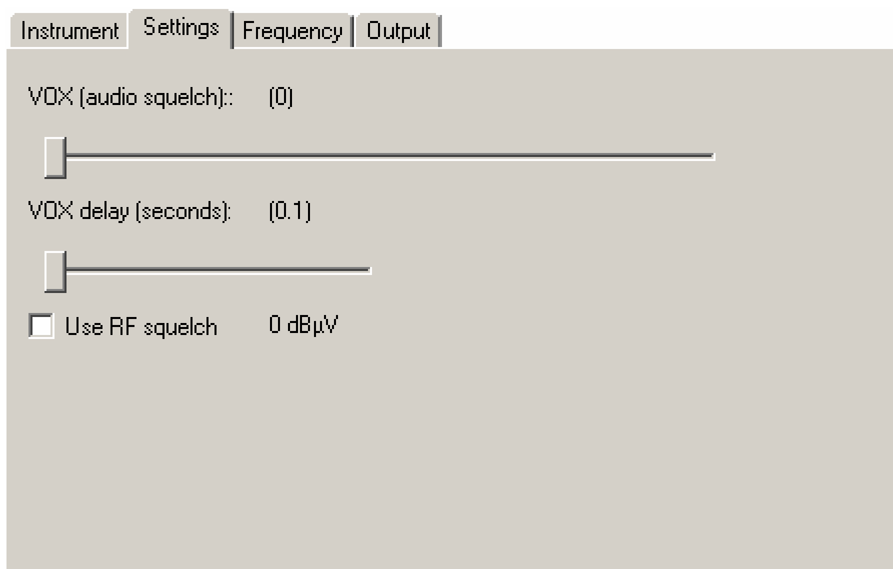
where *`client`* is the name of your (the client) computer from which the recording was initiated; *`devid`* is the ISOC name of the audio device; *`ch`* is the audio channel being recorded (A or B); `datetime` is the date and time in numeric format; and `ext` is the filename extension, `WAV` or `MP3` depending on the file type.

The **Compression** area lets you select data compression options. The **GSM** option uses the industry standard GSM algorithm to reduce the data rate by a factor of 5 at a minor loss of quality. The **Half-rate** compression causes only every second sample to be processed and transmitted; the omitted samples are interpolated. This results in a significant loss of audio quality but it may provide a means to receive audio over very limited network connections.

The Recording area lets you select the recording format on the server. The two choices are **WAV** (for uncompressed Windows waveform audio format files) and **MP3** (for highly compressed industry-standard MP3 audio).

3.2.7.3.2. Background tasks reference

The audio can also be recorded by background tasks. The audio instrument's configuration interface in the Task Manager contains three controls:



The **VOX (audio squelch)** slider controls the audio level (volume) that is used to determine when the recording is paused or resumed. The amount of silence required before recording is paused is determined by the **VOX delay (seconds)** slider. Lastly, if the job includes a source instrument (e.g., a receiver) and the audio recording uses it as the signal source, the **Use RF squelch** checkbox becomes available; if selected, the RF squelch of the receiver controls when audio is being recorded. Note that the VOX and RF squelch features can be used concurrently.

3.2.7.4. Audio input

The Audio Input virtual instrument is a "dummy" or placeholder virtual instrument. Its purpose is to provide a user interface that corresponds with an audio connector receiving a signal that is controlled by a switch matrix. The virtual instrument contains a single control: a combo box that contains the list of available signal sources for this audio connector:

The Audio Input virtual instrument may be used to represent the audio inputs of the ISOC server computer, or, for instance, the AF Ext connector of a signal generator.

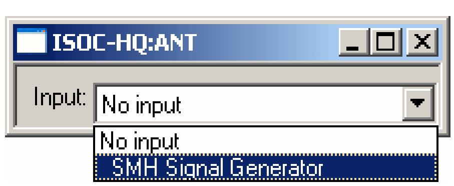
3.2.7.5. Dummy instrument

"Dummy" instruments are instruments that are listed in the ISOC Servers dialog of the main ISOC for Windows application, but to which you cannot connect (i.e., the **Connect** button is greyed out). The dummy instrument type is used for instruments with no user interface when you still wish to have power control, for instance; one example is the switch matrix "instrument" that cannot be directly controlled, but you may wish to be able to turn it off and on remotely.

Note that in earlier versions of the ISOC, there existed a "generic" interface for dummy instruments (i.e., instruments not recognized by any of the virtual instrument drivers). This interface has been removed from production configurations.

3.2.7.6. Test antenna

The test antenna virtual instrument is a placeholder for a passive instrument such as a transmitting antenna. The sole control in the virtual instrument user interface is a dropdown box for selecting the **Input** signal:



The **Input** field controls the switch matrix with settings associated with the Test Antenna device.

The Test Antenna device can also be used to represent extra input ports on instruments where the virtual instrument does not provide such a representation.

3.2.8. Other hardware

There are several instruments used by the ISOC that have no user interface. These include the GPS device, remote control power bars, and the switch matrix.

3.2.8.1. GPS

The ISOC can utilize a GPS device that communicates via the NMEA 0183 protocol with Garmin extensions, such as the Garmin 16.

When a GPS device is configured to work with the ISOC system, there is no visible user interface to this device[8]. However, the system sets up a hidden background task (not visible in the Task Manager) that continuously monitors the GPS and makes its readings available to other ISOC components. Many ISOC components utilize GPS information. Some virtual instruments (e.g., the ESN receiver virtual instrument) receive GPS information along with readings, and this information is recorded in the log file. Other virtual instruments (e.g., DF instruments) provide a user interface panel where the GPS readings are made visible.

3.2.8.2. RPB+ Remote Control Power Bar

The ISOC can utilize a remote control power bar. The specific power bar recognized by the ISOC is the WTI RPB+ "Remote Power Boot" device. This is a 5-outlet remote control power bar with a serial interface. Individual outlets can be selectively turned on, turned off, or made to "boot" (turned off and then turned back on after a specific time interval) under software control.

To use the remote control power bar, virtual instruments must be configured appropriately by the ISOC server administrator. When an instrument is configured with power settings, the **Power On**, **Power Off**, and **Reboot** buttons can be used in the ISOC Servers dialog of the main ISOC for Windows application to carry out their respective functions. Power is also applied automatically by the ISOC server when an attempt is made to use a device that is not powered, e.g., when a background task starts and utilizes that device.

---

[8] A display-only interface that can be used to verify GPS operation, `ISOCGPS.EXE`, is installed on ISOC servers.

Power may also be turned off automatically, in accordance with the settings specified by the server administrator.

3.2.8.3. IPS-400/IPS-800 Internet Power Switch

The IPS-400 and IPS-800 devices are newer remote control power bar devices manufactured by the same company that produced the RPB+ device. The ISOC has the ability to use these devices as well (through serial port only). The ISOC can automatically determine the power bar type; operation of instruments connected through an IPS-400/IPS-800 is the same as through an RPB+ power bar, as described in the previous section.

3.2.8.4. Switch matrix

The ISOC can use a remote control switch matrix to route RF and AF signals to instruments. The specific switch matrices that the ISOC can utilize are the Racal 1250 and 1256 models, and IP switch controllers that are command and interface compatible with the Vektrex ALA1200 RF Switch Controller.

Note that the ISOC does not require a switch matrix; the server administrator can set up "hardwired" inputs to all instruments, i.e., a software representation of fixed wiring at the ISOC server site. The switch matrix adds functionality, as it permits the routing of specific signals to specific instruments at the user's convenience.

When a switch matrix is present at a server site, the **Input** or **Signal source** fields in virtual instruments will become active. Switch matrix selections are made through these fields.

The switch matrix also has an optional audio frequency component. If this component is present, the switch matrix can route not only RF signals but AF signals as well.

In many installations, the switch matrix is powered through a remote control power bar. This enables you to reboot the switch matrix in case it becomes unresponsive.

> **Tip:** it is very important not to reboot a switch matrix that may be in use. Doing so can disrupt ongoing measurements. Before you choose to reboot a switch matrix, be certain that no other users are using it, and that in particular, no scheduled tasks are running using signals routed through the switch matrix.

4. Installation and Configuration

Like any complex software system, before it can be used, the ISOC has to be installed. Specifically, it has to be installed with the appropriate installation options on both client and server computers.

Installation of the ISOC consists of three steps. First, the core ISOC system must be installed; second, the DF components must be installed; and third, if this is a server installation, the server must be configured to recognize its collection of instruments.

4.1. Application installation, uninstallation, and reinstallation

As of version 2.13, ISOC installation kits are built using Microsoft's toolkit for Setup and Deployment projects.

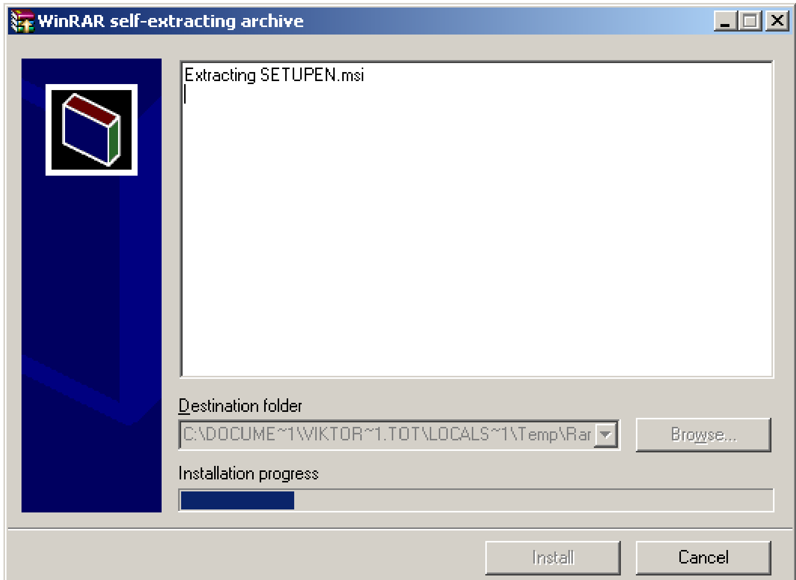
> **Tip:** ALWAYS UNINSTALL pre-2.13 versions before attempting to install version 2.13 or later of the ISOC software. Due to the change in installer technology, older installers are not detected, and a duplicate installation may make it difficult to uninstall or reinstall the software at a later time..

4.1.1. Core system installation

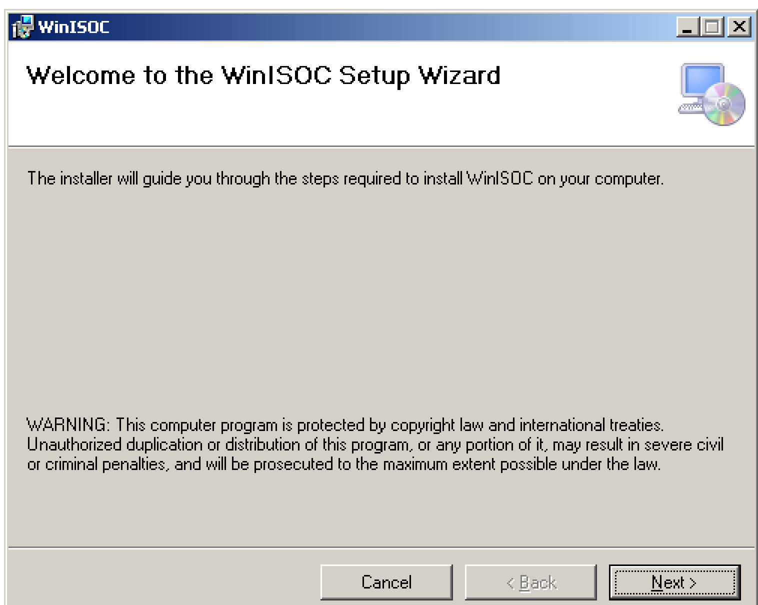
The ISOC core system installation package comes in two versions: one with an English, and the other with a French user interface. The installation is started by running the appropriate version of `setup.exe`. (NB: Depending on how the packages were distributed, the installation files may be renamed, using names that incorporate the language and version number, e.g., `isoc2.4.12(f).exe`.)

After you have started the installation program, and before installation can commence, the installer asks for a password:

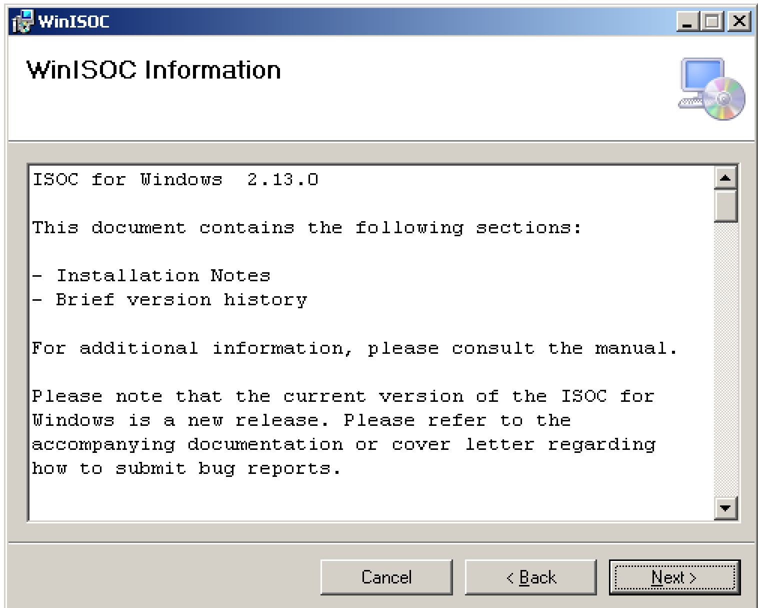
When the installer is being run, compressed files are first extracted to a temporary folder. During this time, a progress dialog is displayed:



When initialization has been completed, the installer displays the Welcome screen. Click the **Next** button to proceed with the installation:

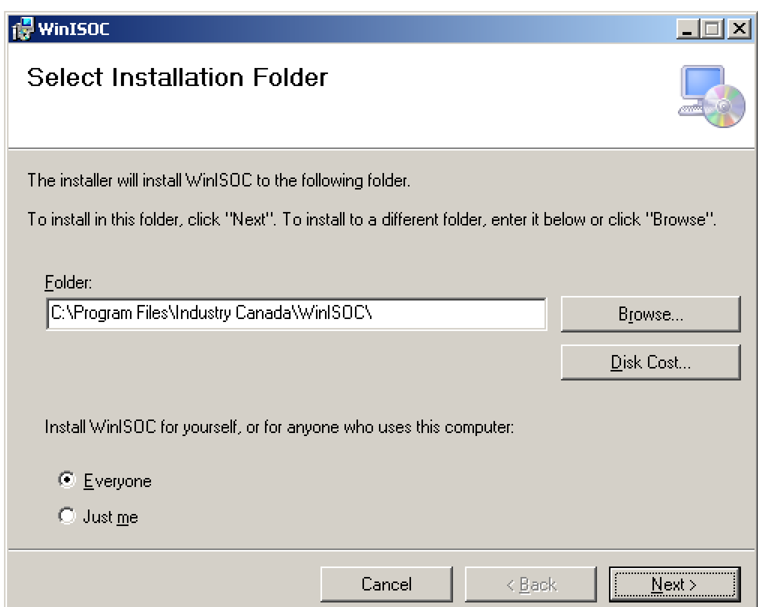


The next screen displays important Readme Information. This "readme" file contains late-breaking news and installation notes about the ISOC version that you are about to install. Information contained here may be particularly relevant if you are upgrading from an older version, as important differences present in the new version may be discussed here:

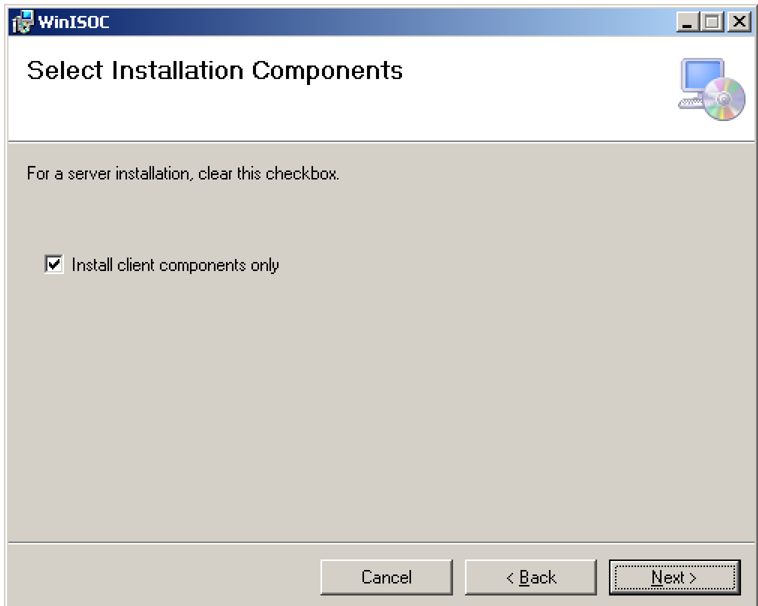


Clicking the Next button takes you to the next screen, where the Destination Folder for the ISOC installation can be specified. The default is `%ProgramFiles%\Industry Canada\WinISOC`, where `%ProgramFiles%` stands for the location of your program files, typically `C:\Program Files`.

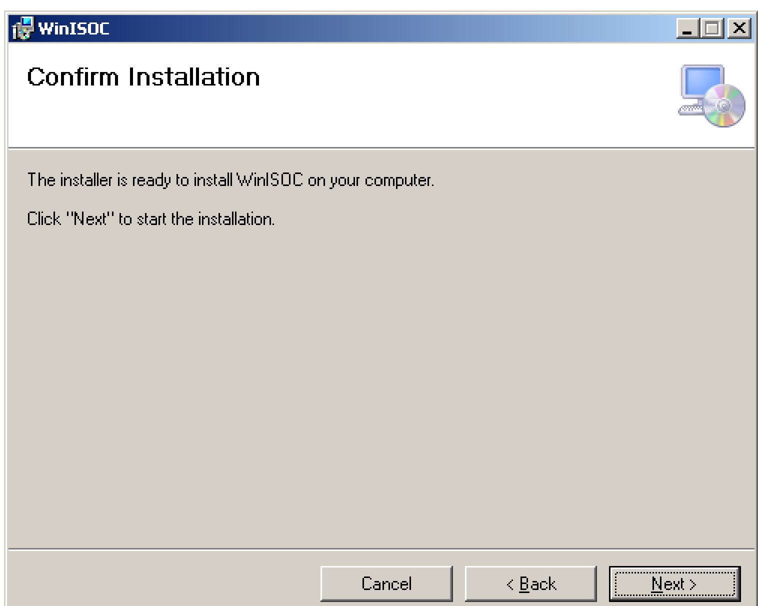
To change the destination folder for this installation, click the **Browse…** button:



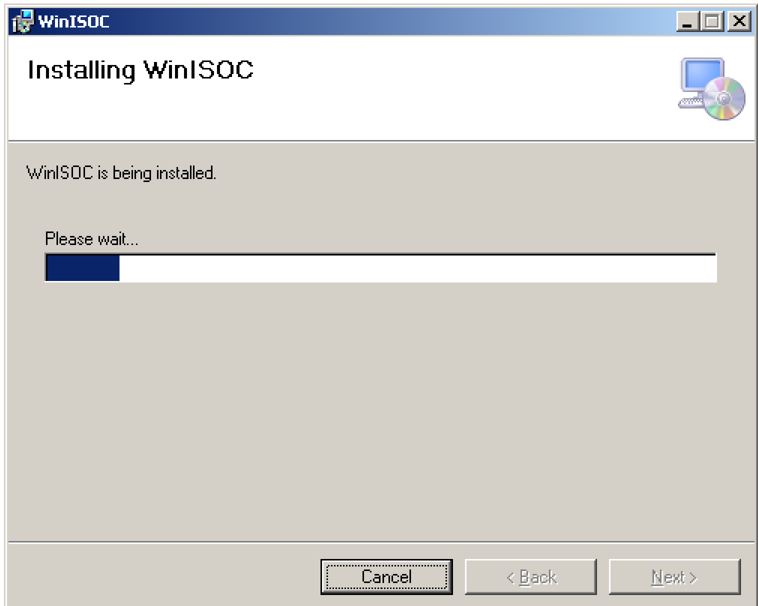
When you click the Next button, the Select Installation Components dialog appears where you can choose between a client or server installation. The **Install client components only** setting contains recommended installation options for computers that are only intended to be used as ISOC clients; clearing this checkbox results in an installation suitable for servers (the installer always installs ISOC client software on servers, for testing and troubleshooting):



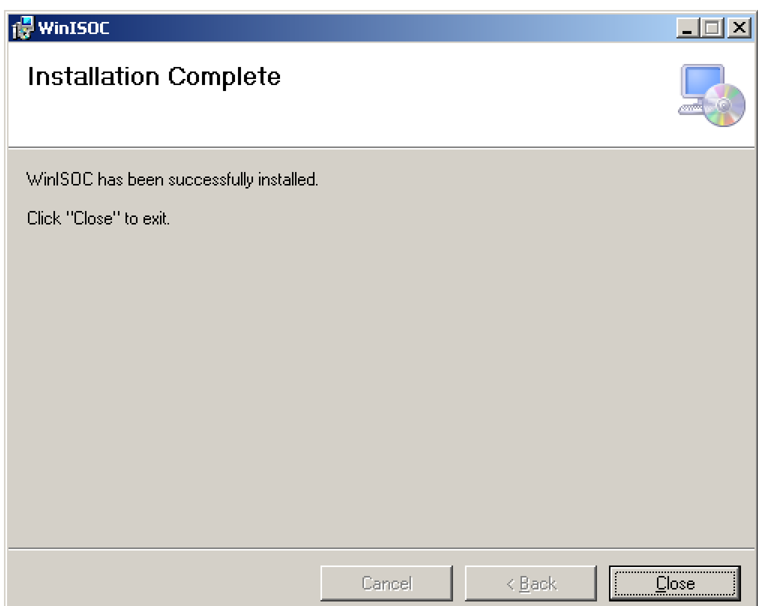
When you click **Next**, the Confirm Installation dialog appears:



At any time up to this point, you can also use the **<Back** button to return to one of the previous installation dialogs and change a setting, as the actual installation procedure has not begun yet. To begin installation, click the **Next** button. The installer responds by starting the process that copies files, registers content, and establishes application settings. While this is taking place, a progress dialog is shown:



If the installation is successful, the installer reports success in the form of the final dialog in the installation sequence:

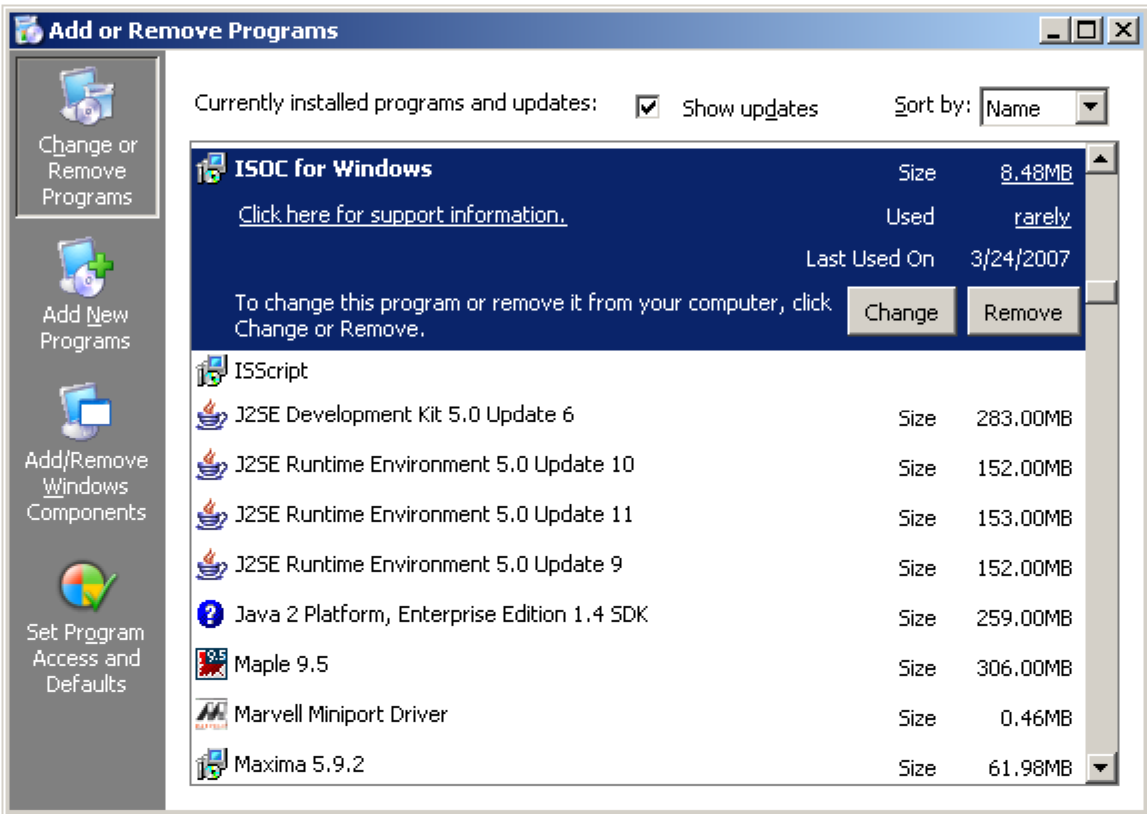


Clicking the **Close** button dismisses the installer. The ISOC is ready to use.

Note that installing the ISOC almost never requires a reboot of the system. However, if by chance a reboot is required, the installer will notify you of this fact and offer you the option to reboot the system upon completing the installation.

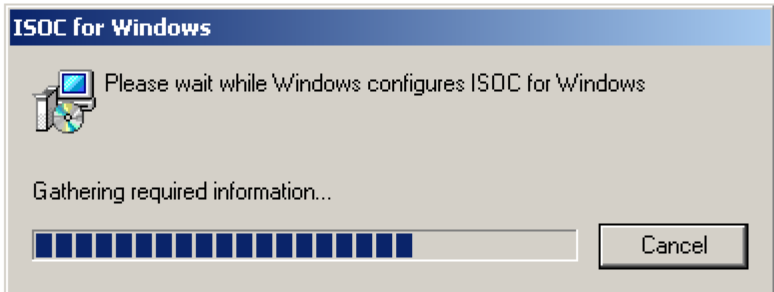
4.1.2. Uninstalling ISOC

The ISOC system, like other well-behaved Windows application packages, can be uninstalled. To initiate uninstallation, you need to start the Add or Remove Programs applet from the Windows control panel:



The uninstaller will display a prompt to verify whether you are indeed intending to uninstall the application:

If you click Yes, a progress dialog is displayed while ISOC installation files are removed and the system is reconfigured:



Tip: Sometimes, the ISOC "leaves behind" the ISOC Service and ISOC Scanner services, no longer functional but still listed in the Services applet of Windows. Though this is harmless, it can be annoying. To make sure that these two service applications are properly uninstalled, you can unregister them by hand. Before initiating an ISOC uninstallation, open a command prompt, navigate to the ISOC installation folder, and issue the following commands:

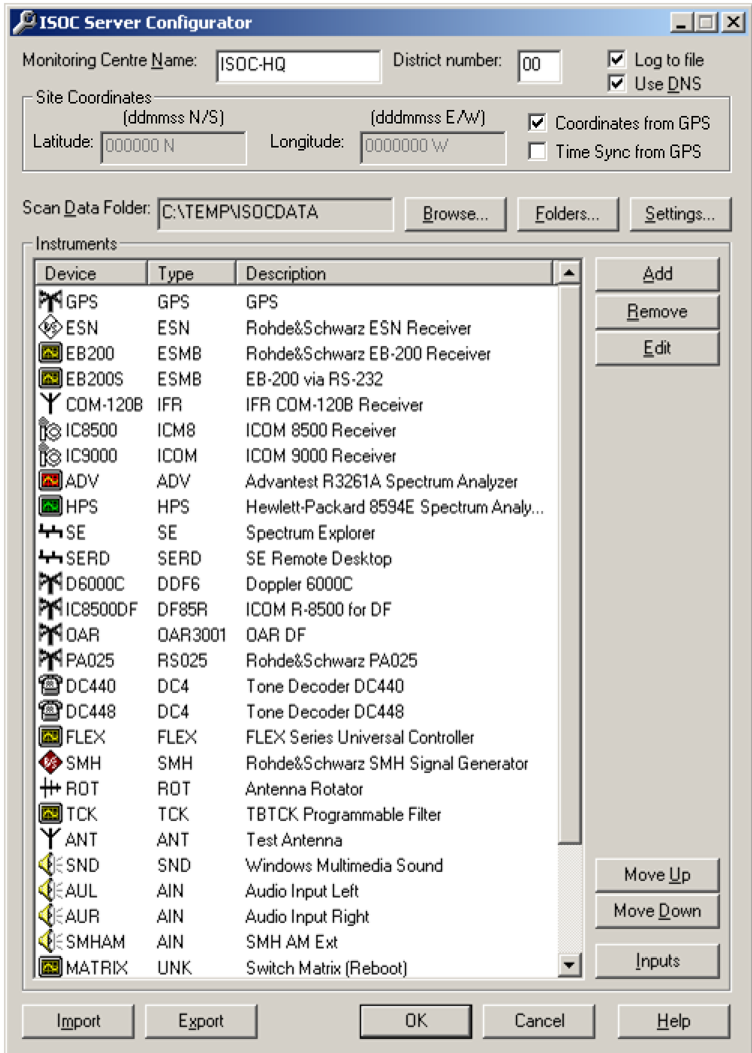
```
net stop "ISOC Scanner"
net stop "ISOC Service"
isocscan -remove
isocsvc -remove
```

4.2. Configuration reference

Before an ISOC server system can be used, it has to be configured: the ISOC software must be told about the instruments that are available at that server, and other configuration settings. Almost all configuration of the ISOC system is accomplished through a graphical utility program called the ISOC Server Configuration Utility (`ISOCCONF.EXE`), or ISCU for short. This utility can be run from the Start menu; it is installed whenever a Server installation is requested.

4.2.1. The ISOC Server Configuration Utility (ISCU)

The ISOC Server Configuration Utility appears initially in the form of a dialog-based interface. The top portion of the dialog contains some global settings, whereas most of the lower part is reserved for the instrument list available at the server. The ISCU window is resizable; feel free to set it to a size that best suits your needs:



Any changes made to the ISOC configuration can be saved by clicking the **OK** button. If you click **Cancel**, your changes will be discarded as the ISCU terminates.

The **Export** button can be used to export your currently active settings (here, "active" means settings presently in the Registry, not including changes already made in the ISCU but not yet saved) into a file. The file will have the standard .REG format of Windows Registry export files.

Saved settings can be reloaded by clicking the **Import** button.

Very important: when loading saved settings using the Import button, the following apply:

1. The effect of an import operation is ***instantaneous and non-reversible***; i.e., the settings are directly imported into the Registry where operational settings are stored.
2. The newly loaded settings will overwrite existing settings in the Registry, but will ***not cause anything to be deleted***. For instance, if an instrument definition is present in the Registry but not in the file to be imported, it will remain in the Registry after the import.
3. Any ***unsaved changes*** in the ISCU ***will be lost***. After the import is completed, the ISCU will reload data from the Registry.

Global settings that can be configured through the ISCU include:

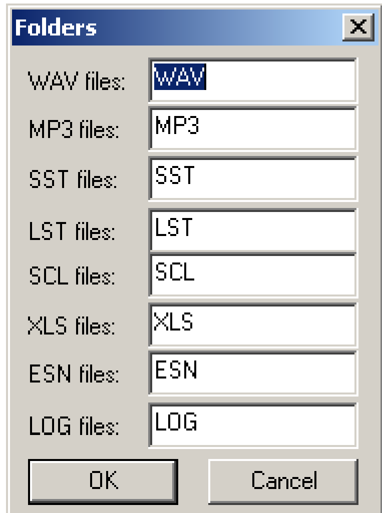
- The **Monitoring Centre Name**, which is used as the identifier of the server in the title bar of virtual instruments, for instance;
- The **District number**, a two-digit number that is recorded in binary scan (`.ESN`) files;
- The **Log to file** checkbox, which instructs ISOC server programs to log all error, warning, and informational messages in a file;
- The **Use DNS** option that instructs ISOC server components to try to resolve numeric addresses using the Domain Name System protocol (if the server is installed on a network with no DNS servers, it is advisable to turn this option off, in order to avoid excessive delays as the server tries to unsuccessfully resolve names).

The ISCU also provides an area where the site's geographic coordinates (**Latitude** and **Longitude**) can be entered. This information is used mainly for direction finding, though other log files may also include geographic information.

If a server is in a mobile installation and it is equipped with GPS, make sure the **Mobile Site** checkbox is set. In this case, the site coordinate fields will be disabled; geographic information will be obtained dynamically using the GPS receiver. This checkbox also ensures that the DF instrument will default to Relative (to the front of the vehicle) as opposed to True North compass display.

ISOC servers, primarily the ISOC Scanner service, use and create many files. The main directory for all files is specified through the **Data Directory for scanner service** field. To change this directory, click the **Browse…** button; this displays the Windows standard Open dialog where a new directory can be selected.

Optionally, you may decide to store some types of files in specific subfolders. If you click the **Folders…** button, the Folders dialog is presented, where you can specify separate subfolders for `.WAV`, `.MP3`, `.SST`, `.LST`, `.SCL`, `.XLS`, `.ESN`, and `.LOG` files:



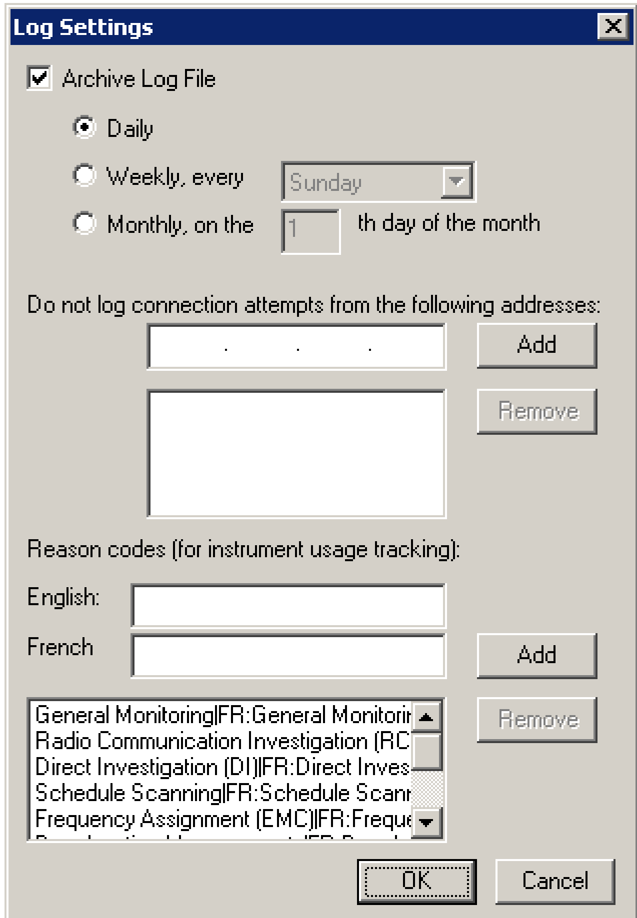
It is not mandatory to specify all of these subfolders; if a subfolder name is omitted, the ISOC will use the main data directory for the corresponding file type. You can also specify the same subfolder for multiple file types (e.g., AUDIO for `.WAV` and `.MP3` files). If a subfolder does not exist, it will be created the first time the ISOC attempts to place a file in that subfolder.

Additional log file settings can be specified by clicking the **Settings…** button, which invokes the Log Settings dialog, shown below.

When the Archive Log File checkbox is selected, the log files maintained by the two ISOC server processes (`ISOCSVC.EXE` and `ISOCSCAN.EXE`) are regularly rotated at the specified intervals. Old log files are renamed by appending the date to the file name.

It is also possible to prevent connection attempts from specific IP addresses from being logged. This is most useful when external tools are used to check for the availability of the ISOC server; frequent and regular attempts by these tools can clog up ISOC logs, and this can be avoided by adding the IP addresses of the host(s) where these tools run to the list in the Log Settings dialog. This list can hold a maximum of 100 IP addresses.

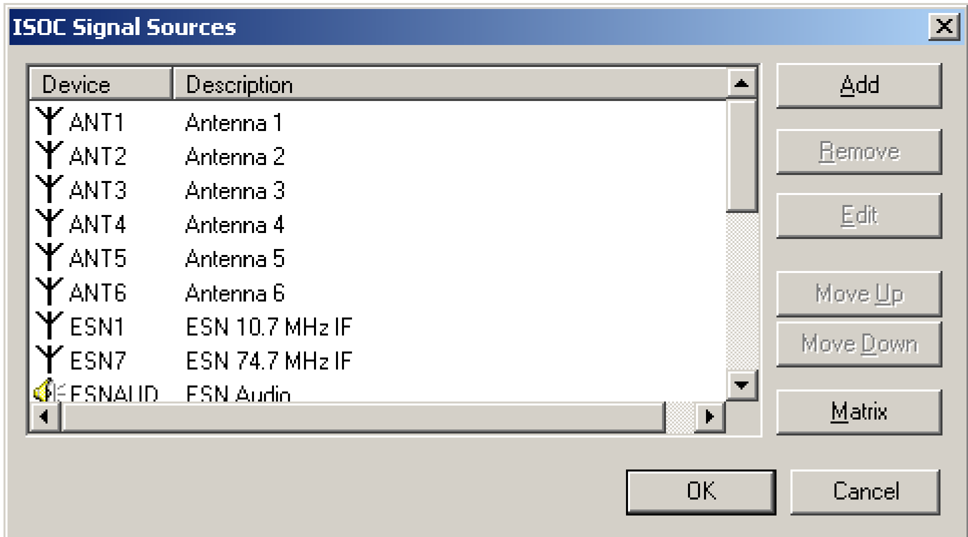
The Log Settings dialog is also used to manage the reason codes that are used for usage tracking. English and French texts for new reason codes can be added by filling in the **English** and **French** fields and then clicking **Add**; unwanted reason codes can be removed by selecting the code and clicking **Remove**:



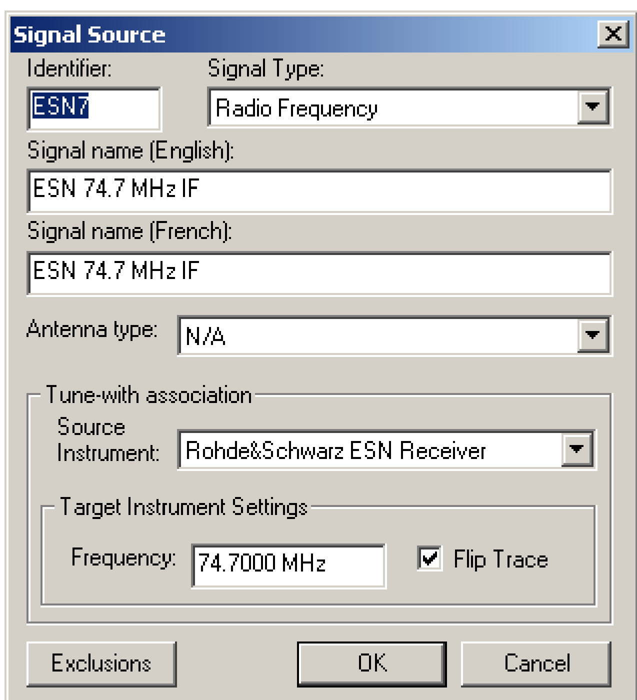
The entire lower portion of the ISCU dialog is used for specifying instruments. Indeed, the most prominent function of the ISCU is to maintain the instrument list available at the server. The **Instruments** area contains a list of all presently defined instruments, which you can manipulate using the **Add**, **Remove**, and **Edit** buttons; you can also change the order in which the instruments appear by clicking the **Move Up** or **Move Down** buttons. The order in which the instruments are presented here is also the order in which they will appear in the ISOC for Windows application.

Before editing instruments, however, it is advisable to set up inputs (i.e., signal sources). This is especially true if the server site is equipped with an RF switch matrix. Later, as you specify instruments, you will be able to specify switch matrix commands that connect specific signal sources to the instrument.

By clicking the **Inputs** button, you can invoke the Inputs dialog:



This dialog lists all signal sources in the order in which they will appear in client programs, such as the ISOC for Windows application. There are two types of signal sources: an AF source is marked by a little speaker symbol ( ), while an RF source is marked by the symbol of an antenna ( ). Signal sources can be added by clicking **Add**; edited by clicking **Edit**; or deleted by clicking **Remove**. The order in which they appear can also be manipulated, by selecting a signal source and clicking **Move Up** or **Move Down**. When you add or edit a signal source, the Signal Source dialog appears where details for that signal source can be specified:



Each signal source must be identified by a unique label in the **Identifier** field.

A signal source can be AF or RF; select the appropriate type in the **Signal Type** field.

The signal source's name (**Signal name**) must be specified in both **English** and **French**. This is regardless of the language that you are presently using; remember, you are specifying a signal source that may later be used by both English-speaking and French-speaking users.

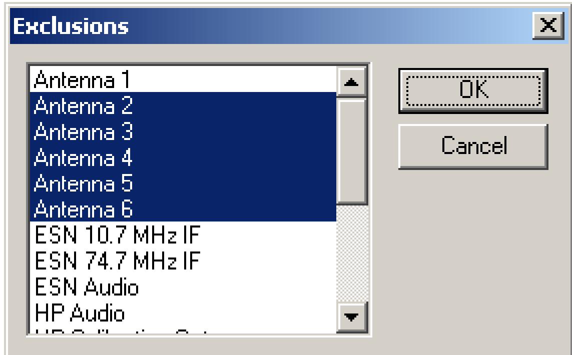
For RF sources, you may specify an **Antenna type** by selecting from a list of antenna types. Although the antenna type is not used by the ISOC suite itself, it is recorded in many log files that may later be processed by other applications that utilize this information.

Some signal sources are identified with specific instrument. For instance, the IF output of a receiver is identified with that receiver. If you are specifying a signal source that is identified with an instrument, you may select that instrument in the **Tune-with association** area, by picking it from the **Source instrument** list. (NB: Needless to say, you can only select a source instrument if it has already been defined; this means that you may have to return to the Signal Sources dialog and edit previously defined signal sources after you have added instruments).

When an associated instrument exists, you can also specify a corresponding **Frequency**. This ensures that when this signal source is selected as the input signal for an instrument during interactive operation, the instrument is automatically tuned to the right frequency. For instance, if you select the IF output of a receiver as the signal source for a spectrum analyser, the spectrum analyser will be tuned automatically to the receiver's IF frequency.

The **Flip Trace** checkbox informs the ISOC system that this signal source provides a signal that is flipped in the frequency domain. When such a signal source is selected into a spectrum analyser, the spectrum analyser automatically reverses the trace to ensure that it is shown correctly.

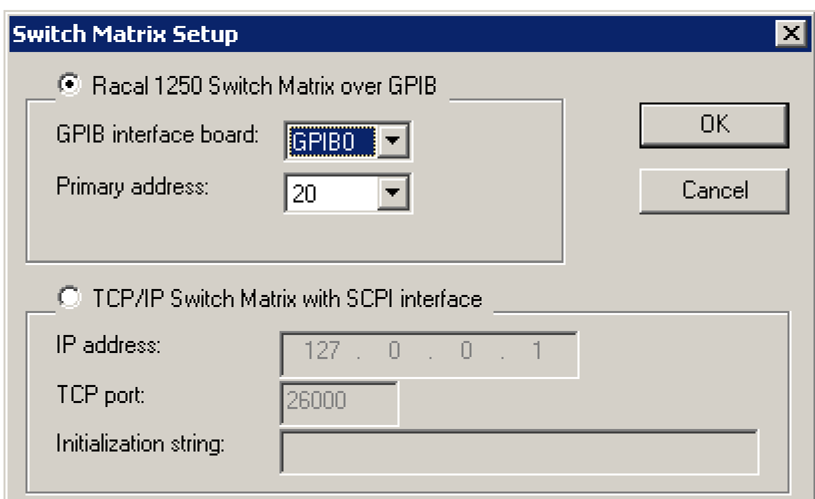
For a signal source you can also specify a list of exclusions by clicking the **Exclusions** button. This opens the Exclusions dialog:



Simply put, the list of exclusions is the list of those signal sources that cannot be used simultaneously with the currently edited signal source. For example, your switch matrix configuration may be such that it does not allow certain signal path combinations. You can record those combinations in the form of exclusion lists here to ensure that the ISOC will not attempt to use a combination of signal sources that is invalid.

Note that the exclusion list is not symmetrical. For instance, if Antenna 1 and Antenna 2 cannot be used together, you must specify ***both*** Antenna 1 on Antenna 2's exclusion list and Antenna 2 on Antenna 1's exclusion list.

The Signal Sources dialog also provides a **Matrix** button. This is where the interface settings for the switch matrix can be specified:



For a Racal type switch matrix accessed through GPIB, the GPIB interface parameters must be specified. If the switch matrix is an IP switch matrix, you need to specify the IP address and TCP port number of the matrix instrument. Optionally, you may also specify an initialization string. As an example, the following initialization string

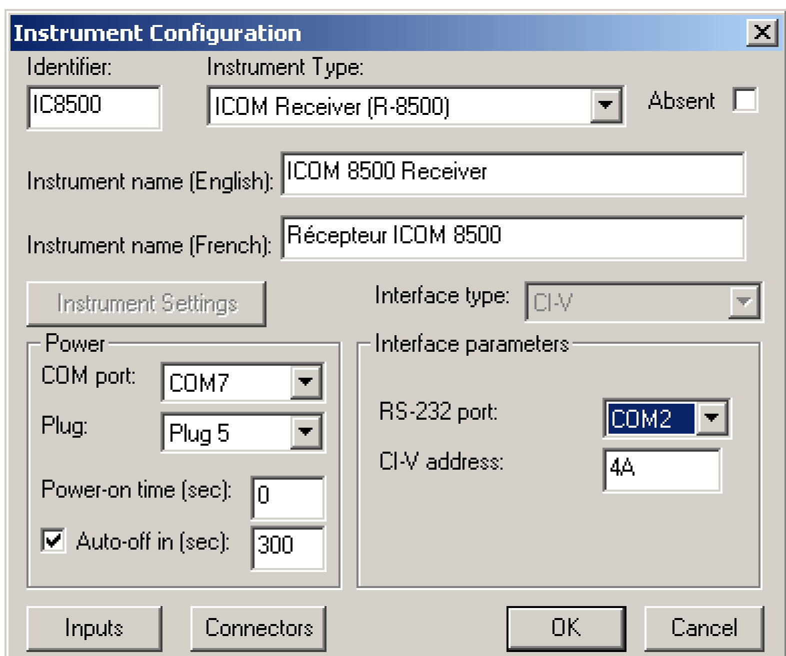
```
CONF:SW 1 (@3:24-27);CONF:SW 2 (@1:4-7) (@SW1-1)
```

specifies two logical switches, one of which is dependent on the other. For further information, please refer to the *ALA1200 RF Switch Controller Operation Manual*, from Vektrex Electronic Systems, Inc.

These settings apply regardless whether or not you later add a switch matrix instrument to the instrument list.

After you completed specifying the system's signal sources, you may return to the main ISCU dialog and start adding instruments by clicking the **Add** button, or editing instruments by selecting the desired instrument and clicking the **Edit** button.

When you add or edit an instrument, the details of the instrument are displayed in the Instrument Configuration window:



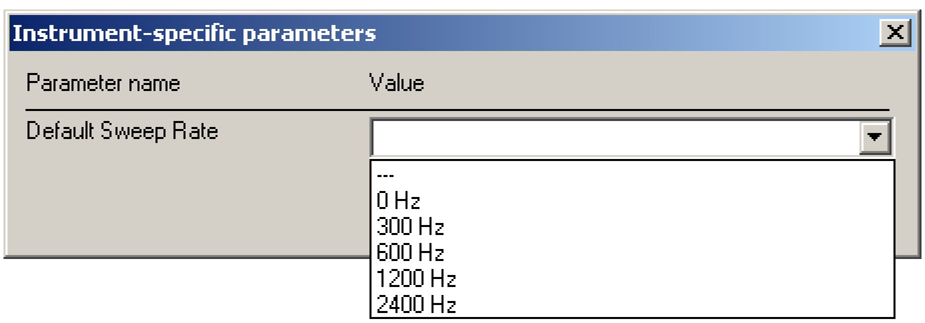
Just as it is for signal sources, the most important field to fill in is the instrument's **Identifier**. The name you put here uniquely identifies this instrument on the server. It may also be visible to users; the title bars of virtual instrument windows contain text that combines the monitoring centre's name and the instrument identifier.

Next comes the **Instrument Type**. The dropdown list here contains all instruments presently recognized by the ISOC server. Some instrument types appear only after the DF component has been installed; the ISOC also allows add-on (third party) drivers to provide support for additional instruments, though no such drivers are known to exist at present.

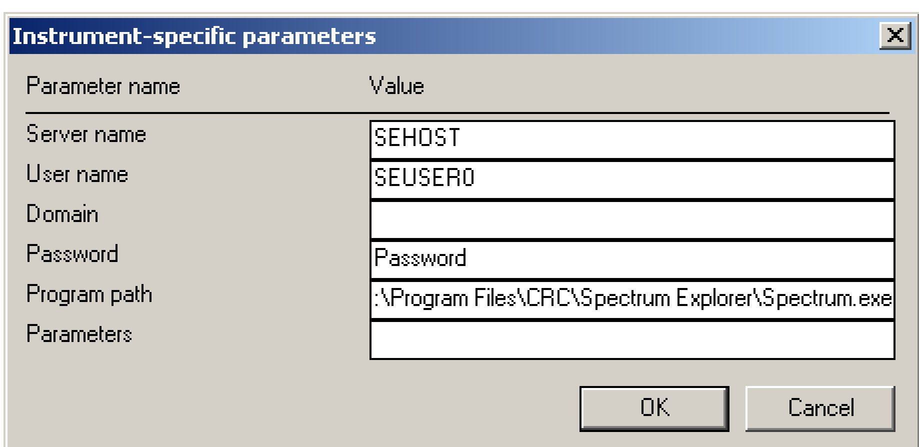
An instrument that is marked **Absent** will not be seen by users. This feature is useful to temporarily remove an instrument from the list of instrument, e.g., if it is being serviced.

The **Instrument Name** must be specified in both **English** and **French**, as it may be accessed by users using either English or French ISOC client software configurations.

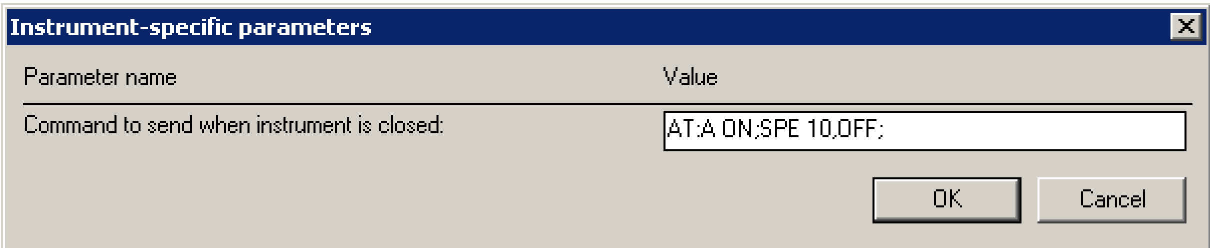
The **Instrument Settings** button provides for additional settings specific to an instrument type. At present, two instrument drivers use this feature: the Doppler 6000C/7001 and the SE Remote Desktop. For the Doppler 6000C/7001 instrument, the default sweep rate may be specified:



For the SE Remote Desktop, it is necessary to specify the target host, login credentials, and the location of the Spectrum Explorer application:



For several receivers and spectrum analyzers, it is possible to specify a series of commands that are executed when the instrument is no longer in use. This feature can be used, in particular, to ensure that an instrument does not remain powered up with a dangerous sensitivity setting that could cause physical damage:



Before an instrument can be used, its **Interface Type** must also be specified. For most instruments, this field is not editable, as the instrument works only through a specific interface type, which is preselected here. Some instruments, however, are (or can be) equipped with multiple interfaces (e.g., serial vs. GPIB). For these instruments, the **Interface Type** dropdown box is active; however, it accepts only those selections that are valid for the instrument.

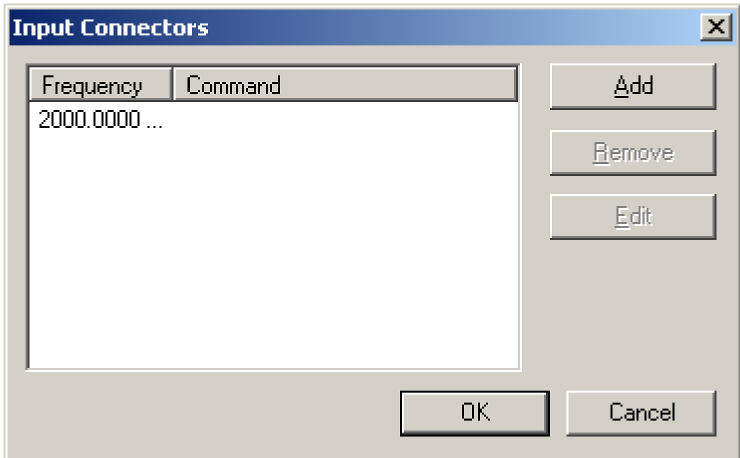
Some instruments may be powered through a remote control power bar. For these instruments, you may specify **Power** settings. The power bar parameters include the **COM port** to which the power bar is connected, and the **Plug** that the instrument uses. The ISOC supports multiple power bars in the same installation.

If a **Power-on time (sec)** value other than 0 is specified, the ISOC takes this value into account when granting access to an instrument that has just been powered up. If the time elapsed since applying power to the instrument is less than this value, access to the instrument will not be granted, as it will be assumed that the instrument is still initialising and is not yet usable.

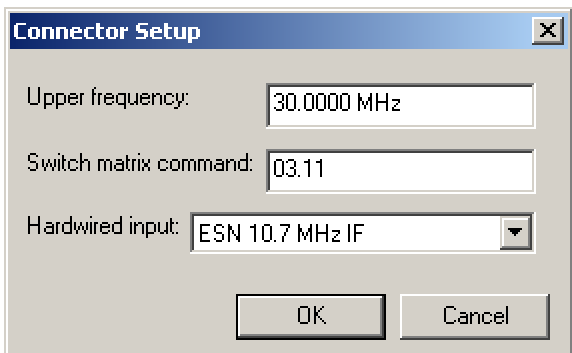
If the **Auto-off** checkbox is set, when the instrument is no longer in use, it will be automatically powered down after the amount of time specified in the **in (sec)** field elapsed. It is generally not a good idea to specify a value here that is less than 90 seconds; otherwise, the instrument may be powered down unnecessarily, for instance between two scheduled task sessions.

In addition to instrument, interface, and power parameters, the Instrument Configuration dialog also allows you to specify switch matrix commands for the instrument. This is accomplished through the **Inputs** and **Connectors** buttons.

The Inputs button is available for all instruments; the Connectors button is available only for instruments that have multiple input connectors. For instance, the ICOM R8500 receiver has two connectors, one for the 100 kHz – 30 MHz band, the other for the 30 MHz – 2 GHz band. For the ISOC to apply the correct switch matrix commands, it needs to know if a receiver has multiple inputs, and the frequency bands associated with these inputs. To accomplish this, click the **Connectors** button. This invokes the Input Connectors dialog:



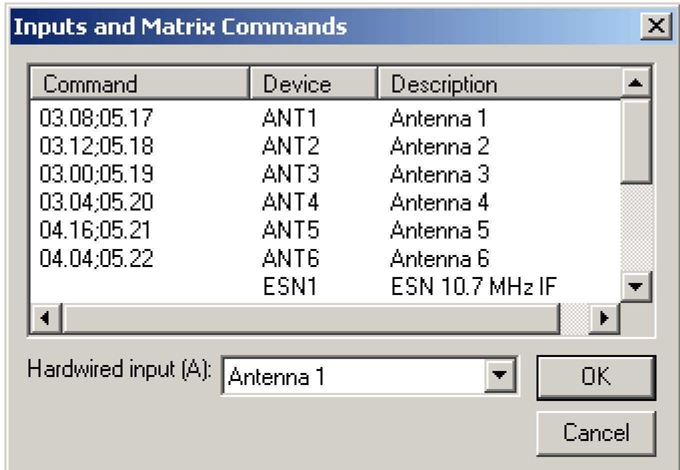
This dialog contains the list of defined input connectors, along with the **Add**, **Remove**, and **Edit** buttons that can be used to manipulate this list. When you add or edit a connector, the Connector Setup dialog appears:



A connector is characterized by the top frequency of the associated frequency band. (The bottom frequency need not be specified, as it is either 0 or the top frequency of the previous band of the receiver). In addition to the top frequency, you may also enter a **Switch matrix command** that is used to ensure that the signal is routed to the proper connector.

The Hardwired input field can be used in setups with no switch matrix present. Even though the user will not be able to select a signal source, the name of the signal source will still appear for informational purposes in the virtual instrument user interface if it is correctly specified here.

Clicking the **Inputs** button in the Instrument Configuration dialog brings up the Inputs and Matrix commands dialog. This dialog lists all available signal sources (RF signals only if the instrument is an RF instrument, AF signals otherwise):



If a signal source can be connected to the instrument by a specific set of switch matrix commands, click the Command area in the corresponding row in this list. This part of the list is editable in place, and you can enter the desired switch matrix command.

For Racal type switch matrices, the ISOC system sends `OPEN` and `CLOSE` commands to the switch matrix, appending the command string specified here. The semicolon (;) character can be used to separate argument lists if multiple `OPEN` and `CLOSE` commands are required. For instance, the string `03.08;05.17` will result in the following switch matrix commands sent when the input signal is requested:

```
CLOSE 03.08;
CLOSE 05.17;
```

When the input signal is no longer needed, the ISOC sends the following commands:

```
OPEN 03.08;
OPEN 05.17;
```

The actual syntax of the arguments to the `OPEN` and `CLOSE` commands depends on the switch matrix options installed and their configuration, which is beyond the scope of the present manual.

For IP switch matrices, the command structure is different. A string such as 1.2;2.3 is translated into the following commands for closing and opening the respective switches:

```
SETSW SW1-2
SETSW SW2-3
```

and

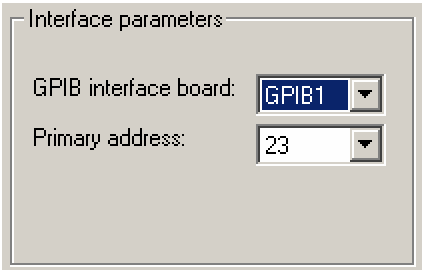
```
SETSW SW1-0
SETSW SW2-0
```

In order for these commands to work, logical switches must be specified through the switch matrix initialization string that can be set up when the switch matrix IP address and port number are being configured. For further details on the IP-based RF switch matrix operation, please refer to the *ALA1200 RF Switch Controller Operation Manual*, from Vektrex Electronic Systems, Inc.

4.2.2. Interface types

The ISOC system can utilize instruments through a variety of interfaces. Some interfaces require physical hardware; other drivers are logical drivers implementing specific protocols over an existing (e.g., network) interface.

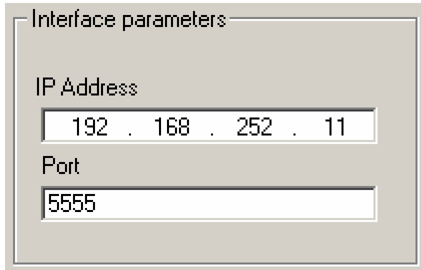
The first driver historically that was implemented in the ISOC is the GPIB driver. When configuring an instrument that uses the GPIB interface, two parameters must be specified: the **GPIB interface board** identifier, and the instrument's **Primary address**:



The interface board identifier depends on the number of GPIB interface boards installed. A single board is usually `GPIB0`; when multiple boards are used, especially if they are of an identical type, care must be taken to ensure that they are correctly addressed.

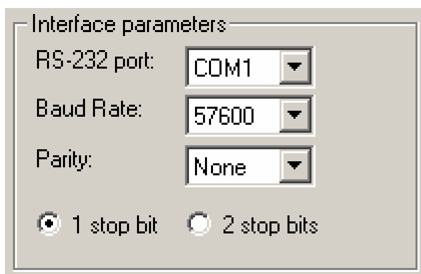
The primary address of an instrument is usually configured to a documented default in the factory, but it can be changed through the instrument's front panel. No two instruments attached to the same GPIB board can have the same primary address, nor can an instrument have the address 0, which is reserved for the host computer. Note that the ISOC does not support configurations that utilize the GPIB secondary address.

Some instruments are connected through the network; specifically, through a TCP connection. For these instruments, the instrument's IP address and TCP port number must be provided:



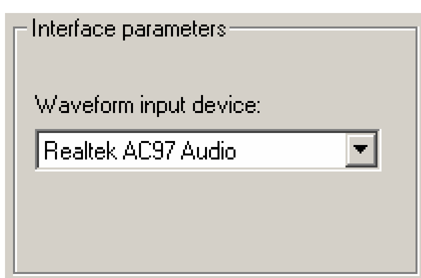
The instrument's IP address and port number are usually configurable through the instrument's front panel. In some cases, the instrument may obtain its IP address from a DHCP server on the network. In these cases, it is up to the network administrator to ensure that the instrument always receives the same address, and inform users if the address has to change for some reason.

For instruments that operate over the serial port, the **RS-232 port number**, the **Baud Rate**, and **Parity** must be specified, as well as the number of **stop bits**:



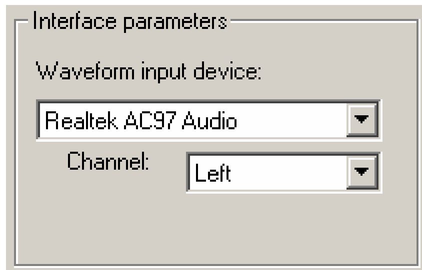
The ISOC uses hardware handshaking when communicating with instruments over the serial port.

The ISOC supports the simultaneous capture of audio using multiple sound cards. For this reason, when setting up the driver for audio capture, it is necessary to specify the sound card (**Waveform input device**):

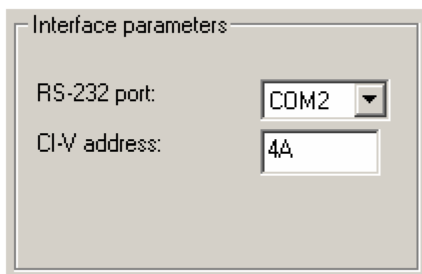


For multiple sound cards, multiple instances of the driver need to be configured, each associated with a specific sound card.

Audio input signals are configured similarly. These virtual instruments each represent a monaural input channel of a specific sound card. Therefore, during configuration, the sound card (**Waveform input device**) and the **Channel** must be specified:

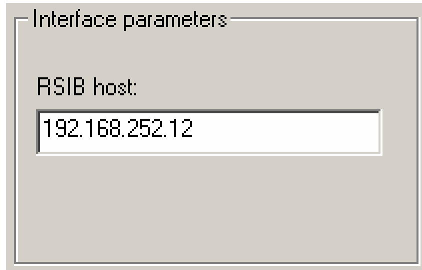


Some devices (most notably ICOM receivers) utilize a special communication protocol over the serial line called CI-V. Multiple CI-V instruments can share the same serial line, so long as they each have a unique CI-V address. When setting up a CI-V instrument, the **RS-232 port** and **CI-V address** must be specified:



Any RS-232 port that is specified for a CI-V instrument is managed by the ISOC (i.e., while the ISOC Service is running, no other application can use that port). The ISOC server can reliably communicate with several instruments over the same serial port using the CI-V protocol. The CI-V address of each instrument, a 2-digit hexadecimal number, is set to a factory default, but may be configurable from the instrument's front panel.

Some new Rohde & Schwarz instruments, notably the FSP series spectrum analysers, use a proprietary protocol over a network connection. This protocol, called RSIB, implements a software interface very similar to the software interface of GPIB. For RSIB devices, the only configuration parameter that the ISOC requires is the instrument's IP address (the **RSIB host** address):



4.2.3. Instrument types

The list of instrument types recognized by the ISOC is installed along with the ISOC system in the Registry. Below, all supported instrument types are listed along with some relevant details about instrument compatibility.

4.2.3.1. Spectrum analysers

4.2.3.1.1. Hewlett-Packard 8594E Spectrum Analyzer

This driver was tested only with the HP8594E. May support other, compatible spectrum analysers manufactured either by HP or third parties.

4.2.3.1.2. Advantest R3261A Spectrum Analyzer

This driver was tested only with the R3261A. Not known to support other devices.

4.2.3.1.3. Rohde & Schwarz FSP 3/7 Spectrum Analyzer

Tested with the FSP 3 and FSP 7; probably works with other spectrum analysers in the FSP series.

4.2.3.2. Receivers

4.2.3.2.1. ICOM Receiver (R-8500)

This driver contains ICOM receiver settings specific to the IC-R8500. Not compatible with other ICOM receivers.

4.2.3.2.2. ICOM Receiver (generic)

This driver offers ICOM receiver support for the IC-R9000 that may also work with other ICOM types, such as the R-7100.

4.2.3.2.3. Rohde & Schwarz ESMB/EB-200 Test Receiver

This driver supports both the ESMB and EB-200 receivers. Most testing was done using the EB-200. Serial port and Ethernet operation both supported.

4.2.3.2.4. Rohde & Schwarz ESN Test Receiver

This driver offers full support for the ESN receiver, including support for high speed scans. ***For high speed scan to work, the ESN receiver must be the only instrument on the GPIB bus***. This is because high speed scanning is accomplished by allowing the receiver to take complete control of the GPIB bus.

The ESN driver is also compatible with the Rohde & Schwarz ESNV receiver.

4.2.3.3. Multipurpose instruments

4.2.3.3.1. IFR COM-120B Receiver

The IFR instrument can serve as a receiver, spectrum analyser, oscilloscope, and signal generator. The IFR driver provides virtual instrument access to most of this functionality.

4.2.3.3.2. CRC Spectrum Explorer

The SE driver presently implements support only for scheduled tasks and DF operations. Support for interactive operation is available through Remote Desktop.

4.2.3.4. Signal generators

4.2.3.4.1. Rohde & Schwarz SMH Signal Generator

Driver supports basic RF and modulation functionality.

4.2.3.5. Audio

4.2.3.5.1. Audio Input

This is a "dummy" driver to implement a virtual instrument representing a monaural audio input line on the server computer.

4.2.3.5.2. Windows Sound

The Windows sound driver is used to capture audio from the server computer's sound card(s). Multiple sound cards in the same server are supported.

4.2.3.6. Tone decoders

4.2.3.6.1. FLEX Series Universal Controller

Driver is known to work only with Connect Systems, Inc's FLEX instrument.

4.2.3.6.2. Tone decoder (DC-4xx)

Driver supports both the DC-440 and the DC-448. Mode of operation depends on the interface selected; serial interface implies DC-440, CI-V implies DC-448. May also work with some other Optotrakker models.

The serial interface settings for the DC-440 model are 4800 bps, 1 stop bit. The default CI-V address for Optotrakker models is `A0`.

4.2.3.7. Other RF instrumentation

4.2.3.7.1. Antenna rotator

Driver is really a driver for B&B Electronics' 232SDA10 data acquisition module that provides two-way communication with the rotator: binary (two-level) signals control the rotator's motors, while an A/D converter reads the rotator position.

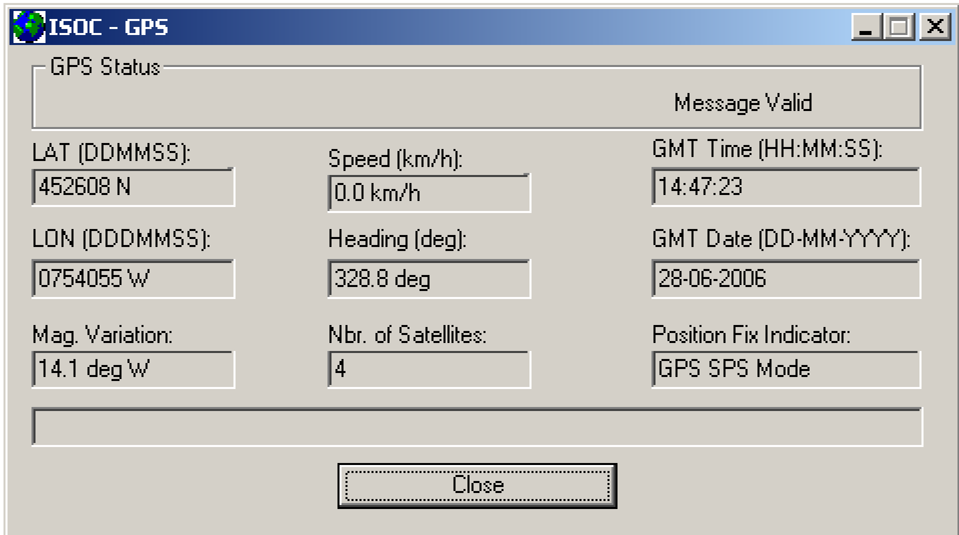
4.2.3.7.2. Telonic/Berkeley TCK Programmable Filter

The TB/TCK driver is designed especially to allow the TCK filter to work as a "slave" to a receiver. In the typical scenario, the filter is used in conjunction with receivers that have insufficient selectivity, e.g., certain ICOM models.

4.2.3.8. Miscellaneous instrumentation

4.2.3.8.1. GPS

The GPS driver supports GPS devices that use the NMEA 0183 protocol with Garmin extensions. A helper applicationm `ISOCGPS.EXE`, provides a real-time readback of the GPS information that the ISOC server receives from the GPS device:



4.2.3.8.2. Dummy Instrument (AC only)

This dummy instrument driver is meant for use with instruments that are not controlled by the ISOC, but are connected via a remote control power bar that is, in turn, under ISOC's control.

4.2.3.9. Direction finding instruments

The following four types of DF processors are supported by the ISOC:

- Doppler 6000C/7001
- OAR3001
- OAR4xxx
- Rohde & Schwarz PA025

An additional set of three instrument types contains ICOM instruments. Certain DF processors work in conjunction with an external receiver. These "for DF" drivers are modified versions of the ICOM instrument driver intended to support the ICOM receiver as part of a DF configuration:

- ICOM R-7100 for DF
- ICOM R-8500 for DF
- ICOM R-9000 for DF

These "for DF" virtual instruments never appear as stand-alone instruments when the user views the list of instruments through the ISOC for Windows application. (It is, however, technically possible to define the same ICOM receiver twice, once using the "regular" driver, and once using the "for DF" driver, the first permitting stand-alone interactive use of the radio, the second for use of the radio with the DF processor.)

4.3. Instrument calibration

Before they can be used to perform reliable measurements, some instruments need to be calibrated. While this is technically true for nearly all test instruments, most of them have built-in calibration capability, and/or they are calibrated using special calibration hardware. Such calibration is not the topic of this section.

A few instruments need to be calibrated in a different sense: the ISOC system must have information on how to translate measurements received from the instrument into meaningful engineering units.

In particular, two instruments in the ISOC suite provide readings that are not very usable in raw form: the antenna rotator, and ICOM receivers. For these instruments, the ISOC suite contains dedicated programs that perform their calibration.

4.3.1. Calibrating ICOM receivers

ICOM receivers provide level measurements in instrument-specific units that correspond with the position of the analog signal level meter on the instrument's front panel. These "S-meter" units are not calibrated, and vary from one instrument to the next. They are also dependent on the received frequency and demodulator settings.

The ISOC has the ability to use calibration tables that control the translation of S-meter units into standard signal level units (e.g., dBm). These calibration tables are built by a special utility program, `ICOMCAL.EXE`, that performs ICOM receiver calibration.

> **Tip:** Always make sure that a newly installed ICOM receiver is calibrated before use; if a receiver is replaced, the calibration procedure must be repeated. Failure to do so may result in highly inaccurate signal level measurements!

Calibrating the ICOM receiver requires the presence of a Rohde&Schwarz SMH signal generator. The SMH must be properly configured for operation with the ISOC server before the ICOM calibration process can be started.

Full calibration of an ICOM receiver can take hours.

This ICOM receiver calibration utility is a command-line tool. Once invoked with the appropriate parameters, it performs a series of calibration steps to characterize the frequency and amplitude response of the receiver. The calibration procedure is mostly automatic; however, operator intervention may be necessary to ensure that the proper input signals are connected to the receiver.

During the calibration procedure, the `ICOMCAL.EXE` program performs the following steps:

- It characterizes the receiver by finding frequency ranges within which the signal level response of the receiver is approximately constant
- It performs frequency calibration, by sending signals at various frequencies to the receiver, and then establishing the measured frequency at which the signal peak is located
- It performs signal level calibration by sending to the receiver signals at various levels and reading the measured S-meter level.

The frequency ranges that are the result of receiver characterization, and tables that characterize the receiver's signal level response, are then stored on the server. Subsequently, whenever an ISOC client accesses that server, it will receive an updated copy of these calibration tables, allowing the client program to display accurate signal levels.

Note that during normal operations, the ISOC software only uses level correction values; frequency correction values are used only during the calibration process itself.

4.3.1.1. Command-line options

The command-line calibration tool offers a brief help message if started with the `/?` command-line option:

```
C:>icomcal /?

ICOM Calibration (command-line interface)
=========================================

Usage: ICOMCAL [-r] [-m minlevel] [-f] [-l logfile] [-am] [-nofm]
 ICOM SMH level min max bands [bandmax...] tunestep [tunestep...]
```

The meaning of these options is as follows:

`-r` tells `ICOMCAL.EXE` to "recalibrate" a previously calibrated instrument; frequency calibration and initial receiver characterization are not performed.
`-f` tells `ICOMCAL.EXE` to perform frequency calibration. Before attempting to characterize the receiver's response to different signal levels, the program

first attempts to find, at various generator frequencies, the receiver frequency at which maximum signal level is observed. This ensures that the receiver is always tuned to the correct frequency when calibrating signal levels.

`-l logfile` lets you specify a log file into which all output messages of the calibration utility are saved for later review. Replace `logfile` with the desired file name.

-m minlevel is the minimum signal level (in S-meter units) that is considered to be above the receiver's noise level. The default value is 12; replace minlevel with a value of your choosing. This level is used during the initial receiver characterization process.

`-am` tells the program to perform calibration using AM demodulation settings. The default is to calibrate using FM only.

`-nofm` tells the program to not perform calibration using FM demodulation settings.

`ICOM` is the identifier of the ICOM receiver that is to be calibrated, as specified through the ISOC Server Configuration Utility.

`SMH` is the identifier of the SMH signal generator that is to be used for calibration, as specified through the ISOC Server Configuration Utility.

`level` is the level sensitivity in dB during initial receiver characterization. As the receiver is tested at various frequencies, the signal strength of the signal generator is adjusted to maintain a constant measured signal level (in S-meter units) at the receiver. A signal level excursion greater than this value causes the calibration program to establish a new frequency range. Too small a value for this parameter can result in an excessive number of frequency ranges, slowing down the calibration process. Permissible values are 1, 2, and 3; however, the present version of the ISOC uses only the 3 dB value.

`min` is the minimum frequency of the receiver.

`max` is the maximum frequency of the receiver.

`bands` is the number of frequency bands of the receiver. Frequency bands are associated with different input connectors. For instance, the ICOM R-8500 receiver has two inputs and, consequently, two frequency bands: the low frequency band from 100 kHz to 30 MHz, and the high frequency band from 30 MHz to 2 GHz.

`bandmax...` are the upper limits of the receiver's frequency bands, with the exception of the last frequency band. In other words, in this position on the command line there should be *bands* – 1 values present, where *bands* is the number of frequency bands.

`tunestep [tunestep...]` are frequency stepping to be used in the different frequency bands. There should be one `tunestep` value for each frequency band.

As an example, consider the following command line:

```
icomcal -l R9000.log R9000 SMH 3 1e5 2e9 3 3e7 1e9 1e6 1e7 1e7
```

This example calibrates an ICOM R-9000 receiver, the identifier of which is R9000 in the ISOC Server Configuration Utility. The identifier of the SMH signal generator is SMH. All results are logged in a file named R9000.log. Calibration is performed only using FM demodulation (the default). The level sensitivity is 3 dB. The receiver's minimum frequency is 1e5 Hz = 100 kHz, its maximum frequency is 2e9 Hz = 2 GHz. The receiver has 3 distinct bands with separate input connectors. The first band's upper frequency is 3e7 Hz = 30 MHz; the second band ends at 1e9 Hz = 1 GHz. The tuning steps in the three bands are 1e6 Hz = 1 MHz, 1e7 Hz = 10 MHz, and again 10 MHz, respectively.

4.3.1.2. Batch files

To make it easier to perform calibration of ICOM R-8500 and R-9000 receivers using standard options, two batch files are provided as part of the ISOC installation: `R8500CAL.BAT` and `R9000CAL.BAT`. Both of these files require only a single parameter on the command line: the identifier of the ICOM receiver to be calibrated. They both assume that an SMH signal generator is present and its identifier is `SMH`. So for instance, the ICOM R-9000 receiver that appeared in the previous example could also be calibrated using the following, much simpler command line:

```
r9000cal R9000
```

4.3.1.3. The calibration process

The actual calibration process can take a long time, up to an hour or more. During the calibration process, some operator intervention is required; namely, the operator is requested to connect the calibration source to the various input connectors of the receiver. The number of times when operator action is required is kept at a minimum by design.

Note that the ICOM calibration program is not designed to use the switch matrix. You may still use a switch matrix, for instance, by specifying a "Test Antenna" dummy instrument representing the ICOM receiver's input connector(s), with appropriate switch matrix commands defined to connect to SMH to the proper connector. Then, when the calibration program requests you to connect the SMH to a connector, you could use this dummy instrument to manipulate the switch matrix.

In the following example, calibration of an ICOM R-8500 receiver is initiated from the command line. Full calibration is requested (no `-r` option) and frequency calibration (`-f` option) is also being performed. Furthermore, the receiver is calibrated using both AM and FM demodulation (`-am` option). The receiver's identifier in the ISOC system is `IC8500`, the signal generator is called `SMH`. Calibration is to be performed using 3 dB calibration ranges. The receiver is tuneable between 100 kHz (1e5 Hz) and 2 GHz (2e9 Hz). The receiver has two input bands, the first of which ends at 30 MHz (3e7 Hz). In the lower band, a tuning step of 1 MHz (1e6 Hz); in the upper band, a tuning step of 10 MHz (1e7 Hz) is to be used.

This calibration process took approximately 45 minutes to complete and produced the following output (with some lines removed for brevity, indicated by ellipses):

```
C:\Program Files\Industry Canada\WinISOC>icomcal -f -l r8500.log -am IC8500
SMH 3 1e5 2e9 2 3e7 1e6 1e7


ICOM Calibration (command-line interface)
=========================================
AM calibration requested
Backing up Registry entry...
Calibrating IC8500 with SMH
Level accuracy: 3 dB
Receiver range: 0.1 MHz - 2000 MHz
2 input bands:
Band 1 maximum frequency: 30 MHz, step 1000 kHz
Band 2 maximum frequency: 2000 MHz, step 10000 kHz

Characterizing receiver (LEVEL=12)
Frequency calibration will be performed.

 **** Please CONNECT the SMH to band 1 of the IC8500 and press ENTER:

0.275 (+500) MHz: 6.0 dBuV
1.275 MHz: 5.9 dBuV
...
28.275 MHz: -4.6 dBuV
29.275 MHz: -4.1 dBuV

 **** Please CONNECT the SMH to band 2 of the IC8500 and press ENTER:

30.175 MHz: -2.2 dBuV
40.175 MHz: -2.8 dBuV
...
1980.18 (+5000) MHz: 7.5 dBuV
1990.18 (+5000) MHz: 7.8 dBuV
Number of 3 dB ranges: 20

 **** Please CONNECT the SMH to band 1 of the IC8500 and press ENTER:

Switching ICOM to mode 0201:  succeeded.
3 dB range #0 is 5.9 dBuV at 1.275 MHz, calibrating... DONE.
3 dB range #1 is -2.8 dBuV at 6.275 MHz, calibrating... DONE.
3 dB range #2 is -5.1 dBuV at 23.275 MHz, calibrating... DONE.
Switching ICOM to mode 0202:  succeeded.
3 dB range #0 is 5.9 dBuV at 1.275 MHz, calibrating... DONE.
...
3 dB range #2 is -5.1 dBuV at 23.275 MHz, calibrating... DONE.
Switching ICOM to mode 0503:  FAILED, skipping mode.
Switching ICOM to mode 0601:  succeeded.
3 dB range #0 is 5.9 dBuV at 1.275 MHz, calibrating... SKIPPED (WFM <
30MHz).
```

```
3 dB range #1 is -2.8 dBuV at 6.275 MHz, calibrating... SKIPPED (WFM <
30MHz).
3 dB range #2 is -5.1 dBuV at 23.275 MHz, calibrating... SKIPPED (WFM <
30MHz).

 **** Please CONNECT the SMH to band 2 of the IC8500 and press ENTER:

Switching ICOM to mode 0201:  succeeded.
3 dB range #3 is -3.4 dBuV at 90.175 MHz, calibrating... DONE.
...
3 dB range #19 is 7.8 dBuV at 1990.18 MHz, calibrating... DONE.
Switching ICOM to mode 0503:  FAILED, skipping mode.
Switching ICOM to mode 0601:  succeeded.
3 dB range #3 is -3.4 dBuV at 90.175 MHz, calibrating... DONE.
...
3 dB range #19 is 7.8 dBuV at 1990.18 MHz, calibrating... DONE.
The calibration was successful.
```

Note that messages like this do not represent an error:

```
Switching ICOM to mode 0503:  FAILED, skipping mode.
```

The calibration process does try all IF/demodulator combinations regardless of the type of the receiver; if a combination is not supported by the receiver, an error is generated, and that combination will be skipped. (This way, the calibration program may be used with unsupported ICOM receiver types as well, although the results are not guaranteed).

If the calibration is successful, the results are stored in the Registry, and they are available immediately. (No need to restart the ISOC server).

The calibration process can also fail. There can be many reasons for failure, some related to equipment problems, some to operator error, some caused by something as mundane as a badly secured RF connector.

If the calibration fails, an error message is printed, as in the following example:

```
C:\Program Files\Industry Canada\WinISOC>icomcal -f -l r8500.log -am IC8500
SMH 3 1e5 2e9 2 3e7 1e6 1e7


ICOM Calibration (command-line interface)
=========================================
AM calibration requested
Backing up Registry entry...
Calibrating IC8500 with SMH
Level accuracy: 3 dB
Receiver range: 0.1 MHz - 2000 MHz
2 input bands:
Band 1 maximum frequency: 30 MHz, step 1000 kHz
Band 2 maximum frequency: 2000 MHz, step 10000 kHz

Characterizing receiver (LEVEL=12)
Frequency calibration will be performed.
```

```
 **** Please CONNECT the SMH to band 1 of the IC8500 and press ENTER:

0.275 MHz: #####
1.275 MHz: #####
Frequency calibration failed (multiple peaks).
The calibration was not successful.
```

In this case, the error was caused by an improperly secured connector. The first manifestation of the error was the ##### signs printed as an attempt was made to characterize the receiver's response. This indicates that no matter how low a signal level was produced by the signal generator, the receiver continued to report an abnormally high signal level. This by itself is not treated as an error, but it may be an indication of a bad signal path that picks up spurious signals from the air.

Later, however, the calibration program was unable to locate a frequency peak. This is an unrecoverable error, causing the calibration program to terminate.

Here are some of the error messages that the calibration program may report, along with a brief explanation:

`Failed to connect to ISOC server`: The ISOC server may not be running on this computer.

`Failed to reserve` ***`instrument`***: The instrument in question may be in use.

`Calibration out of range`: May indicate that the SMH is not connected to the correct connector of the receiver.

`Frequency calibration failed (multiple peaks)`: Frequency calibration (`-f` option) was requested but it failed. The most likely cause of this error is a spurious signal, perhaps as a result of an improperly secured RF connector or an improperly shielded cable.

`Frequency calibration failed (no peak found)`: Frequency calibration (`-f` option) was requested but it failed. May indicate that the signal generator is not connected to the receiver.

`Frequency calibration failed (plateau too wide)`: Frequency calibration (`-f` option) was requested but it failed. The signal from the SMH was detected, but no well defined peak was located. Could be due to a spurious signal

`Recalibration failed (difference too large)`: Please run full calibration: Recalibration (`-r` option) was requested but at selected signal levels, the receiver's response significantly differs from the data in the Registry.

Cannot recalibrate (no calibration data found): Recalibration (`-r` option) was requested, but no calibration data exists in the Registry for the selected receiver and IF/demodulator settings.

Before it begins the calibration process, the ICOM calibration program saves existing settings in the Registry using a device name formed from the ICOM device name with the string "`.bak`" appended to it. If the calibration fails, or if the calibration results are not satisfactory, this backup copy can be used to recover previous settings. Note however, that repeated attempts to calibrate the ICOM create new backups, destroying any previously existing backup copies, so it might be a good idea to also save the settings in a separate file (i.e., export the Registry subkey using the Windows Registry editor).

The program ICOMDUMP.EXE, as the name suggests, dumps the calibration information stored for a specific ICOM receiver. To use this program, invoke it from the command line, using the ICOM receiver's identifier as the program argument. You would probably also want to redirect the program's output to a file, as in the following example:

```
C:\Program Files\Industry Canada\WinISOC>icomdump IC8500 > \TEMP\IC8500.CSV
```

(CSV is a commonly used extension for files containing comma-delimited data.)

Each line in the output contains the accuracy level (1, 2, or 3dB), the receiver mode, upper limit frequency for the given calibration range, and 116 S-meter measurements corresponding with SMH signal outputs between -10 and +105 dBuV, in 1 dB increments. The final two values are the characteristic frequency for the given range, and the frequency offset (measured only if frequency calibration was performed.)

Receiver modes are as follows:

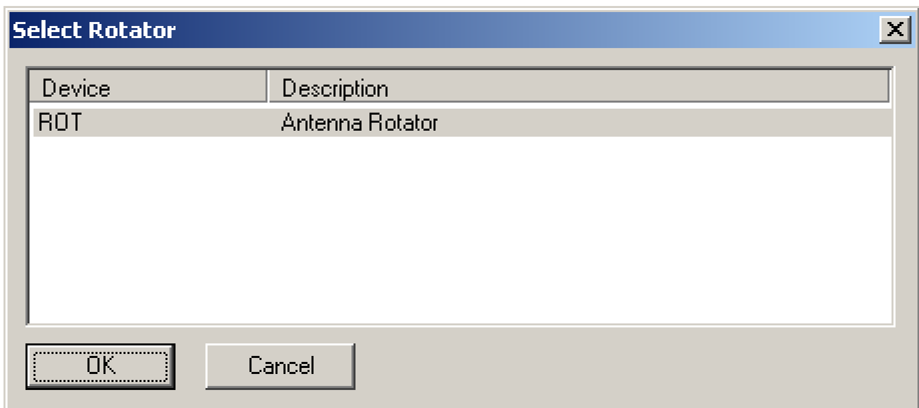
0501	FM wide (R9000) or normal (R8500)
0502	FM normal (R9000) or narrow (R8500)
0503	FM narrow (R9000)
0601	Wide FM

4.3.2. Calibrating the antenna rotator

The antenna rotator reports the horizontal and vertical position of the antenna in the form of analog values. The antenna rotator is connected to the ISOC computer via a 232SDA10 Data Acquisition Module manufactured by B&B Electronics. This module provides an RS-232 interface and a simple command set to query readings of its build-in analog-to-digital (A/D) converter. The ISOC computer controls the antenna rotator and reads the antenna position through this module.

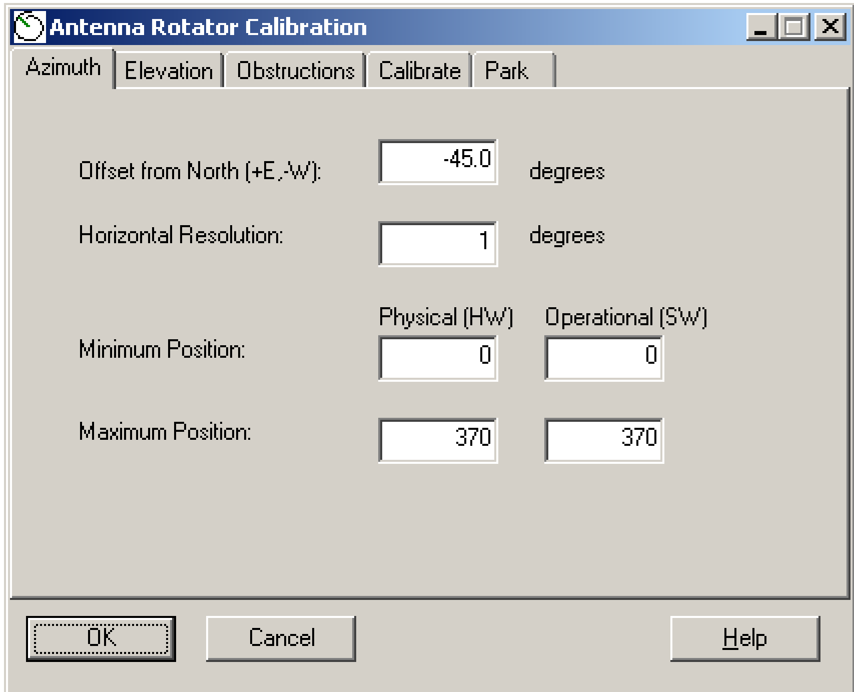
This module needs to be calibrated in the sense that its readings must be translated into azimuth and elevation angles measured in degrees. The module's (and the antenna rotator's) response is assumed to be linear; however, it is still necessary to establish analog levels that correspond with the end positions of the antenna rotator.

Configuration of the antenna rotator and calibration of the data acquisition module are performed by a utility application, the Antenna Rotator Calibration application. If you installed ISOC server components, this application is also installed under the Start menu. When you start this application, it firsts asks you to select which antenna rotator to use (keeping in mind that some installations may use more than one antenna rotator):



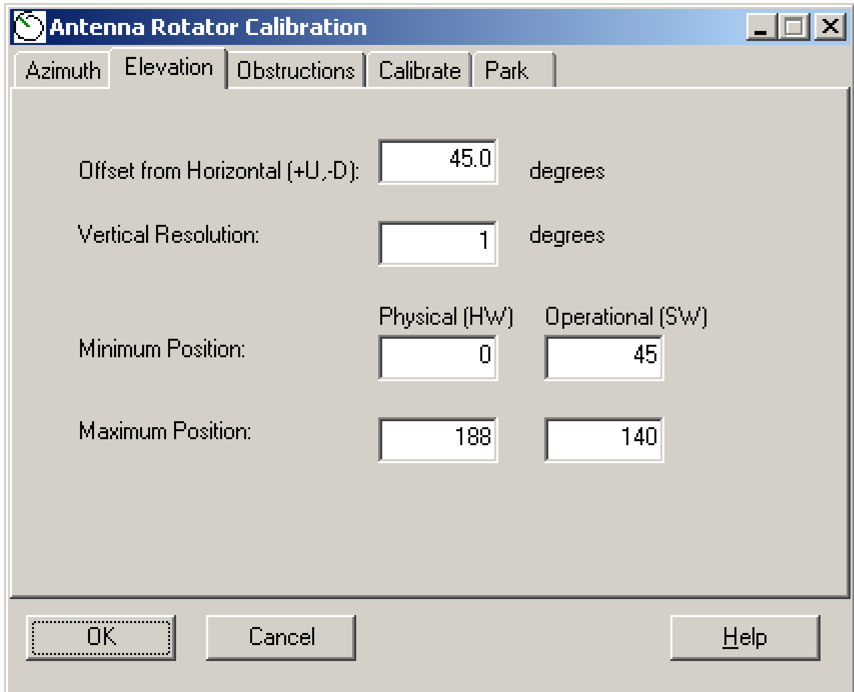
Select the desired rotator and click the OK button. This brings up the main interface of the Antenna Rotator Calibration program.

The Antenna Rotator Calibration program's user interface is presented in the form of a dialog with four tabs. The first of these tabs is for Azimuth control:

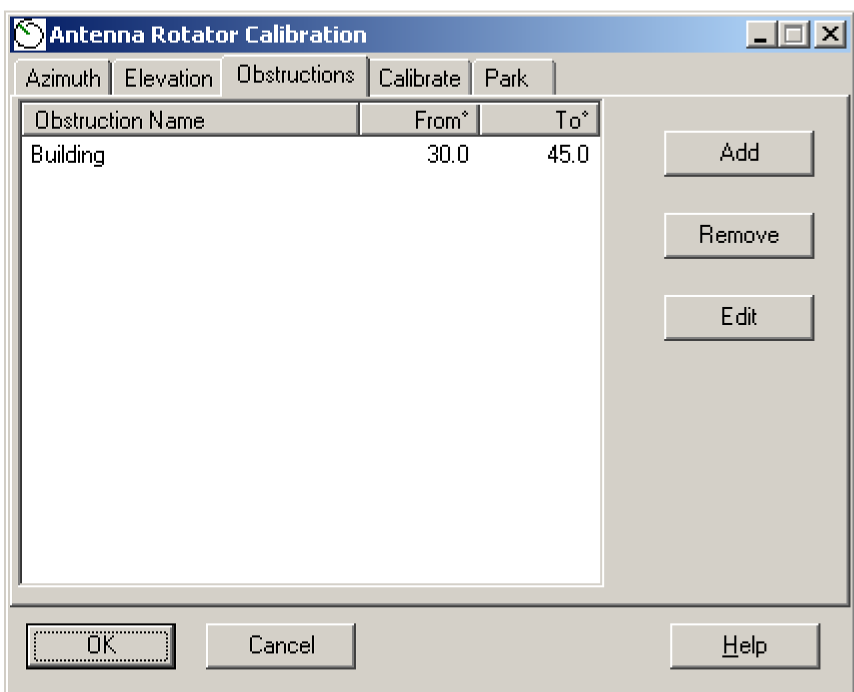


Several settings can be specified here. First, the actual mount orientation of the antenna rotator can be specified by entering the appropriate value in the **Offset from North (+E, -W)** field. The anticipated **Horizontal Resolution** of the rotator and data acquisition electronics determines the accuracy that the software uses when it places the rotator to a desired position. The **Minimum Position** and **Maximum Position** values determine the **Physical (HW)** and **Operational (SW)** limits of the rotator. Physical limits correspond with the end positions; operational limits are never exceeded by the ISOC software during normal operations.

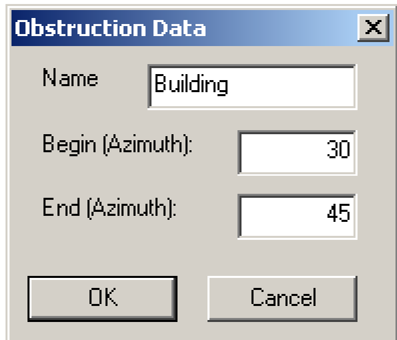
The functionality of the Elevation tab is very similar. The mount elevation of the antenna rotator can be specified in the **Offset from Horizontal (+U, -D)** field. The **Vertical Resolution** field specifies the anticipated resolution of the rotator and data acquisition electronics. The **Minimum Position** and **Maximum Position** fields can be used to specify the **Physical (HW)** and **Operational (SW)** limits of the rotator; the former assigns angle values to the device end positions, the latter determines the limits that the ISOC software is not to exceed during normal operations:



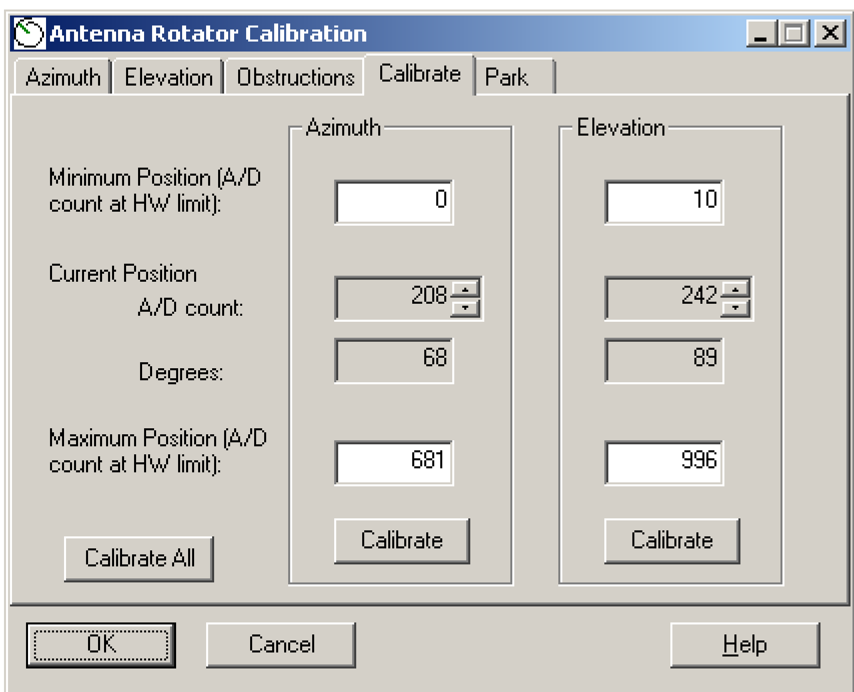
The third tab allows you to specify a list of obstructions. Obstructions are marked in grey in the antenna rotator's user interface. An obstruction is characterized by a name and two angle values:



To remove an existing obstruction, click **Remove**. To edit an obstruction in the list, select it and click **Edit**. Or, click **Add** to create a new obstruction. In both cases, the program presents the Obstruction Data dialog where details for an obstruction can be specified:



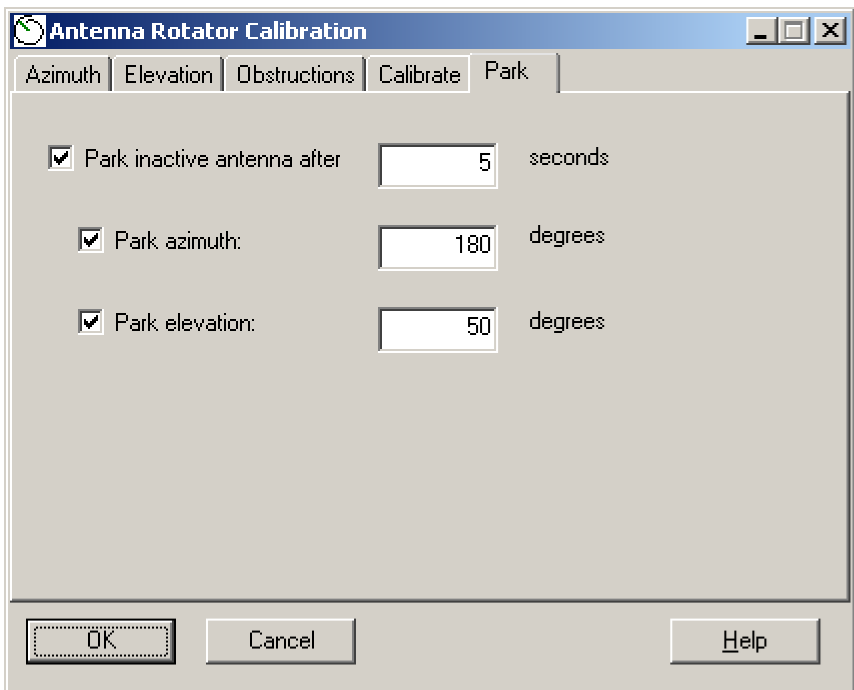
The fourth tab in the set is the Calibrate tab. This tab provides the main calibration interface for the antenna rotator. The purpose of the calibration process is to find the A/D converter readings at the horizontal and vertical limits of the rotator device. The **Azimuth** and **Elevation** limits can be calibrated separately by clicking the corresponding **Calibrate** button; or, you can click **Calibrate All** to perform both calibrations simultaneously:



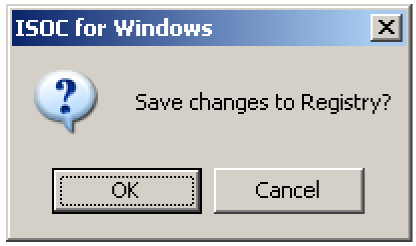
The calibration process fills in the values of the Minimum Position (A/D count and HW limit) and Maximum Position (A/D count and HW limit) fields. During the calibration process, the progress is visible as the software updates the **Current Position**, **A/D count** and **Degrees** fields.

The Antenna Rotator Calibration program can also be used to directly manipulate the rotator. The **A/D count** field is not editable, as it contains the A/D values read from the instrument. However, you can use the up/down controls next to both A**/D count** fields to turn on the antenna rotator motors and change the rotator's position. The rotator continues moving so long as the up/down control remains depressed; you can observe the change in the antenna rotator's position as the readback in the **A/D count** field changes.

The final tab is where the park position for the antenna rotator can be specified. If the antenna rotator is not used for the specified period of time, the ISOC software automatically positions the antenna at the prescribed azimuth and elevation if the corresponding checkboxes are selected.



When calibration is completed, you can dismiss the Antenna Rotator Calibration program by clicking the **OK** button. This causes the following prompt to be displayed:



If you click OK, all changes (new Azimuth and Elevation settings, changes to the Obstructions list, and new Calibration values) are saved in the Registry; otherwise, the changes are discarded, and the values in the Registry remain unchanged.

4.4. Network connections

In order for the ISOC to work, a TCP/IP connection must exist between the ISOC client and server machines. This connection can take many forms.

A "connection" is always present when the client and server are the same physical machine, so long as TCP/IP software (part of Windows) is installed. Communicating through the "loopback interface" client and server programs can exchange information just as if they were on separate machines across the network. The loopback interface always uses the (reserved) IP address `127.0.0.1`. Another way of thinking about this address is that it is always the address of "this machine", whichever machine "this machine" might be. A synonym for this address is `localhost`; this synonym can also be used on most properly configured computers.

Nearby machines are usually connected via an Ethernet-type network. Ethernet has its own protocol; TCP/IP packets are "wrapped" inside Ethernet packets as they travel across a local area network. A potential source of problems may be the presence of firewall software on ISOC client or server computers. Such firewall software can prevent either all or some communication by the ISOC.

The main ISOC server, ISOCSVC.EXE, listens for incoming data connections on TCP port 25449. Most communication takes place over a TCP socket that is initiated by a client to this port on the server.

ISOC clients may listen to streaming data on UDP ports 27000 through 27100. Streaming data includes audio and graphical trace information. These communications tolerate the occasional packet loss (detected as a brief discontinuity in the audio, or a small "hiccup" in the graphical trace). The ISOC will remain functional if these UDP packets are not delivered, but no audio will be heard and no graphical traces will appear in virtual instrument displays.

The ISOC Scanner service listens for incoming connections on TCP port 25450. The ISOC Task Manager connects to this port on the ISOC server when it communicates with the ISOC Scanner service. The ISOC Scanner, in turn, may communicate with the ISOC Service on the same server machine, on port 25449 on `localhost`.

The ISOC also works over other types of network connections. These include dial-up and VPN type connections. The ISOC is known to work well over Microsoft VPN connections across the Internet. The VPN server can be either the ISOC server or another server that acts as a router. Other manufacturers' VPN products may also work with the ISOC.

Dial-up connections require special consideration because of their limited bandwidth. The maximum bandwidth of a modem connection between two computers is 33,600 bps, or about 4,200 bytes per second. (56 kbit modems work at that speed only when dialling into the specialized servers of an appropriately equipped ISP, and even then, the connection speed is asymmetrical). Some of this bandwidth is used for network overhead; as a general rule of thumb, taking into account both network overhead and less than perfect telephone line conditions, it is reasonable to assume that about 70% of the theoretical bandwidth, or about 3,000 bytes per second is available for use by applications such as the ISOC system.

Simply connecting to an ISOC server (or ISOC Scanner service) or commanding instruments does not require a whole lot of bandwidth, though you might notice that even these operations are noticeably slower when a dial-up connection is used. Graphical traces, and especially audio, are another matter altogether.

To calculate the graphical trace bandwidth requirement, multiply the width of the trace by the number of traces per second. If the trace height is greater than 255 (i.e., if trace values are delivered as 2-byte integers as opposed to 1-byte values) multiply by a further factor of 2. For instance, if you are using an HP spectrum analyser, the trace is 400 samples wide, 200 pixels high, and you get 6 traces per second, that is equivalent to 6 × 400 = 2,400 bytes per second. In other words, a single instrument with a graphical trace can consume most of the available bandwidth over a dial-up connection.

The bandwidth requirements of streaming audio are even higher, at least when the audio is uncompressed. A single monaural channel at the sampling rate that the ISOC uses requires a bandwidth of slightly over 8,000 bytes per second. For this reason, the ISOC offers GSM compression, which reduces the bandwidth requirement to between 1,600 and 1,700 bytes per second. A much more aggressive approach is to reduce the sampling rate further; at half the sampling rate, the bandwidth requirements are slightly over 4,000 bytes per second for uncompressed, and 800-900 bytes per second for GSM compressed audio.

Unfortunately, at this aggressively low sampling rate, the audio quality is not very good, speech is barely comprehensible.

If you have more than one phone line available, the ISOC can take advantage of the built-in multiline load sharing capabilities of Windows.

The following table summarizes the ISOC's bandwidth requirements and the bandwidths available using various connection technologies:

Network/usage type	**Est. bandwidth (bytes/second)**
ISOC simple commanding	< 100
ISOC trace: ESN, 400 samples, 1 trace every 2 seconds	200
ISOC audio: 1 channel, half-rate + GSM	850
ISOC audio: 1 channel, GSM compression	1,650
ISOC trace: HPS, 400 samples, 6 traces/second	2,400
ISOC low-bandwidth operations: ESN, HPS at 2 traces/second, 1 GSM audio, instrument commanding	2,750
Dial-up networking	3,000
ISOC normal operations: ESN, HPS, 2 GSM audio, instrument commanding	6,000
Dial-up networking with two modems	6,000
ISDN single-channel	6,000
ISDN dual-channel	6,000
ISOC audio: 2 channels uncompressed	16,100
DSL @ 256 kbps	25,000
10Base-T Ethernet	900,000

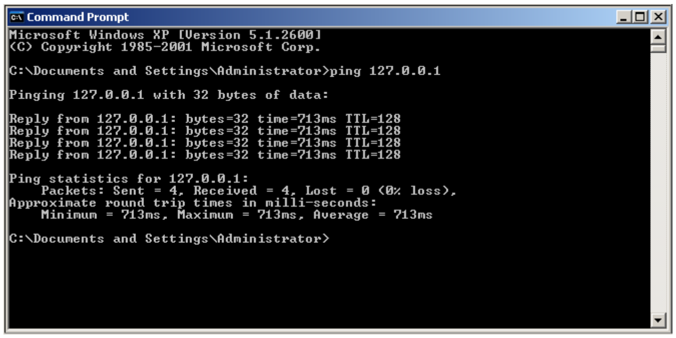
4.5. Troubleshooting

The ISOC is a complex system that consists of computers, interface hardware, cables, test instruments, and, last but not least, control software. If any of these components malfunctions, the system may not operate properly. When that happens, it is an often difficult and arduous task to identify the cause of the problem and arrive at a suitable solution.

4.5.1. Client-server issues

In the following, it is assumed that the ISOC server and client computers are functioning correctly: the operating system is installed and working, it is patched with the latest fixes provided by the operating system vendor, and that the computers are connected to a network through which they can communicate with each other.

To verify that one ISOC computer can see another (e.g., that an ISOC client computer can see an ISOC server) you can use the `ping` utility. This command-line program sends test packets to another computer and when a response is received, it displays the round-trip time:



If the `ping` utility fails, that is an indication that connectivity is not established between the two computers. The ISOC will not function in this case![9]

Once you have established that the ISOC client and server computer can see each other across the network, you should be able to connect to the ISOC server using the ISOC client program. If you are unable to do so, this may be due to several reasons:

- Is the ISOC server running? You can start the server interactively, and monitor its log messages. For more information, see section 4.5.4 below. If you have access to the server and the ISOC client is installed there, you may try running the ISOC client locally on the server, to verify that the server is operational.
- Is the ISOC client software correctly installed on the client computer? Incorrect installation may result in missing Registry keys that prevent some components of the ISOC from loading properly. In particular, if in response to selecting the *Connect...* command from the *Site* menu, the ISOC Servers window does not appear, you may try to re-register the ISOC virtual instrument control. To do so, open a command prompt, navigate to the ISOC installation directory (`C:\Program Files\Industry Canada\WinISOC` is the default) and issue the following command:

```
regsvr32 isocinstrument.dll
```

[9] In some situations, it is possible that a network firewall prevents `ping` packets from reaching another computer even though other types of packets are allowed through; i.e., `ping` may fail even though the ISOC works. Troubleshooting such configurations is beyond the scope of the present manual.

- Is the correct encryption key installed on the ISOC client and server? A normal installation installs this key as a binary value in the Registry. The name of this value is Key, and it is installed under `HKLM\Software\Industry Canada\ISOC for Windows\`. The client and the server must have the same two-byte value present for this key, otherwise they will not be able to communicate with each other.
- Are you using the correct IP address? Sometimes, especially in corporate network environments where computers obtain an IP address from a central (DHCP) server automatically, the IP address of a server may change. If you are using the old numeric IP address, or if you are using a symbolic address but it has not been correctly configured to reference the server's new IP address, the connection may fail.
- Do you see anything appear in the server's output (or log file) as the client is trying to connect? Even a failed connection attempt should generate lines in the log file like

  ```
  Accepting connection on socket 000002C8 from 127.0.0.1:4487
  ```

- If a network firewall (physical or software) is installed on the server, is it configured to permit ISOC traffic through?

4.5.2. Verifying that an instrument is operational

If you can connect to an ISOC server using the ISOC client program, but you have difficulty connecting to a particular instrument, it may be that that instrument is not correctly configured, not connected, or not correctly functioning. Before taking other steps, it is recommended that you

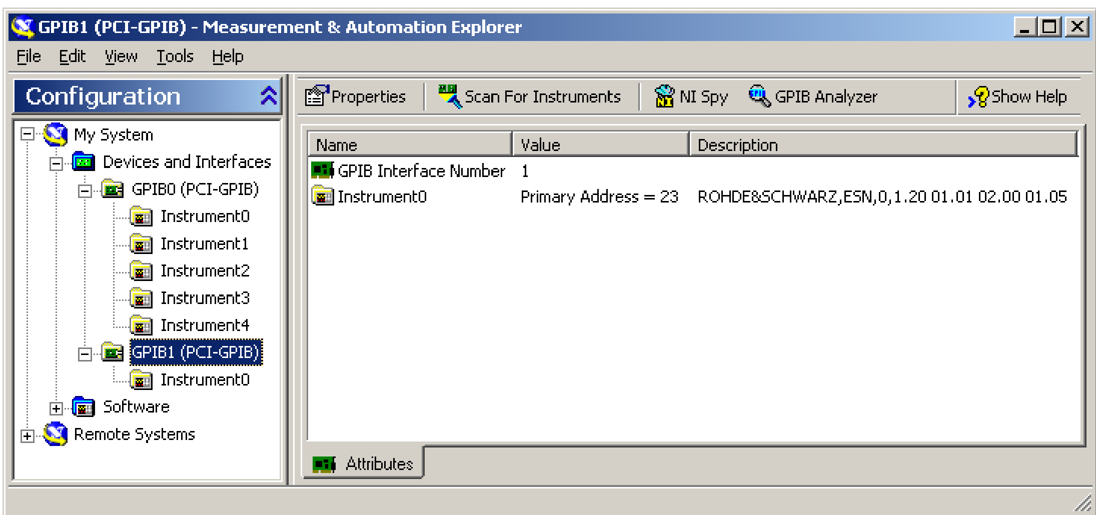
- Verify that the physical instrument is actually powered up and operational. Can you use it interactively from its front panel?
- Verify that the physical instrument is actually connected to the ISOC server computer. Are all cables plugged in securely? A surprising number of problems are caused by cables and connectors. The problem may not always be visible, if a connector is only slightly loose, for instance.
- If there is additional interface hardware required to connect to an instrument (e.g., a network router, CI-V interface, analog-digital converter) make sure that it, too, is properly connected and, if it has an independent power supply, that it is powered up.

In the remainder of this section, further advice is provided that is specific to the various interfaces that the ISOC uses.

4.5.2.1. GPIB instruments

The easiest way to verify that a GPIB instrument is operational and it is properly connected to the ISOC server is by using the utilities provided as part of the National Instruments driver package for the GPIB interface card.

Modern versions of the National Instruments driver package include the Measurement & Automation Explorer. This application can be used to enumerate GPIB cards and devices attached to GPIB cards. When started, the Measurement & Automation Explorer presents an Explorer-style interface; available GPIB cards can be seen on the left, under My System, Devices and Interfaces. If you have only one GPIB card installed, it should be present here as GPIB0; additional cards would appear as GPIB1, GPIB2, etc. If you select any one of the installed GPIB cards, the Measurement & Automation Explorer presents details about that card and the instruments attached to it:

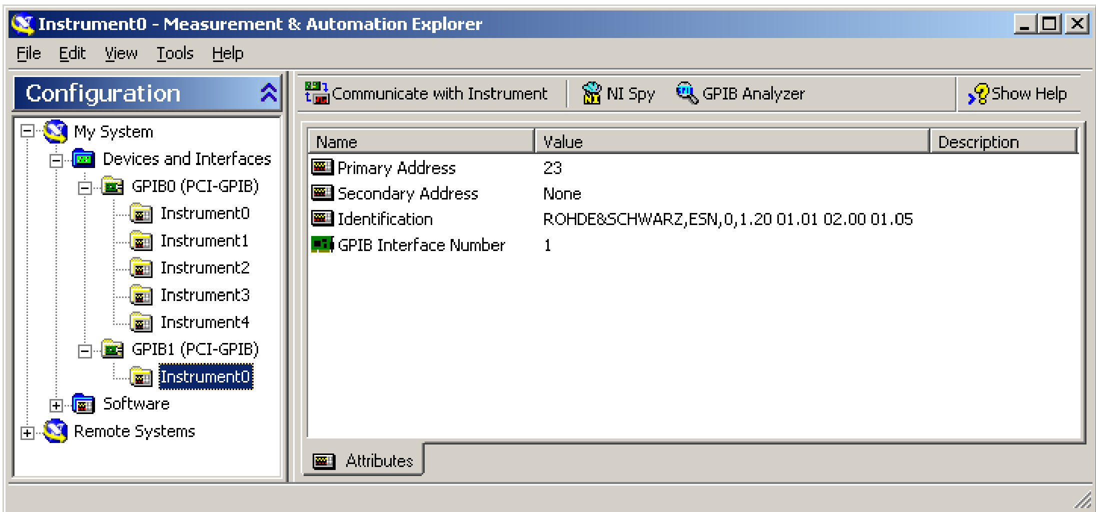


The Measurement & Automation Explorer can scan for instruments. For this to work, all instruments attached to the card must be connected, turned on, and functioning. Clicking the **Scan For Instruments** button at the top initiates the scan. It may take a while for the Measurement & Automation Explorer to complete the scan and report all instruments. When it is done, verify that the instruments list presented by the Measurement & Automation Explorer corresponds with the actual set of physical instruments connected to that GPIB card.

To verify that a specific instrument is operational, select it on the left side and review the information presented on the right. In particular, check the Identification field and make sure that this field correctly identifies the instrument. Also make note of the GPIB Primary Address, as well as the identifier of the

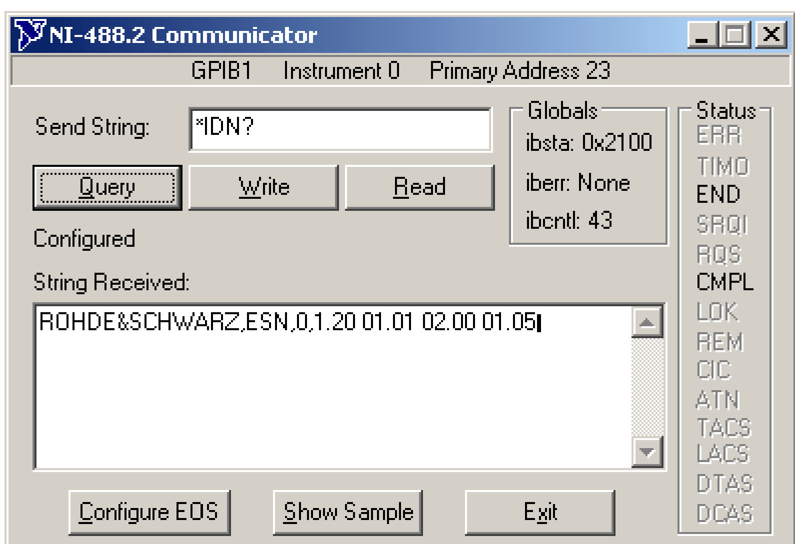
GPIB card that the instrument uses; make sure that the same values are used in the ISOC itself for this instrument.

Instrument details are presented by the Measurement & Automation Explorer in the following form:



A particularly useful feature of the Measurement & Automation Explorer is its ability to communicate with an instrument. This indeed is the final step in a troubleshooting process: by communicating with the instrument, you will have verified that it is connected properly and functioning, so any remaining problems must be due to ISOC misconfiguration or software errors.

To communicate with the instrument, click the **Communicate with Instrument** button. This invokes the NI-488.2 Communicator dialog:



In this dialog, you can enter a command or query string, send it to the instrument, and optionally read a reply. (The **Query** button performs both functions at once; it sends the command and waits for a response from the instrument). Most (but not all!) instruments respond to the GPIB standard command `*IDN?` (identification query), as shown in the example above. One important exception is the Racal switch matrix used by the ISOC; although it accepts commands, it never responds, not even to standard commands such as `*IDN?`.

4.5.2.2. CI-V instruments

The CI-V interface uses an RS-232 style signalling protocol with proprietary signalling levels. The protocol uses a 3-wire interface (no hardware handshaking) and includes collision detection capability, allowing up to four instruments to share the same communication line.

A personal computer can communicate with CI-V instruments through an RS-232 to CI-V level converter. The ISOC system includes a CI-V driver that can recognize up to four instruments on the same communication port, and can communicate with them simultaneously.

The level converter can be either an external level converter unit, such as the ICOM CT-17, or an instrument, such as the ICOM R-8500 receiver that includes level conversion capability.

In order for the ISOC to communicate with a CI-V instrument, it needs to know the COM port to which the CI-V instrument is attached, and the CI-V instrument's address. The address is a one-byte value that is used to uniquely distinguish CI-V instruments sharing the same communication line. Most CI-V instruments have a factory preset CI-V identifier that can be changed by reconfiguring the instrument.

Unfortunately the CI-V protocol is a binary protocol, so it is not possible to verify an instrument's operation using a terminal emulator program such as HyperTerminal. Nevertheless, a process of elimination may still be employed to find the cause of a potential problem.

If more than one instrument is connected through the same CI-V interface, are all instruments exhibiting the problem? If so, the problem may be in the basic configuration (did you get the COM port number right?), the cable connecting the PC with the level converter, or the level converter itself. Is the level converter powered? If it is a converter with configuration (DIP) switches, are those switches configured correctly? (Consult the manual).

If the problem is limited to a single instrument, disconnect all other instruments from the CI-V line. (All other instruments, that is, except the level converter). Does the problem "go away"? Sometimes the presence of another instrument, even when it is powered down, can interfere with CI-V operations. If the problem is still present, verify that you are using the correct CI-V address for this instrument. Is the instrument correctly configured? Some instruments allow you to use different serial communication settings; the ISOC always uses the default 9600 bps, no parity, 1 stop bit. Also, try to replace the instrument with another, working instrument (not necessarily of the same type) to verify that the cable and setup are functional.

Lastly, if you have third-party software available from the instrument manufacturer, you may try that software in place of the ISOC to see if you can establish communications with the instrument. Success may indicate a configuration problem or software error in the ISOC itself; failure would indicate a problem in CI-V communications (hardware, cabling, or instrument configuration problem).

4.5.2.3. Ethernet (TCP) instruments

Many new instruments come equipped with an Ethernet connector. Typically, such instruments use the TCP/IP family of protocols, specifically the TCP protocol to communicate. In the typical scenario, the instrument exposes a TCP port to which "clients" (in our case, the ISOC server acts in the client role) can connect; the client then uses the instrument's proprietary protocol to issue commands and obtain responses.

When you have trouble communicating with such an instrument, the first question is whether the instrument is "on the network" at all. If possible, try to verify the instrument's IP address using its front panel. If you know the IP address of the instrument, see if you can access the instrument using the command-line `ping` utility. If the instrument responds, its network connection is functional.

In some cases, it may not be the instrument or the cabling but your network configuration that is the problem. Is there a firewall (either software firewall or an external physical firewall router) between the ISOC system and the instrument? If so, is the firewall configured to allow access to the instrument? (In some cases, you may never be able to ping the instrument even if the instrument is otherwise functional, as the firewall may be configured not to permit the passage of ping packets).

Do you know the instrument's port number? It should be described in the instrument's manual, and may be configurable through the instrument's front panel. In many cases, you should be able to use the telnet program to connect to the instrument on that port. (In Windows, telnet.exe accepts an optional second parameter that is the port number: e.g., `telnet 127.0.0.1 11111`, issued from either the command prompt or through the **Run** command in the Start menu, connects to IP address 127.0.0.1 using TCP port 11111).

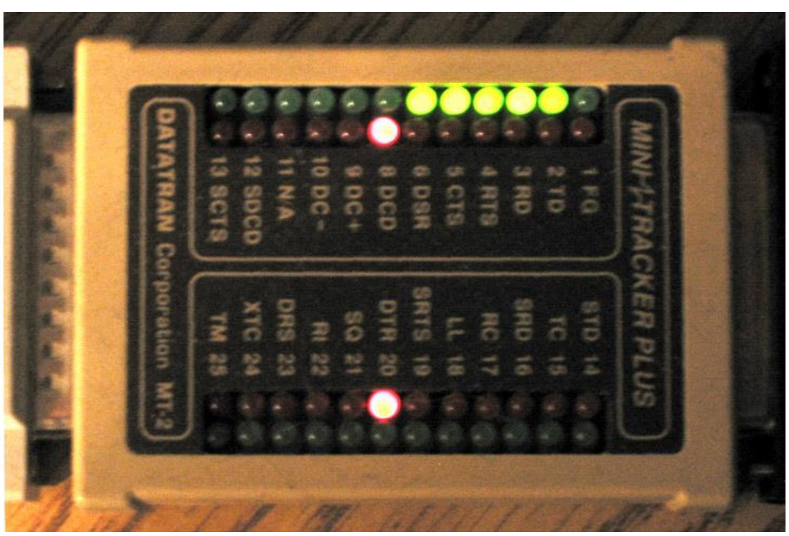
Some instruments (e.g., the Rohde & Schwarz FSP spectrum analysers) use a proprietary binary protocol over TCP. You cannot communicate with these instruments using the telnet program. In this case, if you have third party programs from the manufacturer available, try using those programs to verify if the instrument is functional and can be accessed.

4.5.2.4. Serial port instruments

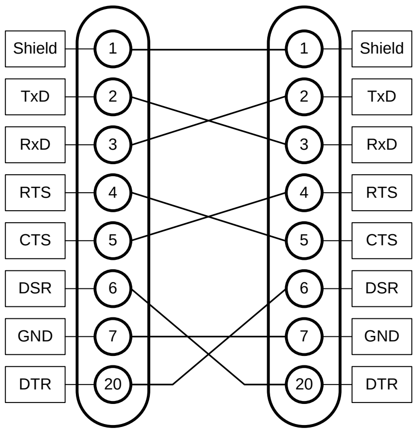
For instruments connected via the serial port, the most likely cause of problems is incorrect serial port settings. The easiest way to verify that the instrument is connected properly is by using a terminal emulation program such as HyperTerminal. Try configuring HyperTerminal with the settings appropriate for your instrument: COM port, data rate, parity, number of stop bits. Then check if the instrument responds by using HyperTerminal to send commands to it (consult the instrument manual for valid commands).

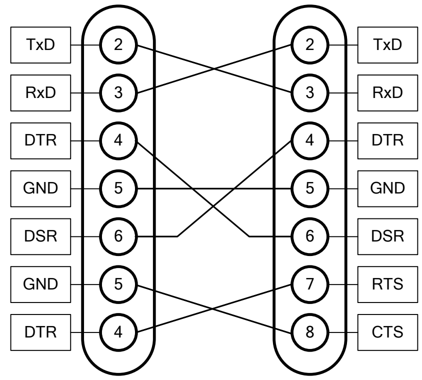
If you believe that you have configured the COM port correctly, but you cannot communicate with the instrument using HyperTerminal, the physical connection may be to blame. By far the most frequently encountered cause is a bad or loose cable, so make sure that your cables are all securely connected, and perhaps try to replace the serial cable with another.

If you have access to a "breakout box", a device that provides visual indication of RS-232 signals over the serial port, use it. The breakout box, like the one shown in the picture below, may help you determine if all RS-232 lines are connected properly, and whether or not a null modem adapter might be needed:



Speaking of null modems, not all null modems are created equal. The recommended null modem to connect two serial ports using 25-pin (left) and 9-pin (right) cables is as follows:





Some commercial null modem adapters use a different signal arrangement, in order to properly "simulate" a modem: a nonsymmetric arrangement intended to simulate the DCD (Data Carrier Detect) signal for the host computer, but neglecting to properly reverse all hardware handshaking signals. If the software requires the presence of the DCD signal, this can be achieved by cross-connecting pins 8 and 20 on each side, effectively causing the DCD signal to be present whenever the computer turns on the DTR line; this is not required for the ISOC, however, as the ISOC does not check for the presence of the DCD signal.

One additional concern is with regards to USB-to-serial adapters (multiport or otherwise). During testing, one particular low-cost USB-to-serial adapter proved to be especially unreliable; it stopped working more or less randomly, and it was necessary to disconnect and reconnect not only the adapter but the USB hub that it was connected to in order to make it work again

Indeed, as one ISOC user recently remarked, "not all USB hubs are created equal". In one particular production scenario, they found that a USB-to-serial multiport adapter frequently stopped functioning even though other equipment connected to the same USB hub continued to work. However, when the adapter was connected directly to one of the host computer's USB ports, the problems disappeared.

4.5.2.5. Switch matrix

The Racal switch matrix used by the ISOC communicates via GPIB. Unfortunately, it is not a very "talkative" instrument, making it very difficult to verify that it is operating correctly. The instrument sends no messages in response to commands; it only accepts commands and executes them. Unless you are using extra hardware that indicates the state of the relays of the switch matrix, it may be difficult to ascertain if a command has been executed as expected. Sometimes, listening helps; as commands to the switch matrix are issued, you may hear the "click" of relays closing, indicating that the command was accepted.

The ISOC verifies that the switch matrix is present by sending it an empty command. If the GPIB bus reports a communication error, the instrument is assumed absent; otherwise, it is deemed functional.

There are two possible failure modes of the switch matrix in the context of the ISOC. Either the switch matrix is not functioning at all, or it is not executing commands as expected.

The former case is indicated by the fact that the Signal Source field in virtual instruments remains disabled. Every time an instrument connects to the ISOC server, the server checks for switch matrix availability. If the matrix is available, this is indicated to the client program, which in turn then enables the Signal Source field in the newly opened virtual instrument. If this field remains disabled even for virtual instruments that have corresponding signal source/switch matrix definitions, that's a likely indication that the ISOC cannot communicate with the switch matrix.

To test the switch matrix, try connecting to it using the Measurement & Automation Explorer utility that is installed along with the National Instruments GPIB driver. Even though you cannot get a response from the instrument, you can still try to send commands to it to see if it is functioning. If you know a specific command to turn on a relay or set of relays, try sending that command and use some means to verify if the relays closed as expected. The Measurement & Automation Explorer may also indicate whether the command was sent successfully, or if an error was encountered.

The presence of an IP based switch matrix can be verified on an IP network using the `ping` utility or, if necessary, using `telnet` in an attempt to connect to the switch matrix at the specified port.

4.5.2.6. Power control

Some ISOC instruments are powered through a WTI RPB+ or IPS-400/IPS-800 remote control power bar. If there is reason to suspect that the power bar is not working properly, you can use a terminal emulation program such as HyperTerminal to test the power bar.

To test the power bar, use the terminal emulation program to open the corresponding COM port at 9600 bps, 8 data bits, no parity, 1 stop bit. As soon as you are connected, hit the Enter key. The power bar should respond by printing its status screen, not unlike the following (this example uses the RPB+ power bar; the status screen of the IPS-400/IPS-800 has a different appearance but essentially the same functionality):

```
Location: Location Name
Default: 00000

Plug  Label                 Condition
 1    PLUG ONE              OFF
 2    PLUG TWO              OFF
 3    PLUG THREE            OFF
 4    PLUG FOUR             OFF
 5    PLUG FIVE             OFF

Command Summary:
/S  Status
/P  Enter Parameters
/D  Set plugs to default
/X  Exit

To Switch /n s   where n = plug #, * = All and s = ON/OFF/BOOT

RPB+>
```

If this screen is not printed even after you hit Enter several times, the ISOC computer is not communicating with the power bar correctly. One possible reason is incorrect DIP switch settings. Make sure that DIP switches 1 and 4 are in the Down position (consult the RPB+ manual for more information about these switches).

If the screen appears, try issuing a command such as

```
/1 ON
```

or

```
/1 OFF
```

to turn plug #1 on and off. (Note that your characters may not be echoed by the instrument; i.e., you'll have to type "in the blind"). If the power bar responds to these commands by turning the requested plug on or off and printing its status screen again, it is functioning correctly and it is properly connected to the ISOC computer.

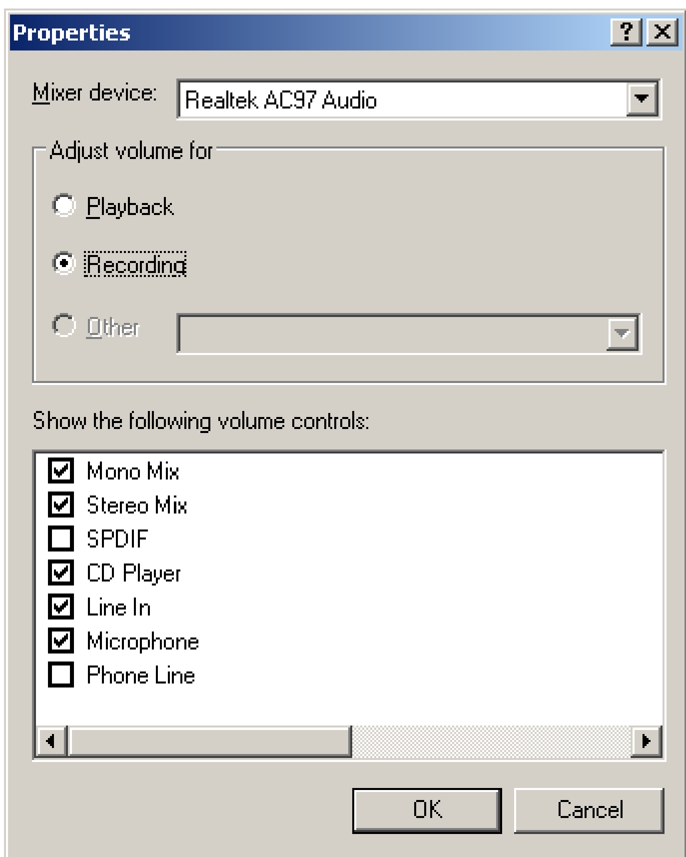
4.5.3. Audio troubleshooting

Audio hardware is used by both the ISOC server and client. The problems in the two situations can be very different in nature, so they are discussed separately below.

4.5.3.1. Server audio

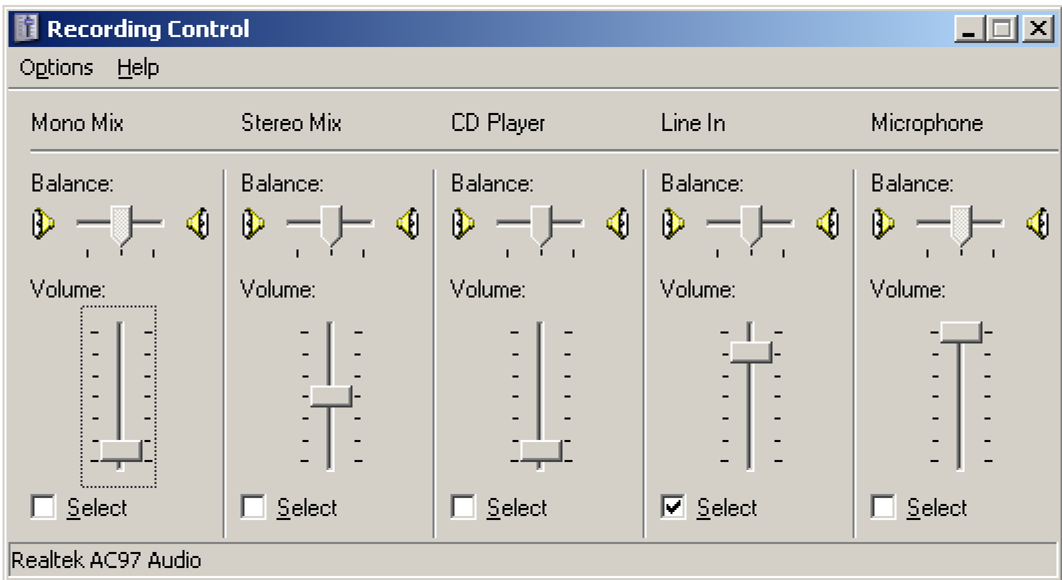
The ISOC server uses audio hardware to receive audio from external sources. The received audio is digitized and captured, either to be saved in a file on the server, or to be compressed and transmitted to remote ISOC clients.

The ISOC server views the stereo input of the audio card as a pair of independent monaural signals. On a server computer with a single sound card, all you need to ensure is that the sound card is properly configured for recording from the desired source. In most cases, this means selecting the Line In source of the sound card for recording and ensuring that a sufficient recording level is specified. This you can do using the Windows Volume Control window:



The Volume Control window can be invoked by double clicking the Volume icon in the Windows system tray (lower right area of the Taskbar)[10]. In the Volume Control window, select the **Properties** command from the Options menu; this should display the Properties dialog. In this dialog, select the **Recording** radio button and click **OK**.

This setting should change the Volume Control window to Recording Control:



Make sure that the desired recording source (typically, **Line In**) is **Select**ed, and that the volume slider is in the appropriate position. In the case of some sound cards, you may also see a Master slider for audio recording; that slider, too, may have to be in a position other than the bottom position in order for the recording to succeed.

The easiest way to test if the settings are correct is through the Windows Sound Recorder utility, which is a simple program that lets you record and play back audio. First, though, make sure that an audio source is actually connected to the Line In connector. This source can be anything (a radio, an MP3 player, etc.) just make sure that it actually produces a signal. You can listen to that signal by increasing the volume for the Line In connector in the Volume Control window (*not* the Recording Control window).

If the signal is present and audible, and you can record it using the Sound Recorder utility, the audio is connected and functioning properly.

---

[10] If the volume control is not in the system tray, try selecting the Sounds and Audio Devices icon from the Control Panel and click the Advanced… button under the Volume tab in the Sounds and Audio Properties dialog.

In some ISOC configurations, the server may be equipped with multiple sound cards, in order to support more than two monaural audio channels. In these configurations, it is especially important to configure *each* audio card properly. The configuration can get even more confusing if two or more audio cards are of the same type; Windows assigns names to these cards somewhat arbitrarily, and a small configuration change may change the order in which the cards are enumerated and named.

In single-computer installations, if you wish to listen to audio through the ISOC, you may wish to first disable audio playback from the Line In connector (or whichever connector an instrument is wired to), otherwise you will hear an "echo": the sound from the instrument passed through from the Line In connector, and the sound of the same instrument, recorded and digitized, transmitted from the ISOC server to the ISOC client, and then played back as digital audio a fraction of a second later. Of course it may be much simpler to just listen to the sound from the instrument directly (by enabling the Line In connector for playback) and not through the ISOC.

4.5.3.2. Client audio

On the client side, the ISOC uses waveform audio playback to play back audio received from a remote ISOC server. If you can hear normal Windows sounds (e.g., the system "bell", but *not* the beeper inside the computer case), waveform audio playback is working properly.

Current versions of Microsoft Windows can play back more than one sound simultaneously, but this was not always so. In order to remain compatible with older versions of Windows, the ISOC uses its own mixer technology. The program that performs the mixing is called `MULTISND.EXE` and it resides in the ISOC installation directory. If you suspect that this program is not functioning correctly, you can try to unregister and then re-register it from the command line by issuing the following two commands:

```
MultiSnd /unregserver
MultiSnd /regserver
```

Before you issue these commands, make sure that your current directory is the ISOC installation directory where `MULTISND.EXE` is installed.

4.5.4. Running server programs interactively

The ISOC server programs, `ISOCSVC.EXE` and `ISOCSCAN.EXE`, are designed to run as Windows Service applications. For debugging purposes, however, it is possible to run them interactively and monitor their activity. The advantage of this mode of operation is that you can instantaneously monitor server activity. That being said, it is not recommended to use the server programs in this mode of operation on a production server, as a) it is necessary to be logged on to the server at the console, and b) the server programs can be easily interrupted by accident, either by hitting Ctrl/C or by closing the command prompt windows in which the servers are running.

To run the ISOC server program interactively, first make sure they are not running already! They may be running as Windows service applications in the background. Such applications can be stopped through the Control Panel, or from the command line by issuing the following commands:

```
net stop "ISOC Service"
net stop "ISOC Scanner"
```

Together, these two commands halt the ISOC system.

With the service applications halted, you can start the two server programs from the command line. (Note that if you are only testing interactive operation and not the Task Manager, it is sufficient to just start the main ISOC Server program).

To start a server program by hand, open a command prompt and navigate to the ISOC installation directory (`C:\Program Files\Industry Canada\WinISOC`). You can now type the following command line:

```
ISOCSVC –debug
```

The ISOC server responds by printing its version number:

```
C:\Program Files\Industry Canada\WinISOC>isocsvc -debug
Debugging ISOC Service.
2006/06/26 11:05:59 Starting ISOC Service Application [2, 4, 0, 0]
```

You can now use the main ISOC for Windows program to connect to the local server (at address 127.0.0.1) and test the desired functionality. As you do so, the server will print many status messages that you can monitor.

The ISOC Background Scanner service can be tested in a similar fashion. Note that in order to test this service, the main ISOC service must already be running, so make sure you started it in another window! Now open a new command prompt window, once again navigate to the ISOC installation directory, and type

```
ISOCSCAN –debug
```

The ISOC Background Scanner prints a series of messages in response, indicating its version number, driver DLLs that it loads, and also a list of scheduled jobs and tasks that it locates in the Registry, which it then loads into operative memory, as in the following example:

```
Select Command Prompt - isocscan -debug
C:\Program Files\Industry Canada\WinISOC>isocscan -debug
Debugging ISOC Scanner.
2006/06/26 11:06:30 Starting ISOC Background Scanner Service Application [2, 4,
0, 0]
2006/06/26 11:06:30 Loading DLLs
2006/06/26 11:06:30 Starting ANTSCAN.DLL
2006/06/26 11:06:30 Starting DC4SCAN.DLL
2006/06/26 11:06:30 Starting ESMBSCAN.DLL
2006/06/26 11:06:30 Starting ESNSCAN.DLL
2006/06/26 11:06:30 Starting ICOMSCAN.DLL
2006/06/26 11:06:30 Starting IFRSCAN.DLL
2006/06/26 11:06:30 Starting SMHSCAN.DLL
2006/06/26 11:06:31 Starting SNDSCAN.DLL
2006/06/26 11:06:31 Starting SESCAN.DLL
2006/06/26 11:06:31 Starting ROTSCAN.DLL
2006/06/26 11:06:31 Starting TCKSCAN.DLL
2006/06/26 11:06:31 Starting DFSCAN.DLL
2006/06/26 11:06:31 Starting GPSSCAN.DLL
2006/06/26 11:06:31 mobileSite
2006/06/26 11:06:31 Starting OARSCAN.DLL
2006/06/26 11:06:31 Starting RSSCAN.DLL
2006/06/26 11:06:31 Adding audio device [0]: SND
2006/06/26 11:06:31 Adding new job: Occupancy [2006/03/30¦2006/04/05¦00000000000
00000000000000000000000000000000¦localhost]
2006/06/26 11:06:31 Adding new task: ESN [2¦ESN¦CBT.SST :20010,1.0,0.0,1.0¦CBT.E
SN:<none>::<none>:¦0¦ANT2¦1¦;PREA OFF;DET A;AT:M LOWN;RA 60;]
2006/06/26 11:06:31 Adding new task: SMH [4¦SMH¦:26500000;26500000;0 :00010,1.0,
0.0,1.0¦ ¦0¦0¦-2¦L -10.000000;AM:OFF;FM:I 10000.000000;AF 400.000000;]
2006/06/26 11:06:31 Adding new task: Antenna [4¦ANT¦ ¦ ¦0¦SMH¦-2¦;]
2006/06/26 11:06:31 Adding new job: Receiver Log [2006/03/30¦2006/04/05¦00000000
00000000000000000000000000000000000¦localhost]
2006/06/26 11:06:31 Adding new task: ICOM [4¦IC8500¦:88100000;107900000;200000 :
10010,1.0,0.0,1.0¦ICOM.LOG:<none>::<none>:¦0¦0¦1¦14010000;14039999;060501;]
2006/06/26 11:06:32 Adding new job: Rotator [2006/03/30¦2006/04/05¦0000000000000
000000000000000000000000000000¦localhost]
2006/06/26 11:06:32 Adding new task: R9000 [4¦IC9000¦:1000000000;1000000000;0 :0
0010,1.0,0.0,1.0¦ :<none>::<none>:¦0¦ANT1¦0¦14010000;14039999;060502;]
2006/06/26 11:06:32 Adding new task: ROT [4¦ROT¦ ¦ ¦0¦0¦-2¦900:1200]
2006/06/26 11:06:32 Adding new job: SE Test [2006/05/29¦0000/00/00¦0000000000000
000000000000000000000000000000¦localhost]
2006/06/26 11:06:32 Adding new task: Task1 [2¦SE¦:88100000;107900000;200000 :100
10,1.0,0.0,1.0¦SEOUT.ESN:<none>::<none>:¦0¦0¦2500¦-24,10000]
2006/06/26 11:06:32 Adding new job: Test job [2006/06/19¦2006/06/25¦000400000000
0000000000000000000000000000000¦localhost]
2006/06/26 11:06:32 Adding new task: Task1 [4¦ANT¦ ¦ ¦0¦0¦-2¦;]
2006/06/26 11:06:32 Adding new task: Task2 [1¦AUL¦ ¦.mp3:<none>::<none>:¦0¦0¦0¦0
:0]
2006/06/26 11:06:32 Adding new job: Tone Decoder [2006/03/30¦2006/04/05¦00000000
00000000000000000000000000000000000¦localhost]
2006/06/26 11:06:32 Adding new task: ESN [4¦ESN¦:160550000;160550000;0 :00010,1.
0,0.0,1.0¦ :<none>::<none>:¦0¦ANT2¦2¦ME:T 0.200000;ME:C L;PREA OFF;DET A;AT:M LO
WN;RA 60;DEM F;SPE 50,OFF;SPE:SQ 0.00;SPE 20,OFF;AT:A ON;]
2006/06/26 11:06:32 Adding new task: DC448 [4¦DC440¦ ¦DC448.LOG:<none>::<none>:¦
0¦ESNAUD¦-2¦;]
2006/06/26 11:06:32 Starting Scheduler thread...
```

To utilize the ISOC Scanner, use the Task Manager, as you connect to the ISOC Scanner with the Task Manager, you will see many more log messages being generated as the Task Manager queries the server and retrieves information.

4.5.5. Reading the server logs

If the ISOC is so configured, the two ISOC services (the ISOC Service and the ISOC Scanner) write log entries to log files. These are normally located in the ISOC data directory (configured through the ISOC Server Configuration Manager) and named `ISOCSVC.LOG` and `ISOCSCAN.LOG`, respectively. (Note that when these service programs are run as Windows services, some important events, such as serious errors, are also recorded in the Windows Event log, regardless of the settings in the ISCU).

Most lines printed by the ISOC Server and ISOC Scanner applications share a common format. The lines begin with the date and time, printed using the format `yyyy/mm/dd HH:MM:SS`.

Both servers print log lines containing the words, "`TCP command on …`". These log lines print commands that were received from an ISOC client. In contrast, other log lines may provide informational messages about the server's internal state or the state of the instruments that the server controls.

TCP commands that begin with the / character are commands internal to the ISOC; other commands are usually forwarded to instruments.

Many log lines reference "`socket` *`nnnnnnnn`*" where *`nnnnnnnn`* is an 8-digit hexadecimal number. Every time a channel of communication is opened by an ISOC client to a server program, it uses a "socket" as the communication interface. Each socket has a unique 8-digit identifier. It is this identifier that is printed in the logs. Matching identifiers allows you to identify which commands came from the same virtual instrument, for instance.

Take, for example, the following excerpt from the ISOC server log:

```
2006/06/26 13:09:38 Authenticating on socket 3B4
2006/06/26 13:09:39 TCP command on socket 00000500: /MD
2006/06/26 13:09:39 TCP command on socket 00000500: SY:S:B?
2006/06/26 13:09:39 Starting TCP thread 00AA35D0
2006/06/26 13:09:39 TCP command on socket 000003B4: /l
2006/06/26 13:09:39 TCP command on socket 000003B4: /p?
2006/06/26 13:09:40 TCP command on socket 00000500: *IDN?
```

In this example, a socket (`00000500`) is already open, when another request arrives and a new socket (`000003B4`) is opened. In subsequent lines, there is communication taking place via both sockets. However, the socket identifier can help you clearly identify which commands were received on which socket. (In this case, socket `000003B4` receives a `/l` and a `/p?` command, internal ISOC commands querying the list of instruments and their power state; these commands were sent by the ISOC Servers dialog in the main ISOC for Windows application. The commands `/MD`, `SY:S:B?` and `*IDN?`, in turn, are commands to query the switch matrix state, and informational commands sent to an ESN receiver; these commands were issued by an ESN receiver virtual instrument, which is the source of the `00000500` socket connection).

ISOC Site, Vancouver, B.C.

A. File formats

The ISOC system uses several file formats that are either human-readable or can be processed by other applications. These file formats are described below. File formats that are private to the ISOC (e.g., instrument state files, workspace files) are not documented here, as these formats are subject to change.

A.1. The `.ESN` file format

The `.ESN` file format is a binary file format used for storing scan results.

The current version of the ESN file format is version 3, which was implemented in January, 2009. The file begins with a variable-length header that contains the following fields:

Pos. (hex)	Bytes	Description
00000000	28	Description
0000001C	28	Monitor centre name
00000038	10	Start date (`YYYY/MM/DD`)
00000042	8	Start time (`HH:MM:SS`)
0000004A	10	End date (`YYYY/MM/DD`)
00000054	8	End time (`HH:MM:SS`)
0000005C	2	Number of frequency list files (2-byte binary integer)
0000005E	2	Number of frequencies (2-byte binary integer)
00000060	4	Address of start of data
00000064	4	Address of EOF (next write address)
00000068	2	Number of sessions in file (2-byte binary integer)
0000006A	4	Test frequency value (4-byte integer in units of 100 Hz)
0000006E	4	IF filter setting (4-byte binary integer in units of Hz)
00000072	2	Attenuation (2-byte binary integer in units of dB)
00000074	42	Reserved (not used by ISOC)
0000009E	50×8	Source file names (8 characters per file, max. 50 names)
0000022E	10	"`VERSION 03`"
00000238	6	"`ISOC  `"
0000023E	20	Antenna description
00000252	12	Antenna model
0000025E	20	Receiver description
00000272	12	Receiver model
0000027E	16	"`LOW NOISE     `" or "`LOW DISTORTION  `"

Pos. (hex)	Bytes	Description
0000028E	8	Detector
00000296	8	Test frequency (64-bit floating point)
0000029E	288	Reserved
000003BE	50×2	Number of frequencies per frequency list file (max. 50 files)
00000422	50×2	Reserved
00000486	n×8	Frequency list (64-bit floating point numbers; *n* is the number of frequencies used).

The ESN file header is followed by one or more session blocks. The start of the first session block is determined by the start address stored at position 60_{hex}. The length of a session block is `30+k` bytes, where k is the number of data points in the session (stored at position $1A_{hex}$).

Session data is organized as follows:

Pos. (hex)	Bytes	Description
00000000	10	Session start date (`YYYY/MM/DD`)
0000000A	8	Session start time (`HH:MM:SS`)
00000012	8	Session end time (`HH:MM:SS`)
0000001A	4	Number of data points in session (4-byte binary value)
0000001E	k	Level readings (1-byte signed binary value)

Sessions can be appended to an existing file; however, in order for the data in the file to remain consistent, the frequency set used must be the same for each session.

A.2. The `.LST` file format

The `.LST` file format is a human-readable (ASCII) file format used for storing frequency lists. These files contain one frequency per line, in human-readable ASCII format. The frequency is a numeric value (in units of MHz), with an optional decimal point and decimal part. Lines are terminated by carriage return or linefeed characters, or carriage-return/linefeed (CRLF) combinations.

A.3. The `.SST` file format

The `.SST` file format is a human-readable (ASCII) file format used for storing frequency lists. Unlike the `.LST` format, the `.SST` format also provides storage for additional parameters for each frequency, though these parameters are often ignored by the ISOC.

A `.SST` file contains a one-line header, followed by frequency lines. The header contains the following fixed-width fields:

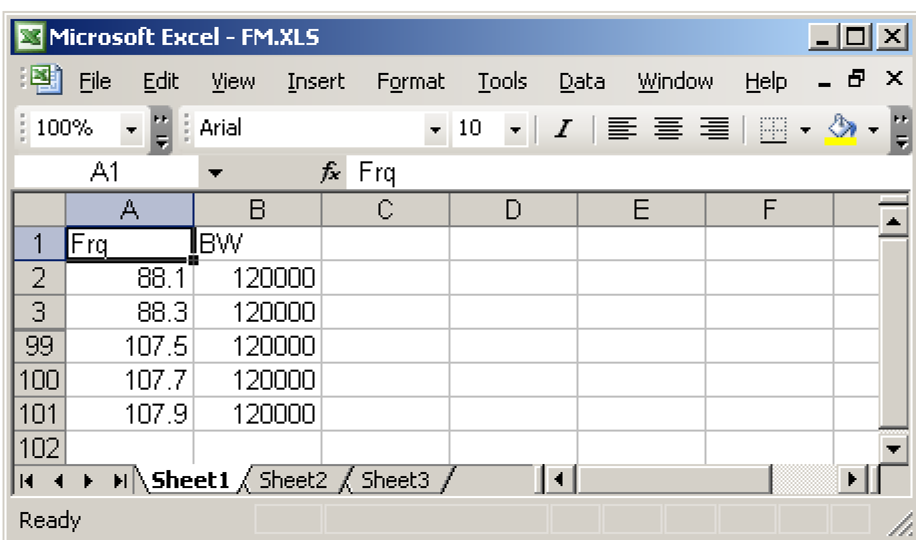
Position	Width	Description
1	8	Scan table name
9	2	Scan table ID
11	4	Creation year
15	2	Creation month
17	2	Creation day
19	24	Comment
43	28	Site name

Data lines in a `.SST` file consist of a one character type identifier followed by four columns of data. The type character can be blank, the letter T indicating a test frequency, or the letter E indicating the end of the file. Data columns include the frequency, band, filter, and antenna values.

The frequency value is in units of MHz. The band value is ignored by the ISOC. The filter value is a numeric selector used with ESN receivers; it can range from –1 through 4, selecting one of the six filters that the ESN receiver may have installed. The antenna value is again not used by the ISOC.

A.4. Microsoft Excel format frequency list files

For scheduled tasks, the ISOC can use Microsoft Excel format spreadsheet files as input. The only requirement for these files is that frequency data should be contained in the first worksheet, in two-column format. Column A shall contain frequency values, while column B shall contain bandwidth values, as in the following example:



A header row may be used. Other information present in the table is discarded, but it may interfere with the ISOC's ability to correctly read the file.

A.5. Log files

Several virtual instruments produce logs in human-readable (ASCII) format. The actual format of the log files differs depending on the instrument type.

A.5.1. Antenna rotator log files

The antenna rotator virtual instrument produces single-line log entries in its log file. When logging begins, a line is printed:

```
yyyy-mm-dd,HH:MM:SS.hh *** BEGIN Rotator data logging for centre:devid
```

where `yyyy-mm-dd` is the date, `HH:MM:SS.hh` is the time, `centre` is the monitoring centre name, and `devid` is the identifier of the rotator device.

Subsequently, each measurement is printed in the log file as follows:

```
yyyy-mm-dd,HH:MM:SS.hh aaa.a°: ee.e
```

where `aaa.a` is the azimuth (up to three digits prior to the decimal point, optionally signed, with one decimal digit) and `eee.e` is the elevation (up to two integer digits, one decimal digit, optionally signed).

A.5.2. DF log files

Log files generated by the ISOC DF program contain lines that begin with a two-character identifier indicating what information is present in that line. DF instrument settings are stored in lines that begin with the symbol `RS`:

```
RS, yyyymmdd, hhmmss.mmm, ffff.ffff
```

where `yyyymmdd` is the date, `hhmmss.mmm` is the time in millisecond resolution, `ffff.ffff` is the tuned frequency in Megahertz, with up to 4 decimal digits.

New bearing information is recorded using lines that begin with the symbol `BR`:

```
BR, site, n, ddmmmmN, dddmmmmW, bb.b, l.l unit, qqq,
```

where `site` is the site name, `n` is the site type, `ddmmmmN` is the latitude (degrees, minutes, hundredths of minutes), `dddmmmmW` is the longitude, `bb.b` is the bearing in degrees, `l.l` is the measured signal level, `unit` is the level unit (dBm or dBuV), and `qqq` is a signal quality value.

Fix information is recorded in lines that begin with the symbol FD:

```
FD, ddmmmmN, dddmmmmW, M.MM, m.mm, iii
```

where *ddmmmm*N is the latitude, *dddmmmm*W is the longitude, *M.MM* is the major axis of the fix ellipse, *m.mm* is the minor axis, and *iii* is the inclination in degrees.

A.5.3. Receiver log files

Receivers (the Rohde & Schwarz ESN, Rohde & Schwarz EB-200 and ESMB, and the ICOM R-8500/R-9000) now all use a common log file format known as a "Version 2.0" log file. This log file contains three distinct portions: a file header, a settings header, and readings.

The file header appears once per file and contains two lines of text:

```
"Version 2.0"
"Log File / Fichier journal","type",devid,yyyy-mm-dd,HH:MM:SS.hh\
"centre","dn","mobile",latitude,longitude
```

where the quotation marks are part of the file; the backslash at the end of a line is not, it merely indicates text that continues, only broken into separate lines here to fit the page. The symbol *type* represents the instrument type (ESN, ESMB, EB-200, R7100, R8500, or R9000). The symbol *devid* represents the device identifier; *yyyy-mm-dd* is the date; *HH*:*MM*:*SS.hh* is the time to hundredths of seconds; *centre* is the monitoring centre identifier; *dn* is the district number; *mobile* stands for the text Mobile or Fix/Fixe; and *latitude* and *longitude* are the GPS coordinates at the time of the measurement. Note that the latitude/longitude values are printed only for mobile sites, when a valid GPS reading is present.

The settings header appears every time the instrument's settings are changed and contains the following information (again, the backslash character is used to indicate continuation lines; these characters and the subsequent line breaks are not part of the actual log file):

```
yyyy-mm-dd,HH:MM:SS.hh,"New Instrument Settings Header / \
Nouvelle entête des réglages d'instrument"
"Input/Entrée                          : ","antenna-type"
"Demodulation/Démodulation             : ","demodulator"
"Range/Plage (dB)                      : ",range-value
"Meas. time/Temps de mesure (ms)       : ",measurement-time
"IF Bandwidth/Largeur FI (kHz)         : ",ifbw
"IF Level/Sortie FI                    : ","Fixed"
"Detector/Détecteur                    : ","detector"
"Mode/Mode                             : ","mode"
"Level Unit/Unité de mesure du niv : ","amplitude unit"
"Squelch/Silencieux                    : ","squelch value or OFF"
"Attenuation/Atténuation               : ","attenuation or AUTO"
```

```
"Generator/Générateur              : ","ON or OFF"
"Preamp/Préamp                     : ","ON or OFF"
```

Strings in italics are replaced with the appropriate values.

The settings header is followed by a header line for subsequent data lines, repeated in both English and French:

```
"yyyymmdd","hhmmss.ss","Latitude","Longitude","Level",\
"Attenuator","Tuned Frq(MHz)","Offset(kHz)","Deviation(kHz)",\
"Modul Depth (%)"
"aaaammjj","hhmmss.ss","Latitude","Longitude","Niveau",\
"Atténuateur","Fréq synt(MHz)","Écart(kHz)","Déviation(kHz)",\
"Taux de modul(%)"
```

Lastly, readings are presented in single lines of data using the following format:

```
yyyy-mm-dd,HH:MM:SS.hh,lat,long,lvl,att,freq,offset,dev,mod
```

where the date and time are followed by the GPS coordinates (*lat* and *long*), signal level (*lvl*), attenuation (*att*), measured frequency (*freq*), *offset*, and modulation (*mod*).

The format used by ICOM receivers is a slightly modified version of that presented here. The settings header omits the Range, Meas. Time, IF Level, Detector, Mode, Attenuation, Generator, and Preamp lines. A new line is added after the Input line:

```
"Connector/Connecteur              : ","band range"
```

The readings header also omits a few fields:

```
"yyyymmdd","hhmmss.ss","Latitude","Longitude","Level",\
"Attenuator","Tuned Frq(MHz)"
"aaaammjj","hhmmss.ss","Latitude","Longitude","Niveau",\
"Atténuateur","Fréq synt(MHz)"
```

Accordingly the readings do not contain values for offset and modulation.

A.5.4. IFR COM-120B log files

When used as a receiver, the IFR COM-120B can also generate logs. This virtual instrument still uses an old style log format that consists of a header followed by data lines. The header contains the following lines of information:

```
yyyy-mm-dd,HH:MM:SS.hh      New Header information for COM-120B
Frequency         : frequency-val       Input            : input
Demodulation      :   demodulator       Range            : N/A
```

```
Measurement Time  :     meas-time       Report Time       : rtime
IF Bandwidth      :  if-bandwidth       IF Level          : N/A
Level Detector    :           N/A       Mode              : N/A
Squelch           :    squelch          Attenuation       : att
Generator         :           N/A       Preamp            : N/A
```

Field values in italics are replaced with the appropriate values in the logs. Fields marked with N/A are not used by the IFR COM-120B virtual instrument.

This information is followed by a header line that indicates the format of subsequent data lines:

```
                          Frequency    Offset      Modulation      Level
```

Data lines contain readings in the following form:

```
yyyy-mm-dd,HH:MM:SS.hh  freq      offset      modulation      level
```

The date and time are followed by four fixed-width columns containing the frequency, offset, modulation, and signal level readings.

A.5.5. Tone decoder log files

Tone decoder log files contain single-line entries that may take the following forms:

```
yyyy-mm-dd,HH:MM:SS.hh DTMF: n
yyyy-mm-dd,HH:MM:SS.hh CTCSS ON
yyyy-mm-dd,HH:MM:SS.hh CTCSS: nnn.n Hz
yyyy-mm-dd,HH:MM:SS.hh CTCSS OFF
yyyy-mm-dd,HH:MM:SS.hh DCS ON
yyyy-mm-dd,HH:MM:SS.hh DCS: +nnn -nnn
yyyy-mm-dd,HH:MM:SS.hh DCS OFF
yyyy-mm-dd,HH:MM:SS.hh LTR: n nn nnn nn
```

where *yyyy-mm-dd* is the date, *HH:MM:SS.hh* is the time to hundredths of seconds, and *n* is a numeric digit (may also be one of the letters *A–D* or the symbols * or # for DTMF data). Note that the CTCSS ON/CTCSS OFF and DCS ON/DCS OFF messages are specific to the DX-4xx series of tone decoders; LTR is supported only by the FLEX Series Universal Controller.

B. Units of measurement

The ISOC suite accepts different units of measurement for various physical quantities. In some cases, the relationship between units of measurement is obvious; in other cases, less so.

For values of frequency, the ISOC accepts the following units:

Unit	Magnitude	Abbreviations
Hertz	1 Hz	Hz, c, h
kilohertz	1 kHz = 1,000 Hz	kHz, k, kc, kz
megahertz	1 MHz = 1,000,000 Hz	MHz, mc, mz
gigahertz	1 GHz = 1,000,000,000 Hz	GHz, gc, gz

The default unit of frequency (i.e., the unit that is implied when you supply no abbreviation) is context dependent; typically, in RF fields the default unit is MHz, in AF fields it is kHz.

Time values can be specified using the following units:

Unit	Magnitude	Abbreviations
second	1 s	s
millisecond	1 ms = 10^{-3} s	ms
microsecond	1 µs = 10^{-6} s	µs, µ, us
minute	1 m = 60 s	m
hour	1 h = 3600 s	h

Signal level (amplitude) units can be logarithmic and linear. The conversion between these units is less trivial, as it depends in some cases in the input impedance of the instrument being used.

Linear level units include volts and watts. To convert from one to the other, one must utilize the following formula:

$$P = U^2 / Z,$$

where P is the power expressed in watts, U is the voltage expressed in volts, and Z is the impedance expressed in ohms.

Logarithmic level units include dBm (decibel over milliwatt) dBmV (decibel over millivolt), and dBµV (decibel over microvolt). The conversion between linear and logarithmic units of power is as follows:

$$a \text{ dBm} = 10^{a/10} \text{ mW}.$$

The case of the other two logarithmic units is somewhat more confusing. Although they are logarithmic units referenced to a voltage level, they nevertheless express a quantity of power, and therefore the conversion functions are a little less obvious:

$$a \text{ dBmV} = 10^{a/20} \text{ mV},$$
$$a \text{ dB}\mu\text{V} = 10^{a/20}\ \mu\text{V}.$$

The conversion between units of dBmV and dBµV is easy:

$$a \text{ dBmV} = a + 60 \text{ dB}\mu\text{V}.$$

The conversion between units of dBm and dBmV once again depends on the input impedance, Z, of the device in use. The formula can be calculated as

$$a \text{ dBm} = 10 \log_{10} Z + 30 + a \text{ dBmV}.$$

In the case of most instruments, the input impedance is a fixed 50 ohms. In that case, the above formula reduces to

$$a \text{ dBm} = 46.9897 + a \text{ dBmV}.$$

Often the conversion factor is rounded to the nearest integer, resulting in the following commonly used conversion formulae:

$$a \text{ dBm} = 47 + a \text{ dBmV} = 107 + a \text{ dB}\mu\text{V}.$$

Additionally, the ISOC also accepts units of $\text{dB}\mu\text{V}_{emf}$ (electromotive force), defined as:

$$a \text{ dB}\mu\text{V}_{emf} = a - 6 \text{ dB}\mu\text{V}.$$

To summarize, the ISOC accepts the following level units:

Unit	Magnitude	Abbreviations
volt	1 V	V
millivolt	$1 \text{ mV} = 10^{-3} \text{ V}$	mV
microvolt	$1 \mu\text{V} = 10^{-6} \text{ V}$	µV
watt	$a \text{ W} = (aZ)^{1/2} \text{ V}$	W
milliwatt	$1 \text{ mW} = 10^{-3} \text{ W}$	mW
microwatt	$1 \mu\text{W} = 10^{-6} \text{ W}$	µW, uW
nanowatt	$1 \text{ nW} = 10^{-9} \text{ W}$	nW
decibel over mW	$a \text{ dBm} = 10^{a/10} \text{ mW}$	dBm
decibel over mV	$a \text{ dBmV} = a - 10 \log_{10} Z - 30 \text{ dBm}$	dBmV
decibel over µV	$a \text{ dB}\mu\text{V} = a - 60 \text{ dBmV}$	dBµV, dBuV
$\text{dB}\mu\text{V}_{emf}$	$a \text{ dB}\mu\text{V}_{emf} = a - 6 \text{ dB}\mu\text{V}$	dBµVemf, dBuVemf, dBµV(emf), dBuV(emf)

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Glossary

AGC	Automatic gain control.
AF	Audio frequency (~20 Hz – 20 kHz).
AFC	Automatic frequency control.
Client	A computer, such as a workstation, that accesses one or more *servers* in order to obtain a service.
bps	Bits per second.
CI-V	Communications Interface number five: an ICOM proprietary data communication standard.
CTCSS	Continuous Tone Coded Squelch System is a sub audible tone in the frequency range 67-254 Hz. It can signal the presence of a desired signal or encode simple commands; the low-frequency tone can be easily separate from voice transmissions by a high-pass filter. For more information, see http://www.directcon.net/pacres/ctcss.htm.
DCS	Digitally Coded Squelch is a digital code transmitted as low-frequency voice audio. It is a 134.4 bps signal with audio frequencies typically not exceeding 300 Hz, and thus easily separable from typical voice frequencies. See http://www.directcon.net/pacres/dcs.htm.
DF	Direction Finding.
DHCP	Dynamic Host Configuration Protocol. Member of the family of internet protocols, DHCP allows a computer to dynamically obtain an IP address from a DHCP server, drastically simplifying the task of configuring a network.
DTMF	Dual-tone multi-frequency: the number encoding used by the "touch tone" dialling system. A combination of two audio frequencies, selected from two sets of four frequencies, encodes a maximum of 16 symbols: the digits 0-9, the letters A-D, and the special symbols * and #.
EMF	Electromotive force.
GPIB	General Purpose Interface Bus: an old standard for a high-speed parallel data interface typically used to control test instruments. A GPIB connection can typically control up to 31 devices, though sometimes, it is necessary for a device to be connected via a dedicated GPIB connection.

IF Intermediate frequency (of a superheterodyne receiver).

Internet Protocol The basic network protocol that allows multiple computer networks to be connected together in a “network of networks”, or internet; one example is the global Internet.

IP See *Internet Protocol*.

ISP Internet Service Provider or Independent Service Provider: a company that provides access (dial-up or otherwise) to the global Internet for customers.

Job A collection of *tasks* that are executed together automatically at a scheduled time.

LTR Logic Trunked Repeater. An audio frequency scheme to encode information in the form of a sub-audible signal.

MDI Multiple Document Interface; a standard presentation of windows and commands for applications that can open multiple documents simultaneously.

MSI Microsoft System Installer, the preferred installation technology on current versions of the Windows operating system.

LAN Local Area Network. The meaning of the term is somewhat imprecise, but it typically means a network where all computers "see" each other as neighbours and no routing protocol is required to deliver data across different network segments.

OBW Occupied Bandwidth.

Protocol A set of standards and conventions that different computers can use, for instance, as a common standard for communication. The Internet uses a series of such protocols as standards for various types of connections.

PTP Probable Transmitter Position.

Registry A Windows facility that allows applications to efficiently store and retrieve configuration information without scattering files all over the file system. The Registry can be edited using the Windows Registry Editor (*Start* menu, **Run** command, and enter `regedit` as the command name to run). The Registry is organized into a hierarchy of keys, each of which can contain several numeric, binary, or text values. Settings specific to an application are typically stored under the Registry key `HKEY_LOCAL_MACHINE\Software\vendor\application`; settings that belong to a specific user of that application

would be found under
`HKEY_CURRENT_USER\Software\vendor\application`.

RF Radio frequency.

RMS Root mean square. Defined as the square root of the arithmetic mean of the square of sample values: i.e., $x_{\text{rms}} = (\Sigma x_i^2 / N)^{1/2}$.

RS-232 "Recommended Standard" 232 by the Electronic Industries Alliance (EIA). The data communication standard for serial communications.

SCMO Subsidiary Communications Multiplex Operations (also known as SCA—Subsidiary Communications Authority in the USA) is a technique to provide an additional audio signal on an FM or TV broadcast frequency.

Server A computer whose main role is to provide services that *clients* can use. Services that server provide are often shared; for instance, a server may provide access to shared disk storage, a shared printer, or, in the case of the ISOC, a shared set of radio frequency instruments.

Squelch A circuit function to suppress audio output or recording when either the audio level (*VOX* squelch) or the received *RF* signal level (RF squelch) is below a predefined threshold.

Task In the ISOC, a session that executes on schedule automatically, controlling an instrument and performing a measurement or taking a recording. Tasks are organized into *jobs*.

TCP Transmission Control Protocol. A network protocol used on *IP* networks. It is a “connection-oriented” protocol, meaning that when TCP is used, a client establishes a connection to a server, they both use that connection to exchange data, and when the session ends, the connection is terminated. While the connection is established, the network guarantees delivery of each packet of data in the correct order. This is not unlike a telephone call in everyday life. Compare with *UDP*.

TMRS Technical Measurement and Reporting System. TMRS is the national repository database for monitoring data. It offers a user-friendly Web interface (*TMRS Web application*) which provides history reports. Another application is *TMRS Preview* that can be used to analyze and graphically present data in `.ESN` files, and present statistical occupancy results.

UDP Universal Datagram Protocol. A connectionless protocol used on *IP* networks. Since there is no connection, each UDP packet (datagram) is addressed and sent individually. The network does not guarantee delivery of packets, and packets may arrive out of order. This is not unlike a old-style telegram in everyday life. Compare with *TCP*. The ISOC uses UDP for high-bandwidth transmissions when the occasional lost packet does not cause a problem: this includes the graphical traces in *virtual instruments* such as spectrum analysers, and also digital audio.

Virtual Instrument In the ISOC, the software representation of a remote instrument on an operator’s computer workstation.

VOX Voice Operated switch (also, voice *squelch*), that opens or closes based on the measured audio signal level.

VPN Virtual Private Networking: a "tunnelling" protocol that allows two distant computers to communicate with each other across a wide area network, such as the global Internet, as if they were situated together on a local area network. VPN connections are often protected by encryption.

WAN Wide Area Network. A WAN typically consists of more than one distinct network segments (e.g., *LAN*s) and a routing protocol is used to deliver data packets across different network segments to their final destination.