W51 Manual V6.6

WAVECOM Decoder

by WAVECOM ELEKTRONIK AG

PUBLISHED BY

WAVECOM ELEKTRONIK AG

Hammerstrasse 8

CH-8180 Buelach

Switzerland

Phone	+41-44-872 70 60
Fax	+41-44-872 70 66
Email:	info@wavecom.ch
Internet:	http://www.wavecom.ch

Printed: Wednesday, January 30, 2008, 15:27:39

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Welcome

Congratulations on purchase of a WAVECOM decoder. The product that you bought incorporates the latest technology in data decoding together with the latest software release available at the time of shipment.

Please, check our website http://www.wavecom.ch for software updates.

Always check the latest documentation on the installation CD or on our website.

We thank you for choosing a WAVECOM decoder and look forward to work with you in the future.

This chapter introduces WAVECOM, the field of activity of the company, and how you may benefit from the expertise of WAVECOM.

GENERAL INFO ABOUT WAVECOM PRODUCTS

WAVECOM ELEKTRONIK AG develops and sells products for HF/VHF/VHF/SHF (Satellite) data monitoring.

The WAVECOM products consist of hardware (for example W61PC, W61LAN) and appropriate software. If the customer orders a W61PC or W61LAN, then he automatically receives the actual software that is necessary to operate the unit. This software is an integral part of the W61PC or W61LAN and does not have to be ordered additionally.

This operation software differs between standard/consumer and professional software. The professional software contains additional functions and codes, which are **NOT** integrated in the standard / consumer software.

The list of codes and functions can be found on our web http://www.wavecom.ch/HTML/specs.htm. The specifications comply with the up-to-date software. The differences of the professional to the standard / consumer software are marked in the specifications.

The professional software version is available to authority / government customer only. If an order is placed from an authority / government customer we do need a signed End User Certificate (EUC).

Options

An authority / government customer has the possibility to order further software options additional to the professional software they receive when buying a W61PC or W61LAN. At present the following options are available:

1. W61SAT (INMARSAT)
2. W61BV (BitView)
3. W61CL (Classifier)
4. W61PACTOR3
5. W61CLOVER2

6. W61CLOVER2000

Options 1, 2 and 3 relate to the serial number of the hardware (W61PC, W61LAN). If a customer orders one or several of these options, the activation of the functions is done with a corresponding activation key that is enclosed with the software delivered. The activation key to activate the option/s relates to the serial number of the hardware. This means that any option works only with the hardware for which serial number the key was generated. The key is non-negotiable to other hardware (serial number)!

Options 4, 5 and 6 do NOT relate to the serial number of the hardware (W61PC, W61LAN). The delivery occurs on a USB dongle with a key file for activation.

Prerequisite:

The W61PC/LAN hardware must have the actual software version 6.4.00 or later! Older software versions can be updated (see price list on www.wavecom.ch).

In the manual, options are marked with (Option).

All options are available to authority / government customer only.

Professional Version

Please, register your software if you are a professional customer, i.e. a government agency, otherwise we are unable to deliver the professional version of the software to you and inform you about updates.

In the manual, items only available in the professional software are marked with "Requires Professional Version".

Professional versions are only available to government bodies. WAVECOM maintains a mailing list of our professional customers. For registration details, see "Registration Form on page 289".

Training

WAVECOM offers to all our customers a complete, professional training program covering all the key features of our products. Depending on your skills (if you are an expert or a beginner), together we will work out a special training program for you.

General information in radio data transmission, frequency monitoring and associated topics like basic signal processing and recording methods can also be included in a course.

To safe time, some signals for the training will be played back from hard disk. But also live signals are used for decoding.

Training is available on your location or in Switzerland.

Source Code

Source code is available for professional users. Please, inquire to receive an offer from WAVECOM, if you plan to add your own modes.

Company Profile

WAVECOM ELEKTRONIK GmbH was founded in 1985 in Hohentengen, Germany, close to the Swiss border. In 1991 the company moved to Switzerland and established itself as WAVECOM ELEKTRONIK AG. Now located in Buelach it is within close vicinity of Zurich airport.

The company has focused on decoding and analysis systems for wireless data transmissions. The wide product range spans from professional, high performance systems to devices for private and amateur radio use.

The very high quality standards combined with high system performance are appreciated by all customers worldwide. A global network of authorized sales partners ensures that local assistance and basic level support can be provided in most places. More than 95% of all units sold are exported. The majority of the customers are government agencies, defense organizations and the telecommunication industry.

About 40% of the turnover is invested in research and development. The employees at WAVECOM ELEKTRONIK AG are mainly engineers with experience in DSP technology, computer and RF hardware development, software engineering and radio data transmission. Access to external know-how and human resources enlarges the capabilities for realizing projects. Manufacturing is outsourced to specialized companies within Switzerland which can handle today's needs for processing surface mount components and fine-pitch structures.

WAVECOM ELEKTRONIK AG does not have any juridical or financial links or connections to other companies or official bodies and is completely owned by Mr. Christian Kesselring.

Revisions

Version	Date	Changes
Beta	20.Dec. 2005	Initial draft
6.3	15.Jan.2006	CMH Files, Index, Installation
6.4	15.July 2006	HF PSK CODE CHECK HF MFSK CODE CHECK PSK-AM HF CLASSIFIER CODE CHECK MIL-188-110-16Tone CIS-12 PACTOR-III CLOVER-2 CLOVER-2000 CODAN-9001 Tuning FFT Installation for PACOR-III/CODAN/CLOVER Modes
6.4	25.Aug.2006	W51PC added
6.4.01	4.Oct.2006	W61LAN added
6.4.02	4.Oct.2006	ServerControl
6.5.00	27.Apr.2007	Transmission modes, new release New Modes:

		PACTOR-FEC CV-786 MD-674 MIl-M-55529a MOBITEX-1200 VISEL STANAG-5066 Inputs added (Streaming and user Inputs) Pass band tuning added
6.6.00	23.Jan .2008	ATIS changed CHU DZVEI MIL-188-110-39Tone, 110A or 110B MOBITEX-1200 MODAT NWR-SAME PCCIR PDZVEI PZVEI SAT-AERO (Aero-I) ZVEI-3 Stanag-5065-FSK New chapter WAVECOM Data File format

Install and Uninstall

W51PC Setup

The powerful W51PC hardware utilizes two digital signal processors (DSP) and a fast 16-Bit A/D converter. Five signal inputs are available: AF-IN, IF-IN-VAR, IF-IN-10.7 MHz, IF-IN-21.4 MHz and EXT-DEM-IN. An extremely stable direct digital synthesizer (DDS) translates all input signals to base band. The DSPs demodulate the incoming data, while the PC CPU provides the decoding and display of the data.

One PC can accommodate a maximum of eight W51PC cards. WAVECOM recommends that the number of cards installed in a standard PC does not exceed four.

Plug-and-Play (PnP) automatic installation is supported.

W51PC Hardware Installation

W51PC Card Installation

Before unpacking the W51PC card or installing it in your PC ensure that your body is grounded to avoid damaging static sensitive components on the card or in the computer. You can reduce static electricity on your body by touching the metal chassis of your computer or using a standard ground wrist strap.

Power off your computer, unplug it from its power source and disconnect all peripherals. Then carefully remove the cover of the computer, and locate a free PCI slot. Carefully insert the card into the connector and check that it is fully inserted. Replace the computer cover, and power on the machine.

Connecting to a W51PC Card

The W51PC card has four BNC signal inputs and a Mini-DIN input-output connector:

Input / Output	Frequency Range	Input Voltage Range
AF-IN	0 - 16 kHz	1.0 mVrms – 2.5 Vrms
IF-IN-VAR	14 - 1500 kHz	1.0 mVrms – 0.2 Vrms (jumper for attenuation not installed) 10.0 mVrms – 2.0 Vrms (jumper for attenuation installed)
IF-IN-10.7	10.7 MHz ± 15 kHz	1.0 mVrms – 0.2 Vrms (jumper for attenuation not installed) 10.0 mVrms – 2.0 Vrms (jumper for attenuation installed)
IF-IN-21.4	21.4 MHz ± 15 kHz	1.0 mVrms – 0.2 Vrms (jumper for attenuation not installed) 10.0 mVrms – 2.0 Vrms (jumper for

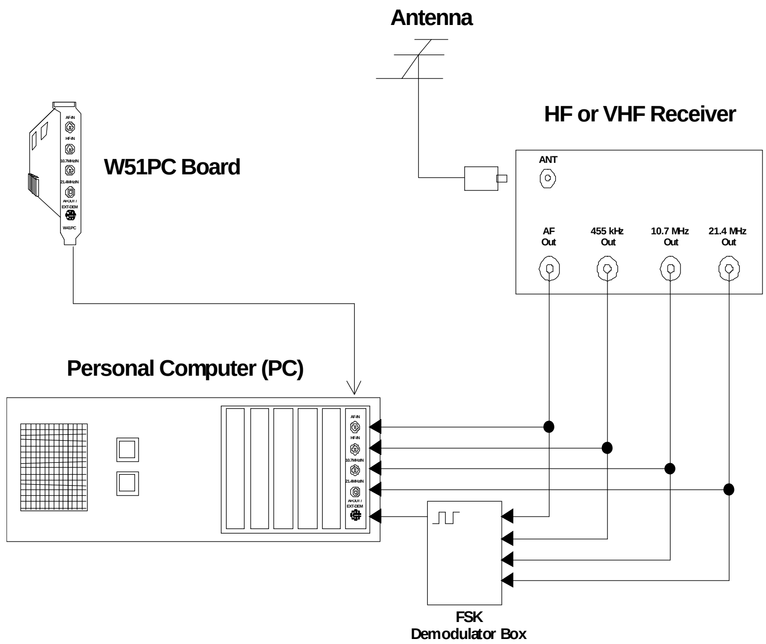
		attenuation installed)
EXT-DEM-IN	External demodulator	[0 V, +5 V] – [-12 V, +12 V]
AF-OUT		stereo D/A converter

One or more of these inputs must be connected to the signal source(s) by a coaxial cable or a similar shielded cable. As an example a HF receiver may be connected to the AF IN connector and a VHF-UHF scanner to the IF-IN-10.7 connector.

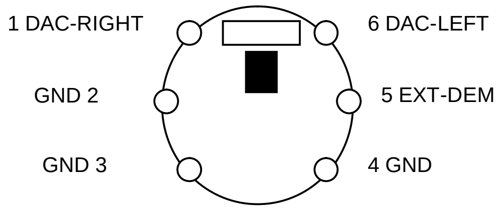
To avoid distortion of the input signal the input voltage ranges listed above should be observed.

20 dB attenuation jumpers are located close to the corresponding input connectors.

Below is an example of how to connect to a W51PC card:



Mini-DIN Connector (EXT-DEM-IN/AF OUT)



W51PC Power Supply Ratings

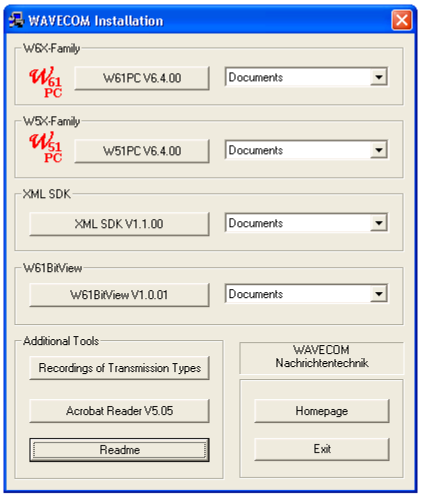
The power supply ratings (from PC) for a W51PC card are:

- +5 V/1.2 A
- +12 V/0.2 A
- -12V/0.005 A

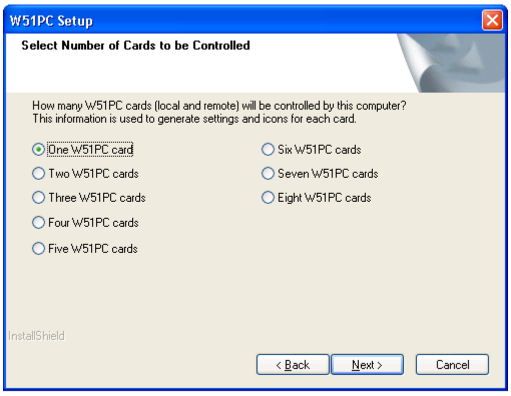
W51PC Software Installation

Windows’ hardware wizard can be used to install the software. Insert the WAVECOM installation CD in the CD drive. When requested, point the wizard to the CD drive and start installation.

If a software update is about to be undertaken, the old version must be uninstalled (see “W51PC Software Un-installation on page 11”). After un-installation has completed, insert the WAVECOM installation CD in the CD drive. The installation program will start automatically. Otherwise it can be started with **WINDOWS Explorer** by double-clicking **Installation.exe**. Now the welcome dialogue of the installation program is displayed:

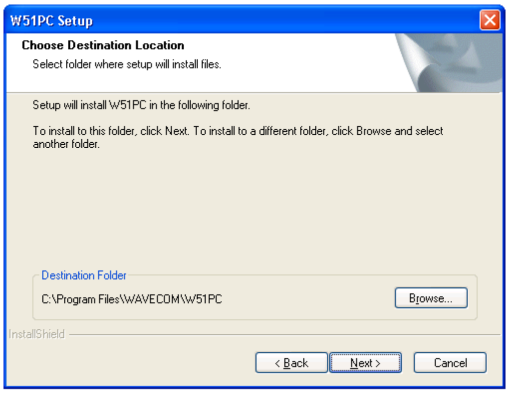


Clicking the **W51PC** button will start the installation of the W51PC application.



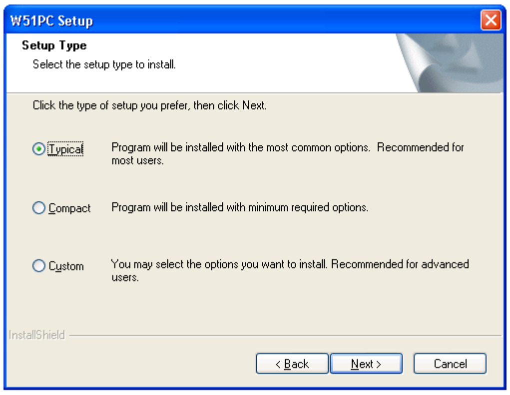
Select the number of W51PC cards you have in this computer.

Clicking on **Next** continues the installation.



The W51PC default software directory is **\Program Files\WAVECOM\W51PC**, but if required the directory may be changed.

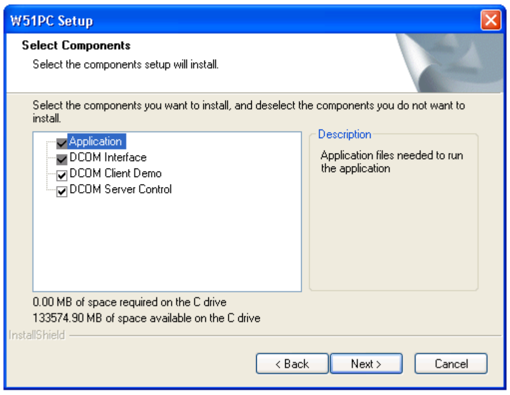
Click on the **Next** button to select the **Setup Type**.



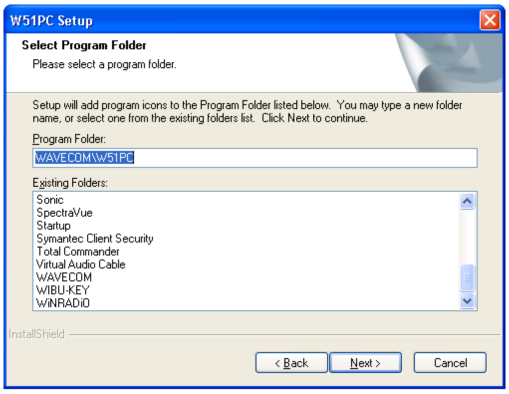
Three different types of setup are available:

- Typical
- Compact
- Custom

If you plan to use third party remote control software, select **Custom.** On the next screen enable **DCOM Interface** and **DCOM Server Control**.



After clicking **Next,** the dialog box asks for the program folder name where the software should be installed. The default is WAVECOM\W51PC.



A click on the **Next** button will start the copying of the files.

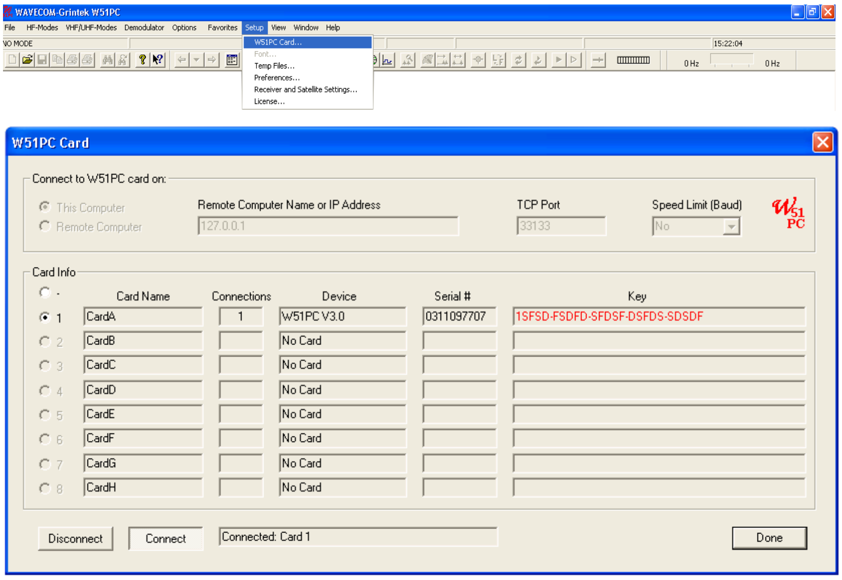
When the installation is completed, the computer will be rebooted.

After the reboot, you may start the software even without the hardware being installed. Click on **W51PC** to make a test start. However, a start of a transmission mode is not possible without decoder hardware.

First Time Start, Card Installed

The software must be informed of the **location** of the W51PC card.

Clicking on **W51PC Card** in the **Setup** menu will display the dialog box shown below.



Configuring the connection parameters requires that you press **Disconnect,** if you are connected.

The following setup parameters are available:

- **This Computer** or **Remote Computer.** If you work with your local computer, the local IP address will be used. If you connect to a remote computer, **Remote Computer Name or IP Address**, **TCP Port** and **Speed Limit** must be set (see below).
- **Remote Computer Name or IP Address**
  - **TCP Port**. Enter the port your server is listening on. The default value for the WAVECOM server is 33133. Clients can only connect to the server if they are using the same port.
  - **Speed Limit**. Select one of the available speeds (range 9600 bps - 10 Mbps). The screen and the tuning display refresh rate are determined by the speed of the connection.

Each W51PC card is identified by a unique **serial number**. Thus the W51PC software is able to automatically search for W51PC cards. This functionality is available for both local and remote computers. Pressing the **Connect** button will start the process. The **Key** field indicates that optional functions for this card are licensed.

The selected entry is stored in the card's initialization file (*.INI file) and no further entry is necessary when the W51PC software is reloaded at a later time. The settings may be changed at any time.

The W51PC system can be used in a network configuration.

W51PC TCP Remote Control

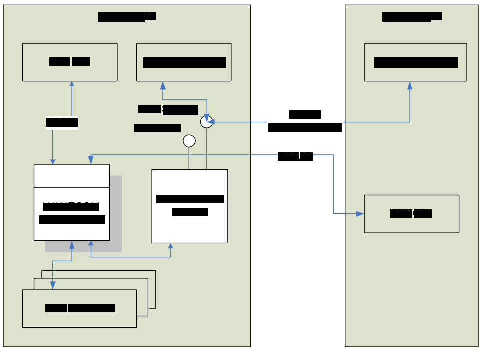
The W51PC uses Microsoft TCP to communicate between the W51PC card (W51PC server) and the user interface (W51PC client).

This structure allows a number of W51PC cards to be remotely controlled from a single PC. Selecting a W51PC card for remote control is simply done using the **Setup** menu.

When not using remote control, the operating details remain unchanged

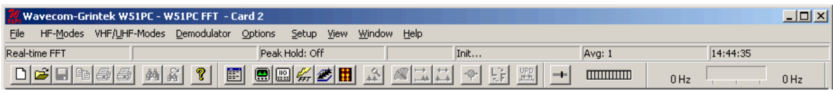
W51PC DCOM Remote Control

The W51PC uses Microsoft DCOM to communicate between the W51PC card (W51PC server) and third party applications.



W51PC Starting a mode

After the W51PC software has been started, software for the two W51PC on-board processors is downloaded. The download duration is approximately one second and the progress of the operation is displayed as **Init....**



Installation is now completed and the W51PC is ready for use. From the **HF-Modes** or **VHF/UHF-Modes** menus a mode may be selected.

W51PC Command Line Parameters

You can pass information to the application by adding command line parameters.

The following commands are valid:

/i <ini file name>

The name of the INI file located in the same directory as the W51PC application. Additionally a path may be entered.

/n <card number>

The number of the card to be connected (a value between 1 and 8).

/c <computer>

The name of the computer to be used for the connection

- **local** (case insensitive) or **127.0.0.1** means that you work with cards on the same computer.
- Computer name or the IP address plus the port number to connect to another computer. The port number must be en-

tered on the WAVECOM Server Control screen. If a port number is not provided, then default port 33133 is used.

Examples:

- W51.EXE /i config1.ini
- W51.EXE /i "\configuration\setupAB.ini"
- W51.EXE /n 2 /c W51Server:5800
- W51.EXE /n 1 /c 192.168.1.12:8080
- W51.EXE /n 3 /c 192.168.2.5

W51PC Software Un-installation

In certain situations e.g. a software update, it is necessary to un-install the software. Use the following commands:

- Click on **Start,** go to the **Settings** menu and open **Control Panel**
- Select the icon **Add/Remove Programs**
- Select **Install/Uninstall**
- Choose **W51PC** from the displayed list
- Click **Add/Remove**

The application has now been removed from the PC - it is however possible, that the icons may have to be manually removed.

How to Configure DCOM

Before you can run a COM application, you must ensure that DCOM is properly configured. Failure to do so typically results in one of the following errors:

- AutomationException: 0x80070005 - General access denied error
- AutomationException: 0x5 - access is denied
- Run-time error '70': Permission denied

Before you can access a COM component via DCOM, you must provide the authentication credentials of a user who has been granted permission to access/launch the component.

Please check our Application Note: “DCOM Security Settings” as and study the newest papers from Microsoft.

DCOM Configuration for Third Party Firewalls

Note: A paper regarding the setup of DCOM is available at: http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dndcom/html/msdn_dcomfirewall.asp

DCOM's dynamic port allocation feature offers great flexibility in that programmers and administrators alike are free from the burden of having to configure (or hard code) applications to specific ports, free from resolving conflicts between multiple applications attempting to use the same port(s), and so on. Unfortunately, because DCOM (by default) is free to use any port between 1024 and 65535 when it dynamically selects a port for an application, it is rather "firewall unfriendly" out of the box. Configuring your firewall to leave such a wide range of ports open would present a serious security hole. Microsoft's developers realized this and have implemented a feature that allows you to restrict the range of ports that DCOM will use to assign to applications.

How to Configure a Firewall

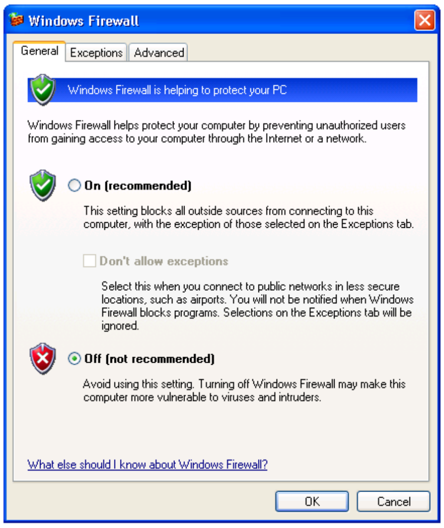
Windows Firewall Configuration

You can either completely disable the Windows firewall or configure the firewall to allow communication with the WAVECOM Server Control.

Disable the Firewall

To disable the Windows firewall completely, do the following:

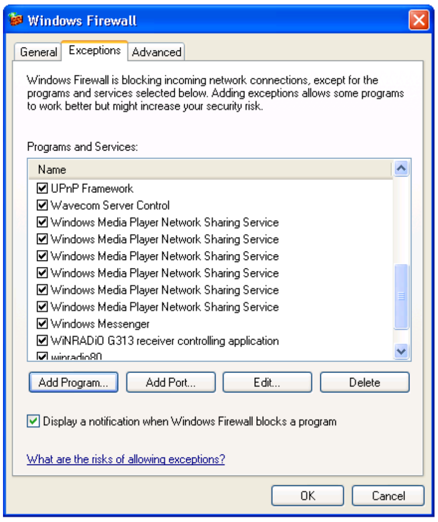
- Open the **Windows Firewall** configuration tool from the **Control Panel**
- Select the **Off** option and press the **OK** button



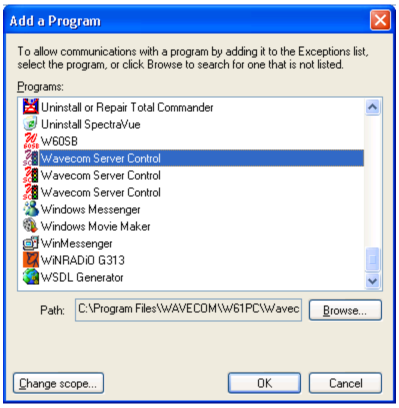
Allow Program or Service

To configure the Windows Firewall to allow communication with the WAVECOM Server, do the following:

- Open the **Windows Firewall** configuration tool from the **Control Panel**
- Select the **Exceptions** tab



- Press the **Add Program** button
- Press the **Browse** button
- Browse to select the **WavecomServer.exe** file (default location is the **C:\Program Files\WAVECOMW61PC folder**) and press the **Open** button

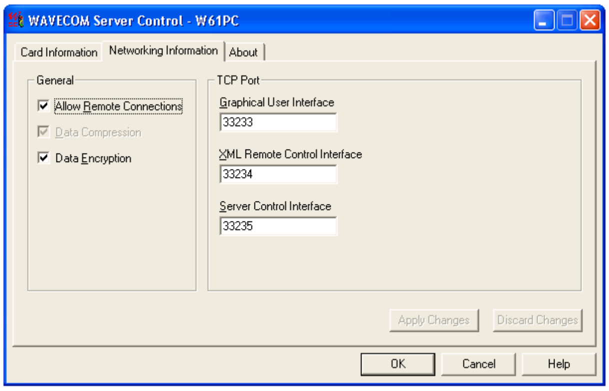


- Press the **OK** button to add **WAVECOM Server Control** to the list of exceptions

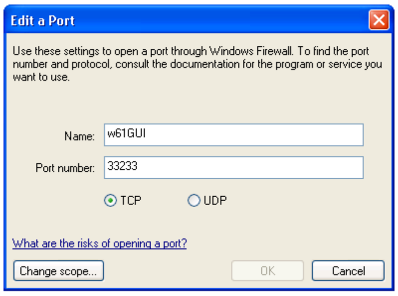
Add Ports

To configure the Windows Firewall to allow communication through some ports to the WAVECOM Server Control, do the following

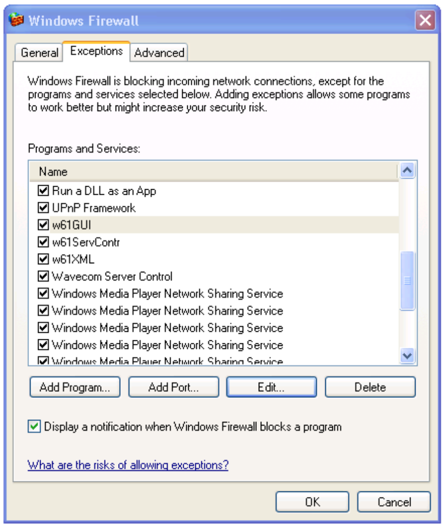
- Check which ports you use with your W61PC card (Start WAVECOM Server Control)



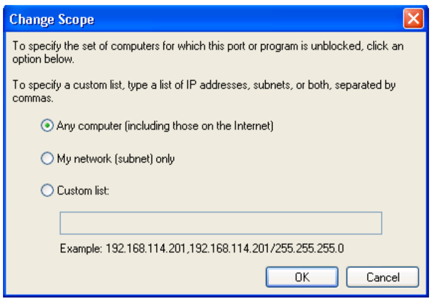
- Press the **Add a Port** button
- Enter a name (for example W61GUI) and the port number 33233 and press the **OK** button to add port 33233 to the list of exceptions. Do the same for the ports 33235 and 33235



- Press the **OK** button to save the Windows firewall settings



- If required change the scope



Optional Modules

Licensing

Different software versions and additional options are available from WAVECOM.

In the manual, options are marked with "Option".

Options are only available in the professional version of the software which is only delivered to government bodies.

The functionalities are not identical in the normal and the professional versions of the application.

Software Upgrades

To use the modes available in the professional version, a software support contract is required. This service is only available to government bodies. An initial 12 months software update contract is included in the price of the device.

A software or hardware key is required to activate the upgrades, and to get the key, you have to register at WAVECOM via fax or the internet (see “Registration Form on page 289”).

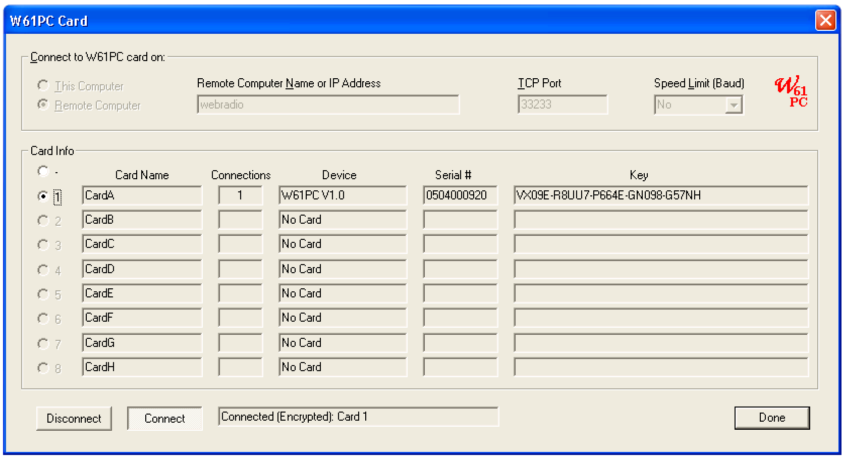
If the device was ordered directly from WAVECOM, the key is automatically provided to government bodies.

Software Options

Additional functions e.g.

- Classifier
- Satellite Modes
- BitView
- PACTOR-III, CLOVER-2, CLOVER-2000 (licensed with an additional USB-Key)

may be enabled and licensed to work with your decoder.



Follow this procedure to order options:

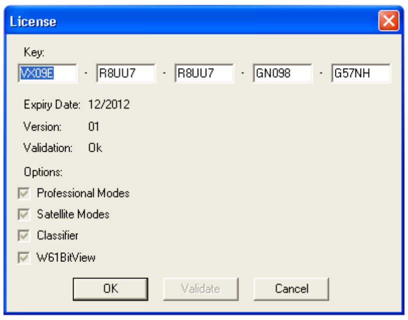
- **Serial number of the card or device**. You have to provide the serial number of your card or device and the desired options. The W61PC card is labeled with the serial number. The serial number can also be obtained from the **Setup/ W61PC** card screen
- WAVECOM will process your order and forward an invoice
- After the payment has been received, a new key will be forwarded to the customer

Enter or Change a Key (SAT, CL, BV)

Enter a Key Using the User Interface

A key will only work with a single W61PC card having exactly the same serial number that was provided during registration or forwarded with the order.

Enter the key in the fields and press the **Apply** button. If the key is validated the enabled options and the expiry date will be visible.

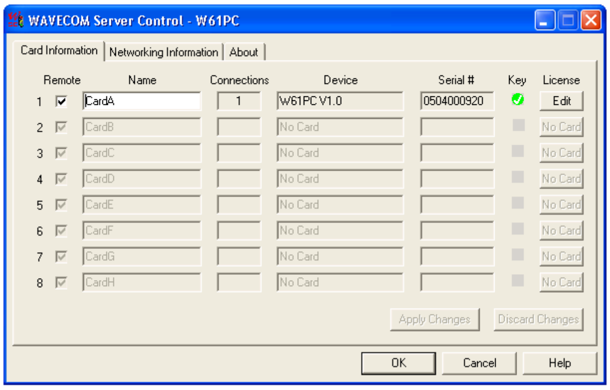


Note: A software version released before the expiry date will still work.

Enter a Key Using the WAVECOM Server Control

Open WAVECOM Server Control from Windows desktop **Start/Programs/Wavecom/W61PC/Wavecom server Control**, and select the **Card Information** tab.

Press the **Edit** button to add or modify a key:



Enter or Change a License File (PACTOR-III, CLOVER-2000, CLOVER-2)

As an option to the professional version of the WAVECOM decoder (W61 or W51 with Software version>6.4.00) the following modes can be purchased:

- PACTOR-III;
- Clover-2;
- Clover-2000
- ...

In order to run the purchased optional modes, a license is required for each mode. The license for a certain optional mode consists of two parts:

- A FLEXid USB dongle with a specific dongle ID and a specific FLEXid number.
- Mode-specific entries in the plain-text license file named “medav.lic”. Such an entry specifies a unique key string as well as the FLEXid (identified through its specific number) with which the mode is associated.

Hence, to enable an optional mode on the personal computer (PC) where the WxxPC hardware decoder resides, the license file “medav.lic” has to be located in the installation directory of the WxxPC software, and the associated dongle needs to be inserted into a USB socket of the same PC.

This document gives some information on the license system and describes the installation steps to be taken in order to enable an optional mode in the professional version of release V6.4.00 of WxxPC.

Preliminary Step

Before proceeding with the installation of the license file for the optional modes, a professional version of release V6.4.00 of WxxPC has to be installed on the PC where the respective decoder hardware resides. The WxxPC software is installed in a specific directory, which we denote in the following by <Wxx_INST_DIR>. Typically, the installation directory is C:\Program Files\WAVECOM\WxxPC, where, again, xx stands for either 51 or 61.

USB Dongle

The FLEXid USB dongle is one part of the licensing system for an optional mode. Such a dongle is identified by a dongle ID and a FLEXid number beginning with 9 (e.g. 9-75C373D3). An optional mode is associated with a specific FLEXid USB dongle, as denoted in the specific entry in the license file “medav.lic” (see section 0). Hence, it is possible that different optional modes are associated with different FLEXid USB dongles. However, there will be only one “medav.lic” file.

In order to have the FLEXid USB dongle fulfill its purpose when it is inserted into a USB socket of the PC where the WxxPC hardware decoder resides, the USB controller must be enabled on that PC. The USB controller can be activated in the PC’s BIOS menu, to which you can access at PC start-up by pressing a specific function key (typically, F2).

The required drivers for the operation of the FLEXid USB dongle are installed together with the professional version of the release V6.4.00 WxxPC software (see section 0). The first time you insert the USB dongle into a specific USB slot on the PC in which the WxxPC hardware decoder resides, you are notified by the system that it has detected a new hardware device (i.e., the USB dongle). The necessary HASP/Aladdin drivers should be automatically set up, and the USB dongle is then ready to operate when its red light-emitting diode (LED) is illuminated.

License File

The provided compact disc (CD) contains the license file “medav.lic”, which is one part of the license system to which the purchased optional modes are subject. An example of a license file for the optional modes Clover-2, Clover-2000, and PACTOR-III is shown below:

```
SERVER any 012345678901
VENDOR medav
FEATURE Clover2Demod medav 1.0 31-dec-2004 25 \
          HOSTID=FLEXID=9-12345678 SIGN=" ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
FEATURE Clover2Demod_DECODEDDATA medav 1.0 31-dec-2004 25 \
          HOSTID=FLEXID=9-12345678 SIGN="EF01 2345 6789 ABCD EF01 ABCD \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
FEATURE Clover2000Demod medav 1.0 permanent 1 \
          HOSTID=FLEXID=9-12345678 SIGN="2345 6789 ABCD EF01 ABCD EF01 \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
FEATURE Clover2000Demod_DECODEDDATA medav 1.0 permanent 1 \
          HOSTID=FLEXID=9-12345678 SIGN="6789 ABCD EF01 ABCD EF01 2345 \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
FEATURE PactorIIIDemod medav 1.0 31-dec-2005 uncounted \
          HOSTID=FLEXID=9-12345678 SIGN="DCBA EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
FEATURE PactorIIIDemod_DECODEDDATA medav 1.0 31-dec-2005 uncounted \
          HOSTID=FLEXID=9-12345678 SIGN="10FE 2345 6789 ABCD EF01 ABCD \
          2345 6789 ABCD EF01 2345 6789 ABCD EF01 2345 6789 ABCD EF01 \
          2345 6789 ABCD"
```

At the beginning of the license file, a SERVER entry is to be found in which the license server (host name and MAC-address) is specified. Since in this case no license server is used, the specified host name and MAC-address are dummy values. The next entry (VENDOR) denotes the vendor of the license. Then, depending on the purchased optional modes, a different number of FEATURE entries may follow. The structure of such a FEATURE entry is as follows:

- name of the module;
- name of the vendor;
- version number of the module;
- date of license expiry ("permanent" if the license duration is unlimited);
- maximum number of concurrently active modules ("uncounted" if there is no limitation);
- "HOSTID=FLEXID=" followed by the number of the FLEXid that is associated with the respective module;
- "SIGN=" followed by a specific key string.

Note that, for the optional modes Clover-2, Clover-2000, and PACTOR-III, two FEATURE entries each are present in the license file, since these modes are each split into two modules, one performing demodulation and the other decoding of the demodulated signal (e.g. Clover2000Demod and Clover2000Demod_DECODEDDATA).

License File Installation

The license file "medav.lic" on the provided CD has to be copied into the WxxPC's software installation directory <Wxx_INST_DIR>. The installation directory <Wxx_INST_DIR> already contains a dummy license file named "medav.lic". Hence, during the copy process, you may be asked whether you want to overwrite the existing version of "medav.lic" with the more recent and typically larger one. Answer 'Yes' so that the version from the CD is copied into <Wxx_INST_DIR>.

The same procedure has to be followed also in case of a license update or upgrade. The new license file will include the license information for the existing and for any newly-purchased optional mode.

Operation

The optional modes are started by selecting the respective entries in the pull-down menu 'HF-Modes' or the respective buttons in the dialog 'Mode Selector' of WxxPC's graphical user interface (GUI). When opening the pull-down menu 'HF-Modes' or the dialog 'Mode Selector', a license check is performed for each optional mode. If the result of such a license check is negative, the corresponding entry or button is disabled, so that the mode cannot be selected.

Entries in the 'History' pull-down menu of the WxxPC GUI are always enabled. Therefore, if an entry corresponds to an optional mode, it will be possible to select that mode from the 'History' pull-down menu even if the USB dongle is not inserted in a USB slot of the PC. However, in such a case, the thereafter performed license check for that mode will result negative. Nevertheless the mode will be started, but no demodulation/decoding will be performed. A dialog window will pop up to notify the user of the license check failure.

Hence, in order to be able to start an optional mode, the associated USB dongle needs to be inserted into a USB slot of the PC in which the WxxPC hardware decoder resides. Removal of the USB dongle from the USB socket while an associated optional mode is running will interrupt the mode's operation after a few minutes. A pop-up window will then notify the user of this fact. Re-insertion of the USB dongle will not resume the mode's operation. You will have to close the optional mode, insert the USB dongle, if not already done, and restart the optional mode.

Important Notes: If you accidentally delete the license file "medav.lic" on your system and, for whatever reasons, the provided CD containing the license file is lost; the latter can be replaced at no cost. However, if you lose the USB dongle, you are not entitled to a replacement of the USB dongle unless you purchase anew the concerned optional modes. Therefore, take good care of the USB dongle.

Program Start

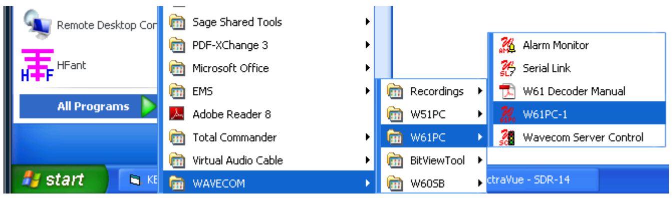
After the decoder card and the software has been successfully installed, the decoder program can be started either from the WINDOWS **Start** menu or by double-clicking the program icon on your desktop, provided that you have allowed **Setup** to create program icons.

If you have not allowed Setup to create program icons on your desktop:

Open the **Start** menu of your WINDOWS operating system and let the mouse move over the **Programs** menu item. In the list box which opens, move the mouse over the **WAVECOM** menu item. In the next list box which opens, select your decoder.

The WAVECOM decoder window will now open, and downloading of the software from the hard disk of the PC to the PC card will start.

You may also start the **Alarm Monitor**, the **Serial Link**, and the **Server Control** programs from here.



If you have allowed setup to create program icons on your desktop:

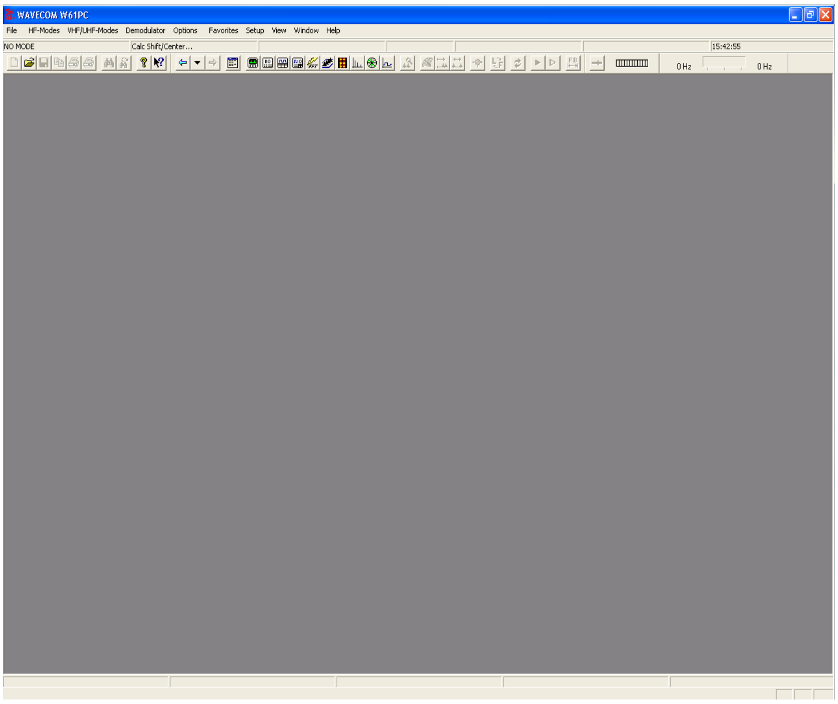
Just double-click on a decoder icon to start the software.

Proper operation of the decoder is indicated by the WAVECOM Server Control icon in the Windows system tray. If the traffic light in the icon is green, then the server is operating normally. You may also move the mouse over the icon and check that you get this status message:

WAVECOM Server – W61PC (running)

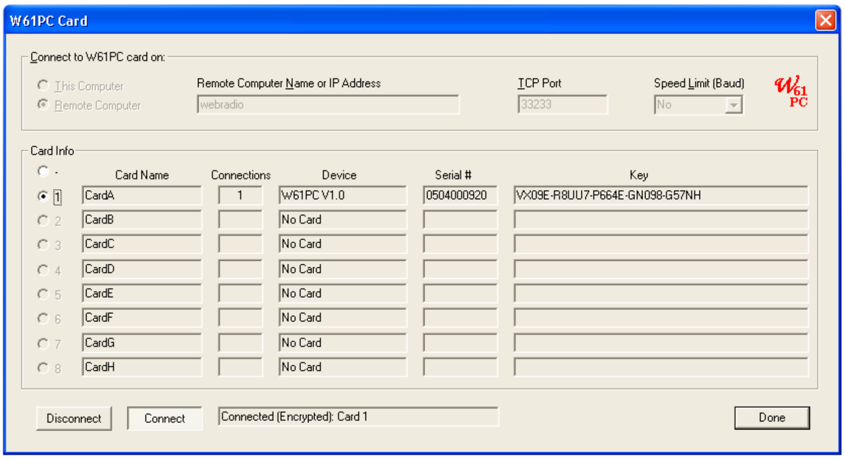
Setup

The user interface of the WAVECOM decoder software conforms to standard WINDOWS interface guidelines. A full window is shown below. This is the window you will see after setup has been completed as described in the preceding paragraph.



The first time the software is used after the installation, you will have to set the decoder card manually.

From the menu bar, go to **Setup**. A drop-down menu will appear. Click on the **W61Card** menu item. A card setup window appears.



Select a card number and click on **OK** to save entry.

Graphical User Interface (GUI)

The user interface of the application conforms to standard WINDOWS interface guidelines. A full window is shown in this section. This is the window you will see after setup has been completed as described in the preceding paragraphs.

The WINDOWS elements **SYSTEM TOOLBAR, DECODER TOOLBAR, LEVEL INDICATOR** and **SPECTRUM INDICATOR** may be moved anywhere in the screen as required. In the **View** menu the user may select or deselect all window elements. After installation has completed all elements are visible.

Please, be aware that the appearance of the GUI will vary depending on software versions and hardware models.

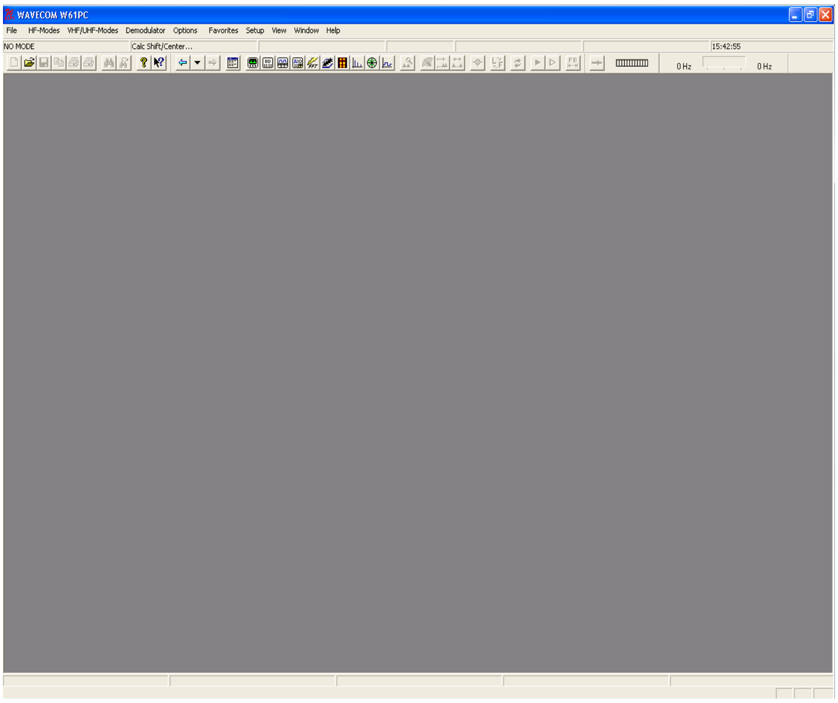
Main Menu

The main menu includes all submenus relating to operating modes as well as analysis and set-up functions.

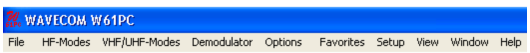
The WINDOWS operating system is based on a multitasking kernel and can handle more than one task concurrently, and therefore the control of and interaction with the menu system will not interrupt the execution of an active function. This allows for example the shift and center frequency to be set in the **Demodulator** submenu without interference to or disruption of the currently active operating mode.

Main Menu Screen Display

This window is displayed as long as a mode is not started.



Menu Bar



As a standard WINDOWS procedure a left-click on a menu item will display the corresponding drop-down menu.

File Menu

The functions of the **Files**, **View** and **Window** menus are general system functions in accordance with the WINDOWS standard.

Using the **Files** menu, files may be saved and opened. In addition printing, preview and printer setup is available.

Save As Bitstream... allows the user to save a bit stream e.g. from an auto-correlation session as a text file of ASCII 0s and 1s.

Save Selection as... allows the user to mark a screen area of text and save it to a text file.

Recent History displays a list of recently opened files.

For context sensitive help on a menu item, use **F1** on the item.

Note: Files that are saved with **Save** and **Save as...** are stored in the new WAVECOM *.WDA format. This format is used to save decoded text together with time stamps in a text file. The import of old *.W40 (W40PC), *.W41 (W41PC) and *.W51 (W61PC) files is also supported.

HF-Modes

The various groups of modes are displayed in the **HF-Modes** and in the **VHF/UHF-Modes** menus. To select the modes of a group, left-click or let the mouse rest briefly on the group item to be selected. Now, the modes of the group are displayed in a separate menu. Start decoding the desired mode by another left-click.

It may be difficult to guess or remember to which group a particular mode belongs. To facilitate an overview a full-screen menu may be opened by clicking the menu item **Mode Selector**. To start a mode, click on the appropriate menu field. Leaving the full-screen menu will not terminate an active mode.

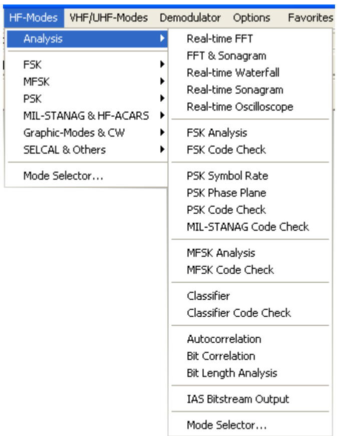
The various analysis tools are displayed in the **HF-Modes/Analysis** and in the **VHF/UHF-Modes/Analysis INDIRECT** and **DIRECT** menus.

The descriptions of the operating modes in a separate section of this manual are arranged in alphabetical order.

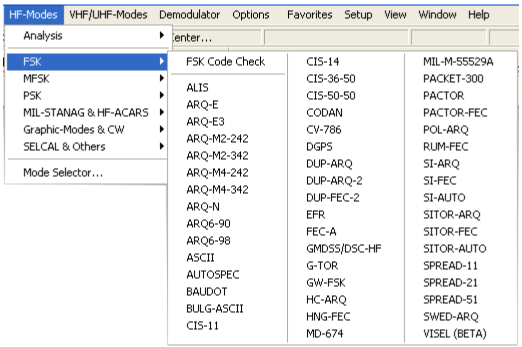
The **Mode Selector** is also available from the **HF-Modes** menu and from the **VHF/UHF-Modes** menu when clicking on **Mode Selector**.

HF-Modes are organized as follows:

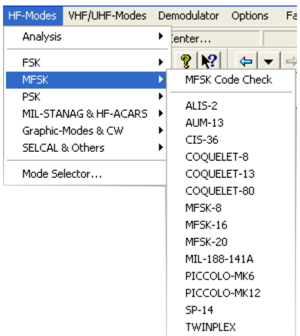
Analysis Modes in the HF Menu



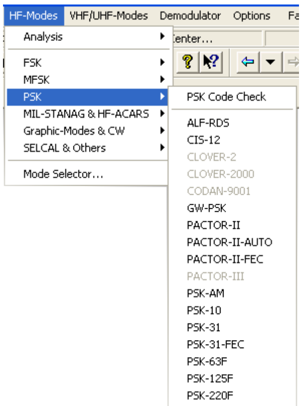
FSK Modes in the HF Menu



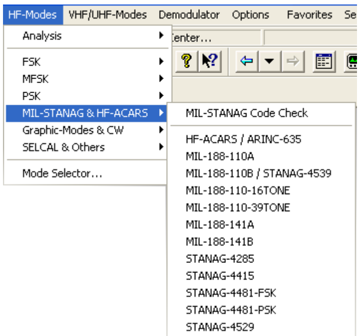
MFSK Modes in the HF Menu



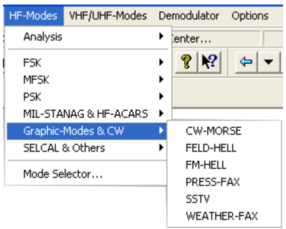
PSK Modes in the HF Menu



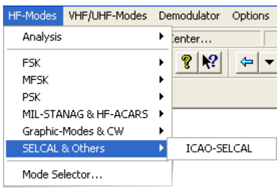
MIL-STANAG and HF-ACARS Modes in the HF Menu



Graphic Modes and CW in the HF Menu



SELCAL and Others



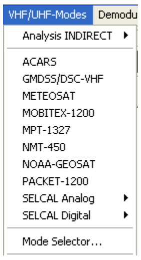
Mode Selector...

See “Mode Selector on page 53”.

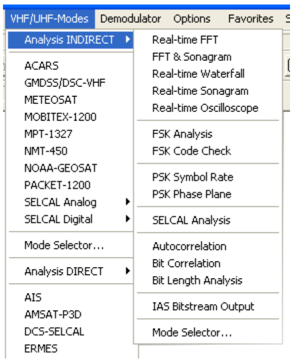
VHF-UHF Modes

INDIRECT Modes in the VHF/UHF Menu

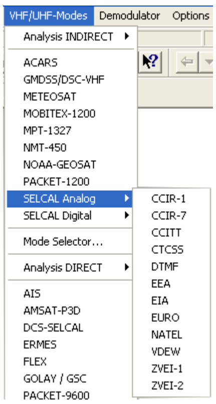
INDIRECT modes require additional AM or FM demodulation in the receiver, if the receiver is connected to the W61PC AF input. If the signal is demodulated from an IF signal (translation frequency <> 0), then a standard AM or FM software demodulator is automatically added to the W61 signal processing path.



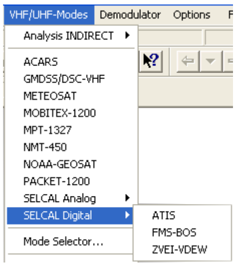
Analysis INDIRECT Modes in the VHF/UHF Menu



SELCAL Analog Modes in the VHF/UHF Menu



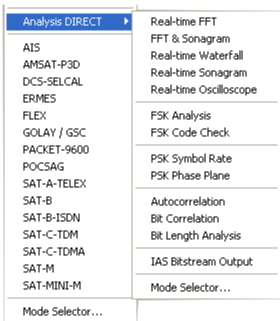
SELCAL Digital Modes in the VHF/UHF Menu



DIRECT Modes

DIRECT modes can only be directly demodulated at the intermediate frequency level (IF).

Analysis DIRECT Modes in the VHF/UHF Menu



Mode Selector...

See “Mode Selector... on page 43”.

Demodulator Menu

Using the **Demodulator** menu all parameters for decoding may be selected. In addition to baud rate, the options and values for mode, shift, center frequency, translation frequency, input and input gain may be manually entered.

The availability of the functions depends on the active mode. For context sensitive help on a menu item, use **F1** on the item.

Auto

Click on the **Auto** button to enable a mode. Shift, center frequency and baud rate is automatically calculated and adjusted. The new value is selected by double-clicking on the preset value or by clicking **OK**.

Mode...

In the **Mode** menu the demodulator mode may be selected.

Most HF-VHF-UHF modes feature a pre-selected demodulator mode for optimum performance.

Demodulator Modes

AM

Satellite weather charts are transmitted using AM. This demodulator uses the quadrature I/Q demodulation method.

The magnitude of the level indication corresponds to the AM modulation depth of the signal. The gain and the amplitude offset may be set using the **Demodulator** menu.

BPSK

BPSK shifts the carrier phase ±180 degrees. For carrier recovery a Costas loop is used. The Costas loop is a PLL with a special phase comparator, which removes the payload data from the PLL loop. The input signal is then down-converted to base band by mixing the carrier in a complex mixer, and the resulting signal is the data signal.

BPSK is almost exclusively used for satellite data links.

BR6028

BR6028 is a commonly found VFT (voice frequency telegraph) frequency and time diversity modem system using 7 data channels. It is sometimes also known as BARRIE.

Theoretically the system may handle up to a 3 second channel dropout before errors occur. An un-modulated pilot tone is transmitted at 560 Hz.

	Center (Hz)	Space (Hz)	Mark (Hz)
Pilot Tone	560		
CH1	850	765	935
CH2	1190	1105	1275
CH3	1530	1445	1615
CH4	1870	1785	1955
CH5	2210	2125	2295
CH6	2550	2465	2635
CH7	2890	2805	2975

- Channel spacing: 340 Hz
- Shift: 170 Hz
- Channels are delayed by a multiple of 1.024 seconds.
- Speed: 45-100 Baud
- Modes: Baudot, ASCII, and some FEC modes

CW

The CW demodulator utilizes a steep, adaptive band pass filter and automatic amplitude control. The AGC attack time may be adjusted according to the propagation conditions. The filter response may be set to **Slow**, **Normal** or **Fast**. This demodulator produces high quality CW decoding. It is important to select the appropriate receiver AGC response (normal or slow).

DSP

The DSP mode utilizes an I/Q demodulator (Hilbert transformation). The received signal is split into an in-phase component and a quadrature component. Next amplitude normalization takes place and the resultant signal is used for the frequency conversion. This method is characterized by a linear relationship between the received frequency and the output voltage of the demodulator.

The DSP demodulator has a good signal-to-noise ratio and yields very good results under most conditions.

DPSK

In differential PSK the absolute carrier phase cannot be used for data recovery as is the case with BPSK and QPSK. To decode multiphase DPSK (up to 16DPSK) the input signal is mixed with a complex, phase regulated reference signal. The resulting data reduced signal is then filtered in a low pass filter. The following phase comparator calculates the phase difference between the signal from the integrator and the delayed signal.

DPSK is almost exclusively used when phase modulation is employed on short wave data links.

DBPSK

Similar to DPSK, but has two phase shifts at ± 180 degrees.

DQPSK

Similar to DPSK, but has four phase shifts at ± 90 and ± 180 degrees.

DTMF

This demodulator handles multi-frequency signals. Filters are switched in on the various frequencies of the signal and the amplitude is then calculated for each frequency. Next the amplitudes are evaluated. Two simultaneous tones are demodulated. The SNR is the same as for the mark-space demodulator.

DXPSK

Adaptive DPSK demodulator for PACTOR-II. This demodulator will automatically adapt itself to DBPSK, DQPSK, D8PSK or D16PSK.

D8PSK

Similar to DPSK, but has eight phase shifts at ±45, ±90, ±135 and ± 180 degrees.

D16PSK

Similar to DPSK, but has sixteen phase shifts at ±22.5, ±45, ±67.5, ±90, ±112.5, ±135, ±157.5 and ±180 degrees.

FFSK and GFSK

Depending on the mode, the FFSK (Fast Frequency Shift Keying) and GFSK (Gaussian Frequency Shift Keying) demodulator is automatically selected. Basically this demodulator utilizes the I/Q principle (Hilbert). However, filters are adjusted to accommodate the special demands of these modes.

MFSK

This demodulator handles multi-frequency signals. Filters are switched in on the various frequencies of the signal and the amplitude is then calculated for each frequency. Next the amplitudes are evaluated. Depending on the number of tones used, the filters are configured as phase linear FIR filters or as IIR filters. The SNR is the same as for the mark-space demodulator. Concurrent multi-tone decoding (e.g. DTMF) is not possible with this demodulator.

MS (Mark-Space)

The mark-space demodulator processes the two keying frequencies of a FSK signal. These are fed to two phase linear FIR filters and the amplitude is then calculated. The mark-space demodulator exhibits an extremely good noise distance and should be used for all FSK modes utilizing a speed of less than 300 Baud.

OQPSK

Carrier recovery is mandatory to demodulate OQPSK. As OQPSK has phase shifts at ±90 degrees, the signal must be squared two times to produce a carrier at four times the original frequency. A PLL recovers the carrier in frequency and phase with ambiguities at ±90 and ±180 degrees. A complex mixer down converts the signal to base band and the resulting signal is the data signal. In contrast to QPSK, OQPSK has only phase steps of ±90 degrees in one step. First the in-phase part is switched, then after half a symbol duration the quadrature part is switched. The advantage of this process is a smaller amplitude variation.

OQPSK is almost exclusively used for satellite data links.

QPSK

Carrier recovery is mandatory to demodulate QPSK. As QPSK has phase shifts at ±90 and ±180 degrees the signal must be squared two times to produce a carrier at four times the original frequency. A PLL recovers the carrier in frequency and phase with ambiguities at ±90 and ±180 degrees. A complex mixer down converts the signal to base band, and the resulting signal is the data signal.

QPSK is almost exclusively used for satellite data links.

SRC

The **Sampling Rate Converter** is used for very complex modes like MIL, STANAG or HF-ACARS requiring an adaptive equalizer. To get optimum results, this equalizer works with a sampling rate that is a multiple of the baud rate.

SUBTONE

Same as DSP, but the parameters are optimized for low frequencies.

PB Center...

Click on the **PB Center** menu item to adjust the center frequency of the pass band filter.

See “PB Bandwidth... on page 31”.

PB Bandwidth...

Click on the **PB Bandwidth** menu item to adjust the bandwidth of the pass band filter.

PB (Pass Band Filter Support)

Perfect signal processing (filtering) is relevant for best decoding results. Best results are achieved by using the correct filters in the receiver. This avoids blocking effects from strong nearby signals. But sometimes such correct processed signals are not available (recorded signals, large bandwidths when working with classifier). Hence additional pass band filters were added to support the operator. This makes it possible to separate different signals available in the analyzed spectrum.

The WAVECOM GUI shows the PB Tuning bar below the Tuning FFT. If no tuning FFT is available (MIL-STANAG, VHF-DIR etc) the parameters can be set in the **Demodulator Menu**.

For many modes the parameters **PB Center**, **PB Bandwidth** and **Center** can be controlled individually (see table below).

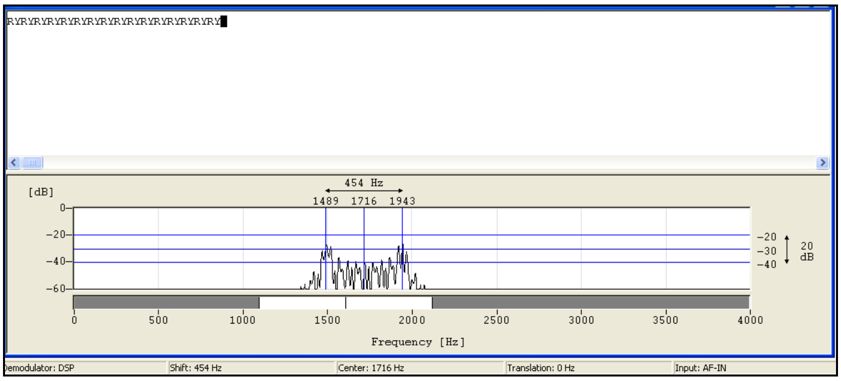
The PB parameters can be set to maximum bandwidth (switched off) with the **Maximize Pass band** button.

Item	PB Conf.	Remarks
DSP	+	Free configuration
AM	+	Free configuration
CW	+	Free configuration
GFSK	+	Center controlled from translation freq.
FFSK	+	Center controlled from translation freq.
MARK-SPACE	-	PB adjusted automatically (depending on center, shift and speed)
MFSK	-	Individual tones are filtered PB adjusted automatically (depending on tone spacing, center and speed)
DTMF	-	Individual tones are filtered PB adjusted automatically (depending on tone spacing, center and speed)
BR6028	-	Preconfigured filters that cannot be changed. The location of the pilot tone can

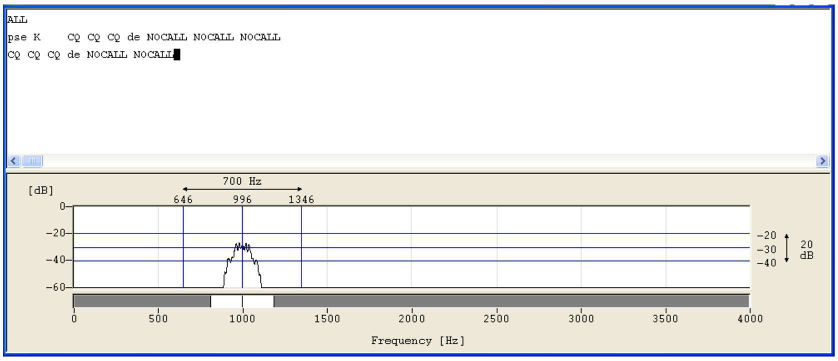
		be set manually
BPSK	+	Free configuration
QPSK	+	Free configuration
OQPSK	+	Free configuration
QAM	+	Free configuration
DPSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
DXPSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
DBPSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
DQPSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
D8PSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
D16PSK	-	PB adjusted automatically (depending on center, shift and speed). The center can be set manually
SRC	+	Free configuration
IQ	+	Free configuration
ANALYSE	+	Free configuration
FFT	-	No filtering implemented
TIME	-	No filtering implemented
OFDM	-	No filtering implemented
SUBTONE	-	No filtering implemented
DISCRIMINATOR	-	No filtering implemented
EXT-DEM	-	No filtering implemented
BYPASS	-	No filtering implemented
Sonogram	-	No filtering implemented
Waterfall	-	No filtering implemented
Oscilloscope	-	No filtering implemented
INDIRECT	+	This signals need the additional AM or FM demodulator from the receiver. Because of that this PB filtering is of limited use.

PB Tuning

The easiest way is to use tuning FFT to adjust e the pass white bar in the gray field below the FFT (dragging the PB center, upper or lower border). The FSK tuning picture below shows how PB center and center frequency can be set individually.



The next picture shows you a tuned PSK signal. The bandwidth was automatically set according to the speed. In this mode the PB center and Center cannot be set individually.



Center...

Click on the **Center** menu item to adjust the demodulator center frequency within 1 Hz accuracy. For modes utilizing direct FSK this button is not available. In this case the translation frequency is equal to the effective center frequency.

Shift...

Click on the **Shift** menu item to adjust the frequency shift within 1 Hz accuracy. In HF modes the range is 50 Hz – 3,500 Hz and in VHF-UHF modes using direct FSK the range is 50 Hz – 16,000 Hz.

Baudrate...

Click on the **Baud rate** menu item to start a mode. A new baud rate evaluation is performed with a maximum resolution of 0.0001 Baud. Depending on the mode the baud rate dialog box contains preset values, which may be directly selected. The new value is selected by double-clicking on the preset value or clicking on **OK**.

Polarity...

Click the **Polarity** menu item to toggle polarity between normal and inverse.

Translation...

Adjusting the translation frequency and the center frequency will adapt the decoder input to a receiver IF output.

The minimum translation frequency resolution available with the decoder is 1 Hz. The effective center frequency is the sum of the translation frequency and the center frequency. The function is similar to the mixing of the signal frequency and BFO of a receiver.

An exception is the FFSK demodulator for direct frequency modulation. In this case the indicated translation frequency is equal to the effective center frequency.

An example for an HF receiver and ARQ-E mode:

- **Receiver IF** 455,000 Hz
- **Translation** 453,300 Hz
- **Center** 1700 Hz

The advantage of this method is that the user only needs to know the center frequency.

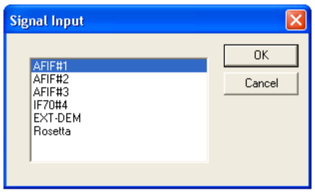
Another example for a VHF-UHF receiver and POCSAG mode:

- **Receiver IF** 455,000 Hz
- **Translation** 455,000 Hz
- **Center** 0 Hz

In this case the translation frequency is equal to the center frequency.

Input...

The decoder supports a number of inputs:



- The **AFIN#1 - 3** have a range of 50 Hz – 25 MHz. These inputs should be used when the source is an AF output (line or speaker) or an IF output of communication receivers and digital recorders
- The **IF70#4** input has a range of 52.5 MHz - 87.5 MHz. This IF is common for satellite equipment
- The **EXT-DEM** input will accommodate voltage levels from TTL to RS-232C, [0 V, +5 V] to [-12 V, +12 V]. Use this input for input from an external demodulator
- The **DIG** input is physically the same as the **EXT-DEM**, but use different pins. Valid input level is -0.5 - +6.5 V. This 3-wire input is used for digital IF output from communication receivers (not yet supported).
- **Rosetta** is a user defined input.

For further specifications, see the “Technical Data on page 265”**.**

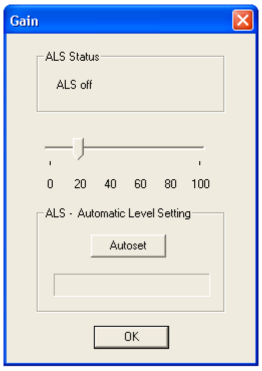
Gain...

For manual gain adjustment, use the slider. The input gain adjustment range is 0 - 100 % of the nominal input sensitivity of the selected input. When the desired gain setting has been found, press **OK** to save the setting.

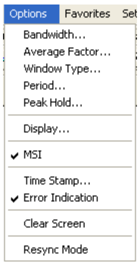
The adjustment is valid only for the selected input. The gain settings of the four inputs are separately saved in the application initialization file.

Gain adjustment should **never** turn on the red bars of the level indicator.

For W61 only: Manual gain adjustment will not optimize the combined input sensitivity setting and the internal gains of the demodulator. To optimize input sensitivity and internal gain, press **Autoset**. This will start **Automatic Level Setting (ALS),** initiate the calculation of the optimized settings and display **ALS running...**. When the calculation has completed status will be displayed as **ALS finished**. Press **OK** to accept the result.



Options Menu



In the **Options** menu all support functions for a particular mode or functionality have been collected in such a way that it is adapted to each individual mode. The **Option** menu will therefore appear with different contents depending on the mode or functionality selected. The menu of the currently active mode is always displayed.

Alphabet...

The **Alphabet** menu has options for transparent and normal output. The normal output includes fonts for e.g. **Latin**, **Greek**, **Cyrillic**, **Hebrew**, **Arabic** alphabets.

The ASCII character sets for output in **German**, **Bulgarian, US**, **Swedish, Danish-Norwegian, Chinese** or other alphabets may also be selected.

Skyper, an alphabet which is used in POCSAG mode in Germany, is also available.

The transparent alphabet includes output of non-printable characters of a data transmission, e.g. ITA-2 control characters like Letter Shift and Figure Shift or undefined upper case characters. In normal alphabets these characters are not output.

Code Statistic...

See "Code Statistic on page 92".

Letters/Figures...

This option is only available for ITA-2 based modes.

The **Letters/Figures** dialog box contains the options **Normal**, **Letters Only**, **Figures Only** and **Unshift on Space (UOS**). **Letters** and **Figures** designates the ITA-2 lower (letters) and upper (figures) cases.

For reception under normal conditions the selection of one case or the other is controlled by the reception of the shift characters.

Special alphabets, e.g. Chinese, comprise only letters so forcing a shift into lower case mode may be an advantage (**Letters Only**). Selecting this function may also be advantageous, when searching for a bit inversion pattern as the pattern may be more easily recognized.

In weather code transmissions five figure groups are used so in this case one may force a shift into upper case (**Figures Only**).

The **Unshift on Space (UOS)** function forces a shift into lower case after a space character has been received. In this manner the readability of the transmission may be enhanced under poor conditions (weak signals or interference).

Compared to the **Letters Only** mode, UOS has the advantage, that single, upper case characters like period and comma are correctly printed. Only when receiving figure groups separated by space characters, the software will incorrectly shift to lower case.

Period...

From the **Period** menu the time unit per measurement may be selected. The lowest value is 50 ms corresponding to 20 FFT's/s. For the highest value of 10,000 ms a measurement is done once every 10 seconds.

Toggle

Clicking the **Toggle** function will immediately change the current case to the opposite case - from **Letters** to **Figures** or vice-versa. Thus an incorrect case shift caused by a character received in error may be corrected at once and the proper case reinstated.

MSI

MSI (Multiple Scroll Inhibit) is a function which will suppress multiple linefeeds (LF). In addition, a software generated Line Feed (LF) is inserted when a carriage return is received.

Using this menu item the function may be separately toggled on and off for the video output.

Using the MSI function has several advantages, e.g. when during reception disturbances a carriage return character is lost, this software prevents lines being overwritten and text to be lost. Some stations do not transmit carriage returns. The MSI function will then automatically generate the missing carriage return. To clearly divide a message into paragraphs many carriage returns are often transmitted.

IAS

IAS is the abbreviation for ISO-ASYNCHRONOUS and SYNCHRONOUS modes. Iso-asynchronous modes have start and stop elements like Baudot, but the code words have an integral number of elements. The IAS function is utilized for the extremely accurate baud rate determination of a synchronous or iso-asynchronous bit stream.

The automatic phase correction for the ideal bit center sampling (bit synchronism) is completely independent of the IAS function and is always active. The extremely accurate baud rate determination uses the number of necessary phase correction steps for the baud rate determination.

In modes working with an interrupted data stream as PACKET-300, it may be advantageous to be able to switch off the baud rate correction to prevent drifting of the pre-selected baud rate. When the IAS function is disabled, any pre-selected variable baud rate will be treated in the same way as a fixed baud rate.

In most of the VHF/UHF modes the IAS is permanently disabled. This is due to the lack of phase coherence between successive data blocks. An exact measurement of the phase shift is not possible for an extended period of time.

In case of difficult HF receiving conditions (fading) enabling IAS may offer substantial advantages. The software will decrease the size of the phase correction steps in accordance with the verified, reduced phase errors, and thus prevent bit glitches and the resulting loss of synchronism. It is therefore recommended to enable IAS as a default.

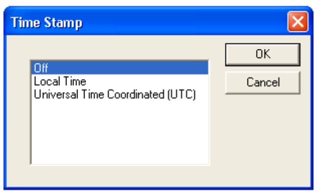
Tick the **IAS** menu item to enable IAS.

Cycle...

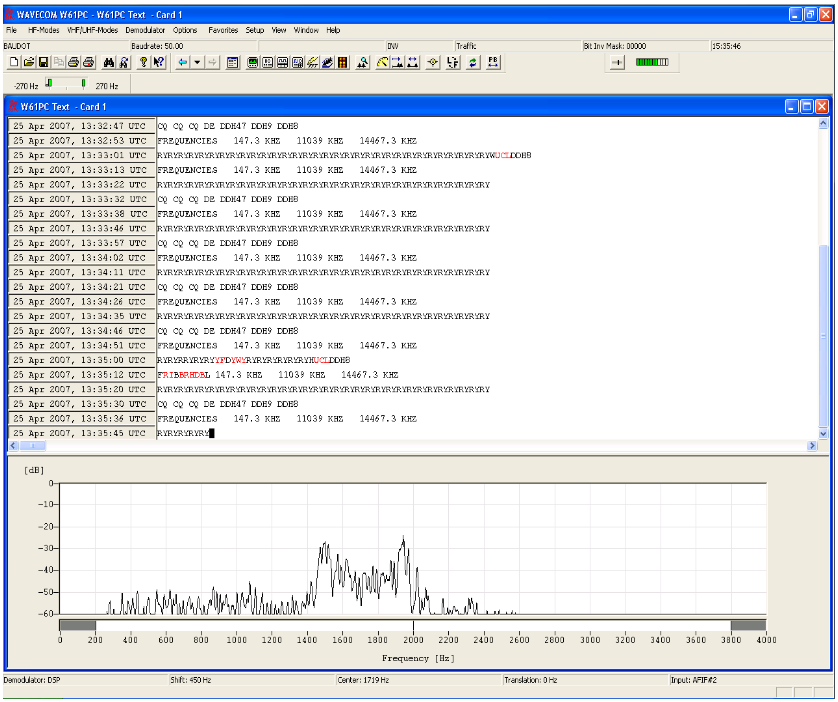
In some modes, the character repetition cycle may be manually selected.

Time Stamp...

Clicking **Options/Time stamp** offers a selection of different time zones for time stamping text output. Time stamping may also be disabled at a later time through this menu.



To display the time stamp a new window is opened on the left hand side of the screen. When a text line has been displayed, date and time is displayed in this window. This function is available for all text output modes.



Error Indication

If **Error Indication** is switched on, then characters containing errors are marked in red color. If possible, the error correction will correct the data in error.

Clear Screen

Clears the actual screen. All data will be lost.

Resync Mode

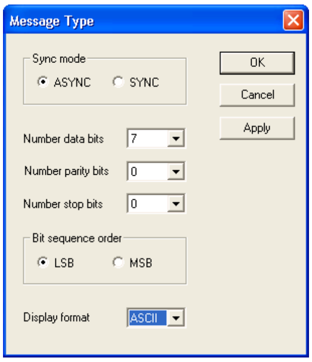
Forces re-synchronization in the current mode.

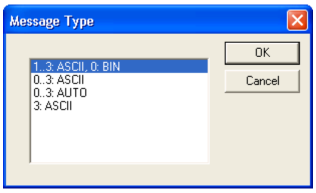
OSI-Level...

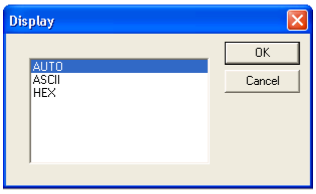
- Level 0: No additional application layer checksum.
- Level 1: Additional application layer checksum used by the French diplomatic service.

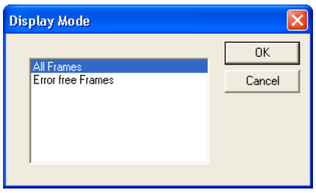
Message Type... , Display... , Display Mode...

Mode specific parameters can be selected

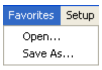






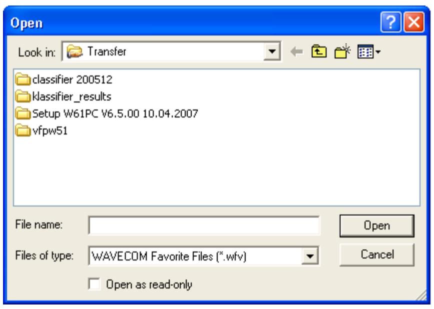


Favorites Menu



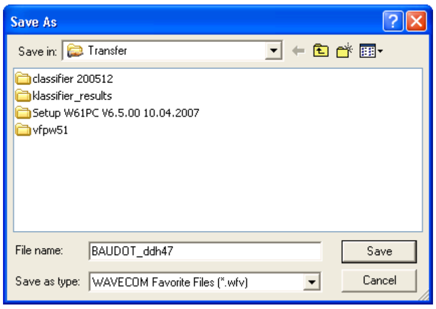
The **Favorites** menu lets the user save and reload a mode and its corresponding settings, i.e. mode, alphabet, center frequency, baud rate etc. The settings are saved in a *.WFV file.

Open...



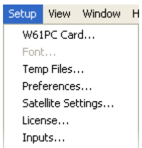
Select **Open...** to reload the settings.

Save As...



Select **Save As...** to save the settings.

Setup Menu



In the **Setup** menu all general setup functions have been collected.

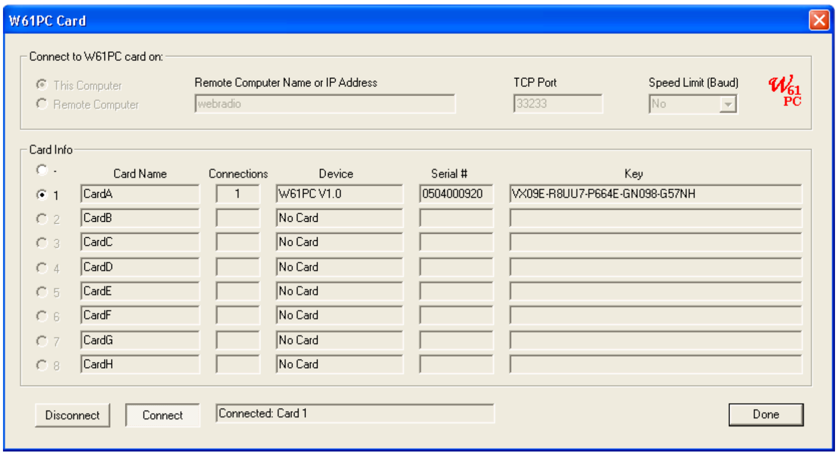
W61PC Card...

First time the decoder application is started with the decoder card installed, the application must be informed of the location of the decoder card.

Clicking on **W61PC Card** in the **Setup** menu will display the dialog box shown below.

In the **Install** chapter the setup is explained for the different decoder types.

As an example the setup of the W61PC is shown below:



Each W61PC card is identified by a unique serial number. Thus the W61PC software is able to search for W61PC cards automatically. This functionality is available for local as well as remote computers. Pressing the **Connect** button will start the process.

In the above example the W61PC software is looking for W61PC cards in a local computer. The process will take only a few seconds.

A W61PC card was detected on the local computer. The entry shows the type of product found as well as the hardware version and serial number.

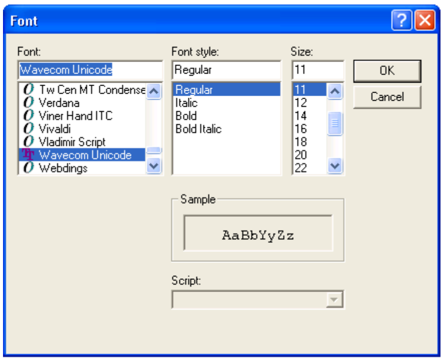
The selected entry is stored in the card's initialization file (*.INI file) and no further entry is necessary, when the W61PC application is restarted. The settings may be changed at any time.

The W61PC system can be used in a network configuration. This allows the system to be remotely controlled.

Font...

As long as a mode has not been started this menu item is disabled.

If a mode is active the menu below is displayed.



Important: Please, note that changing the font and changing the alphabet are two different actions. If you change the alphabet, then you select a table in a Unicode Font. If you change the font, then you change the graphical representation (Arial, Courier etc.) of the characters of an alphabet. You run into trouble if you select a non-Unicode font and change the alphabet.

For some transmissions it will make sense to change the font. This depends on the software that was used for the transmission.

Temp Files...

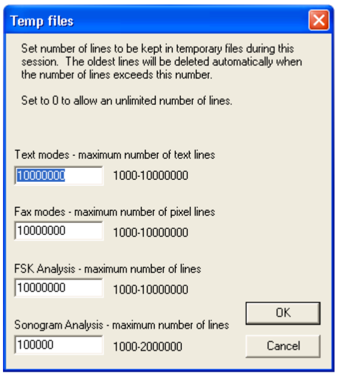
Clicking **Temp Files** opens a configuration window.

You can set the number of lines to be saved to temporary files during a session. These limits are meant to allow a user to leave his computer on for days, but avoiding hard disk space to be exhausted.

If the temp file is more than 50% of free disk space, it will not be possible to save your recording as a new copy of the temp file(s) is made when you perform a save operation.

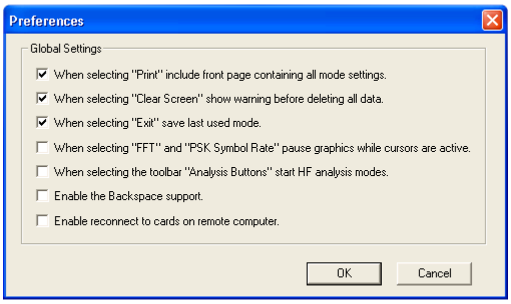
You can select different values for:

- Text modes
- Fax modes
- FSK analysis



Selecting high values allows a scroll back over longer time, but requires more memory and hard disk space.

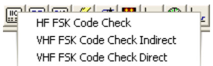
Preferences...



Clicking **Preferences...** opens a configuration window.

You can enable or disable different parameters, to set the behavior of your software.

- **When selecting "Print" include front page containing all mode settings**. Enable or disable the printing of a status page with all mode settings if you use the **Print** command.
- **When selecting "Clear Screen" show warning before deleting all data**. Enable or disable the display of a warning window before the screen is cleared when you use the **Clear Screen** command.
- **When selecting "Exit" save last mode.** Enable or disable storing of settings from the last mode. If enabled, the decoder will start again in the latest mode used.
- **When selecting "FFT" and "PSK Symbol Rate" pause graphics while cursors are active**. Enable or disable the automatic freezing of the graphic as long as the cursors are displayed.
- **When selecting the toolbar "Analysis Buttons" start HF analysis mode**. If enabled, the HF Analysis modes are directly started from the buttons in the toolbar. If disabled, a selector will pop up.

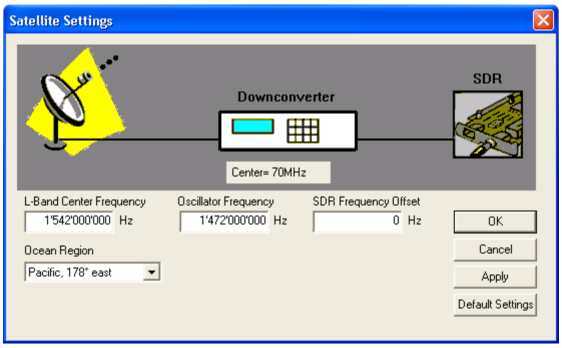


- **Enable the Backspace support.** Sometimes in modes like PSK-31 the operator is sending backspace characters. If Backspace support is enabled, backspace will work as for an ordinary terminal program.

- **Enable reconnect to cards on remote computer**. Enable or disable the GUI to reconnect to a card on a remote computer. If enabled, the decoder will reconnect to the card on the remote computer.

Receiver and Satellite Settings...

These settings are used from the SAT-M, SAT-mini-M and SAT-B modes. It gives you the possibility to configure the receiver, down converter frequencies and to select a satellite.



The input fields have the following meaning:

- **L-Band center Frequency**. This value is used to calculate the Center Frequency displayed in the graphic.
- **Ocean Region**. Select the ocean region to which the monitoring antenna points to.
- **Oscillator Frequency**. Set this parameter to the frequency of the local oscillator used, or set it to 0, if an external converter/mixer is not used.
- **Receiver Type.** Select the type of receiver used. At the moment only the On-Board is available.
- **SDR Frequency Offset**. Find out how accurate the receiver sets its frequency. Use the real-time FFT item in the **Analysis DIRECT** menu and select a bandwidth of 24 kHz to find out the frequency offset of the receiver. Adjust the receiver to the NCSC frequency of the appropriate ocean region. Next the NCSC signal should be centered exactly in the FFT display. The adjustment applied to centre the NCSC signal is the offset (make it accurate to 500 Hz or less).
- **COM-Port.** This is the COM port of your PC that connects to the receiver - use COM1 if possible. Not required with internal receivers.
- **Receiver address.** Used by some receivers, e.g. ICOM. Enter the value in decimal format. Not required with internal receivers.

Set Port Parameters

Not required with internal receivers.

- Select the correct speed and transmission parameters for your receiver.

License...

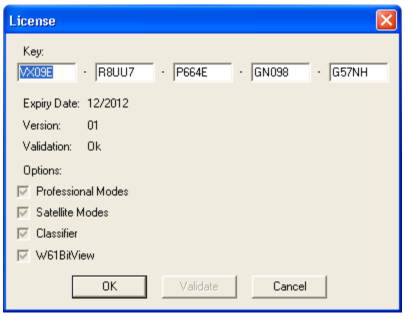
To activate the additional software options a valid activation key is required from WAVECOM.

The key enables the decoder application to

- Check if a customer is entitled to receive certain software upgrades
- Enable certain optional functions

The license activation function is different in the standard and the professional version.

Select **Setup**, then **License...** from the menu bar.



To validate the key, press **Validate.**

When a valid key is entered, the pager modes will be enabled.

The license key is normally printed on your invoice or on your CD.

Note: In some countries decoding of pager modes is not allowed. Check the situation in the country where the decoder is intended to be used.

Inputs...

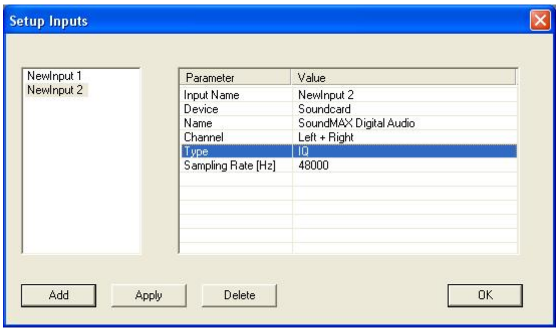
Custom Inputs and Streaming

Streaming and custom inputs belong together. A new custom input has to be defined before streaming can be used to get a specific data stream for decoding. At the moment streaming can be defined for soundcard devices and for .WAV files. If a custom input is set as input source, the data stream is read from the specific input.

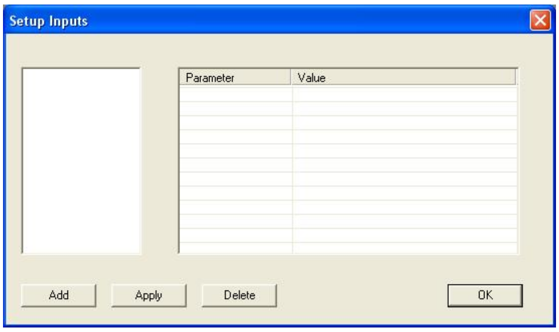
For defining, editing and deleting a custom input the dialog **Setup Inputs** has to be used. The properties of the custom input are stored in a XML file. The defined custom inputs are selectable as normal input source in modes supporting the streaming.

Add a new Custom Input

Select the **Inputs...** menu item in the **Setup** menu to open the **Setup Inputs** dialog.



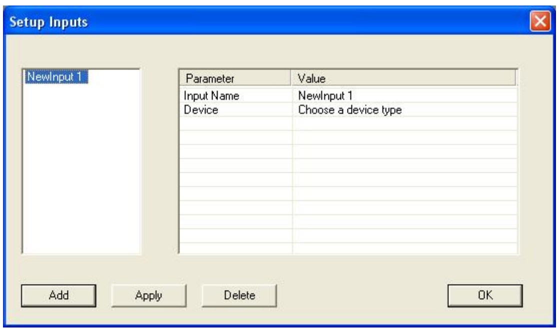
The following image shows the **Setup Inputs** dialog when no custom inputs has been defined so far.



- In the left table the user defined Custom Inputs are listed.
- In the right table the parameters of the currently selected custom input are displayed. The **Parameter** column contains the names of the parameters and the **Value** column shows the related parameter values.
- The **Add** button is used to create a new Custom Input. The **Apply** button saves the parameter settings of new created or an edited custom input. Pressing the **Delete** button removes a defined custom input.

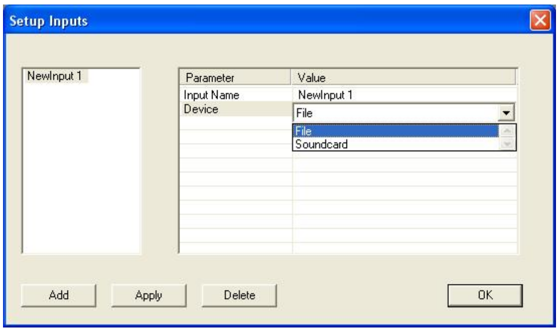
NOTE: If the **Apply** button is not pressed after adding a new Custom Input, the Custom Input will not be created. Pressing the **OK** button closes only the dialog.

The following image shows the 'Setup inputs' dialog after pressing the 'Add' button.



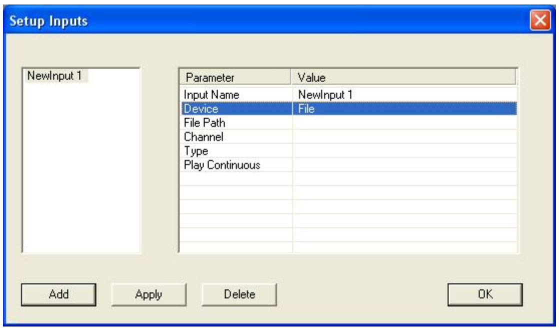
The **InputName** can be edited in the right table by typing a new name into the **Value** field if desired.

Next the device has to be set. **File** or **Soundcard** can be chosen from the appearing list box. By clicking on the **Choose a device typ** the list box will appear.

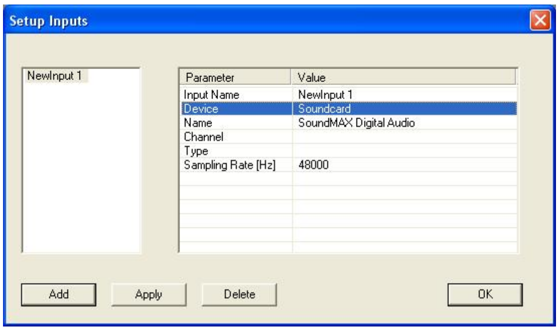


Depending on the chosen **Device**, the related parameter will appear in the parameter list.

The following image shows the **Setup Inputs** dialog after choosing the **File** device from the list.



The following image shows the **Setup Inputs** dialog after choosing the **Soundcard** device from the list.



Soundcard Input Parameter	Value
Input Name	The name of the custom input
Device	For a soundcard custom input **Soundcard** has to be selected in the list
Name	The name of the soundcard. All names of the soundcards that are in-stalled on the specific computer are displayed in a list box where the de-sired soundcard can be chosen from.
Channel	In the appearing list box **Left**, **Right** or the **Left + Right** channel should be used.
Type	PCM or IQ
Sampling Rate [Hz]	The sampling rate is fixed to 48000Hz

NOTE: If the GUI is running in remote mode, the names of the soundcards installed on the server computer are listed.
If the Type **IQ** is set, only **Left + Right** is possible, with **PCM** all three values are possible to select.

To use a WAV-File as signal input, the following parameters have to be set via the **Setup Inputs** dialog:

File Input Parameter	Value
Input Name	The name of the custom input
Device	For a file custom input **File** has to be selected in the list.
File Path	The path to the specific WAV-file is selected.
Channel	In the appearing list box **Left**, **Right** or the **Left + Right** channel should be used.
Type	PCM or IQ
Play Continuous	Indicates if the files are played in repeat mode. Select **On** to switch on the repeat mode or **Off** to switch off the repeat mode.

NOTE: By pressing the **Apply** button the specified WAV-file is copied to the **DATA-INPUT** directory. The **DATA-INPUT** directory is in the installation directory of the WAVECOM product. The name of the WAV-file is renamed to:

<SerialNumberOfWxxCard>_<InputName>.wav

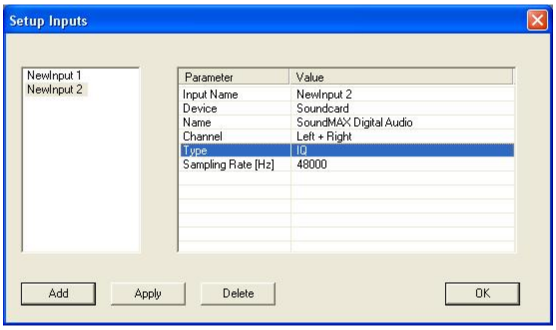
If the GUI is running in Remote mode, then the WAV-file is copied to the **DATA-INPUT** directory on the server computer.
If the Type **IQ** is set only **Left + Right** is possible, with **PCM** all three values are possible to select.

IMPORTANT: At the end of defining the parameters of a new Custom Input press the **Apply** button to create the custom input with the specified parameter settings. The **Apply** button has to be pressed otherwise the new custom input is not created and the parameter settings will be lost.

The XML file **Inputs.xml**, located in the **Config** directory, is updated by pressing the **Apply** button.

Edit a Custom Input

Select the custom input from the input list on the left in the **Setup Inputs** dialog. For instance select the **NewInput 2** entry, which is a soundcard input.



Now it is possible to change the parameter values in the parameter table on the right.

For instance the **Input Name** or the **Channel** parameter value can be changed.

Even the **Device** value can be changed from **Soundcard** to **File**. By changing the **Device** the new device-related parameter will appear in the parameter list and the parameters of the old device will disappear.

By pressing the **Apply** button the changes will be saved in the specific custom input.

The XML file **Inputs.xml**, located in the **Config** directory, is updated by pressing the **Apply** button.

IMPORTANT: At the end of editing the parameters of a custom input press the **Apply** button, otherwise the changes will be lost.

Delete a Custom Input

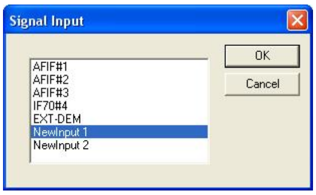
Select the custom input to delete in the **Input** list (left table) and press the **Delete** button. After pressing the **Delete** button the selected custom input will be removed immediately.

The XML file **Inputs.xml**, located in the **Config** directory, is updated by pressing the **Delete** button.

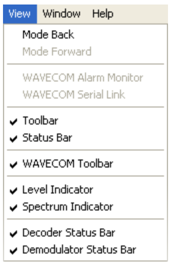
Selecting Custom Input

The user defined custom inputs can be selected via the **Signal Input** dialog. The dialog can be opened over the **Demodulator** menu entry **Inputs...** or by double-clicking the **Input** status bar field at the right bottom of the GUI.

The next image shows the **Signal Inputs** dialog with two user defined custom inputs at the end of the list.



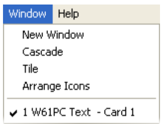
View Menu



In the **View** menu the visibility of each individual status and indicator element may be selected or deselected. A checkmark indicates that the element is selected. A deselected element is not deleted, but may be made visible at any time.

For context sensitive help on a menu item, use **F1** on the item.

Window Menu



Using the **Window** menu new output windows may be opened and organized. These windows may for instance display data stored in a file.

From the **Help** menu, which is not shown here, all help functions and information related to the current software release is available. For context sensitive help on a menu item, use **F1** on the item.

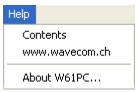
Help Menu

Contents

Selecting **Contents** opens the online help system.

Help on clicked buttons, menus and windows are then available.

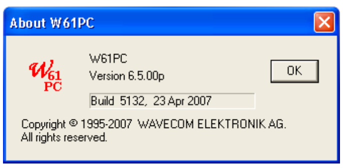
WAVECOM on the Web



Contents access the decoder help file.

www.wavecom.ch links to website of WAVECOM.

About W61...



Displays information on software version, build number, and release date for the installed application.

Button Bars

The selection of the most important decoder functions is facilitated by toolbar buttons. Operation is identical to the use of the menu bar.

If the mouse is resting for more than approximately half a second on a button, a label with the name of the function is displayed (tool tip). In addition a short help text is displayed on the system status bar.

Depending on the active mode, buttons for which the corresponding function is not available are grayed.

Toolbar

Most functions on this toolbar are also available from the **File** menu.

WAVECOM Toolbar

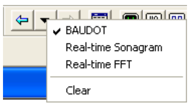
This toolbar is adaptive. Depending on the selected mode or analysis tool, the corresponding buttons are displayed.

Back

Go to last decoding or analysis mode

History

Select one of the last decoding or analysis modes from this drop down menu.



Forward

Go forward in the history list after going back in the history list.

Level Indicator

Click on the **Gain** icon to adjust the input to the correct level. Gain adjustment must **never** turn on the red bars of the level indicator.

Spectrum Indicator

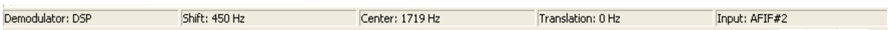
The **Spectrum Indicator** is a tuning tool consisting of a number of colored elements representing an increasing frequency from the left to the right. For FSK signals the mark and space frequencies are displayed. For PSK signals the carrier is displayed.

Status Bars

Decoder Status Bar

The **Status Bar** displays decoder status information.

Demodulator Status Bar



The **Demodulator Status Bar** displays information about the status of the DSP demodulator

Double-Clicking on Status Bar Fields

Double-clicking various status bar fields will activate the corresponding dialog boxes. This facilitates the use of the decoder software.

A double-click on the shift field, baud rate field, frequency shift field etc. of the demodulator status bar opens the corresponding dialog boxes.

Selecting a field will not terminate the active mode. As far as possible changed values will be immediately used without interrupting data acquisition.

Tuning Radio Data Signals

Most modes have an **AUTO** option. If this option is enabled, the decoder will automatically tune to the received signal. First the software measures the mark and space frequencies, calculates the shift and determines the resultant center frequency. Then the demodulator is automatically adjusted to the correct shift and center frequency.

Tuning a FSK (F1B) Signal

Tuning with Mark-Space demodulator

Shift 400 Hz, center frequency 1700 Hz

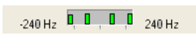
Many radio data modes employ FSK modulation (Frequency Shift Keying). In this modulation type two frequencies called MARK and SPACE are keyed. The two tones should be symmetrically grouped around the center of the tuning indicator.

In some modes a **Tuning FFT** is available, see “TUNING FFT on page 58”.

Tuning a Twinplex (F7B) Signal

Tuning with MFSK demodulator

Shift 115-170-115 Hz, center frequency 1700 Hz



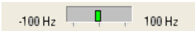
In Twinplex mode four frequencies are keyed to increase the data transfer rate. These frequencies may be asymmetrically grouped (e.g. 115-170-515 Hz) around the center frequency.

In the **Twinplex** menu a menu option gives the operator a choice of six pre-selected shifts in the dialog box **MFSK Shift**.

Tuning a CW-Morse Signal

Automatic pre-selection CW-MORSE demodulator

Bandwidth 200 Hz, center frequency 800 Hz



The transmission of Morse is often done by simply keying the carrier on and off. The demodulated signal is output by the receiver as a tone.

With no signal (tone) present, the bar graph will remain turned off; whereas when a signal is present one bar graph element will turn on at a position determined by the value of the beat frequency relative to the selected center frequency.

The bandwidth of the CW demodulator may be adjusted between 50 and 1200 Hz. A standard bandwidth of 400-500 Hz is recommended. In case of unstable transmissions the bandwidth must be increased up to 1200 Hz. The automatically adjusted FIR filter provides an optimized signal-to-noise ratio.

In addition to the bandwidth the center frequency may be adjusted between 500 Hz and 3500 Hz. 800 Hz and 1000 Hz are regarded as standard center frequencies.

Tuning a WEATHER-FAX Signal

Tuning with DSP demodulator

Shift 300 Hz, center frequency 1900 Hz

Weather and press facsimile signals transmitted in the HF bands are frequency modulated. In contrast satellite fax transmissions from e.g. METEOSAT are amplitude modulated.

In all modes the tuning of the FM or AM signal is done symmetrically around the center of the bar graph. Weather chart signals without gray levels are characterized by white level information being dominant, and as a result of this, one or two elements of the left side of the bar graph will be more intensively lit.

Tuning a MFSK Signal

Selecting FSK Analysis

Pre-selection center frequency 1700 Hz

MFSK signals as PICCOLO or COQUELET employ a varying number of sequential tones. Therefore tuning is most easily done using the **MFSK Analysis** feature. The lower spectrum window graphically displays the various tones which have been sampled over a certain time interval. In this case the signal shown is a PICCOLO-MK6 transmission. By tuning the receiver or changing the decoder center frequency in the menu field **Center,** the tones must be symmetrically grouped around the center frequency.

Minor frequency deviations up to 5 Hz are automatically compensated utilizing the AFC (Automatic Frequency Control) function.

Tuning an ERMES Signal

Selecting ERMES

Shift 10000 Hz

The Europe-wide ERMES paging system is one of the very few Twinplex modes in which the idle state (no information) frequencies are not symmetrically grouped around the center frequency. Thus the VHF-UHF receiver must be tuned in such a way, that the two idle state indications are displaced to the right. Only in traffic state the two other frequencies may be observed.

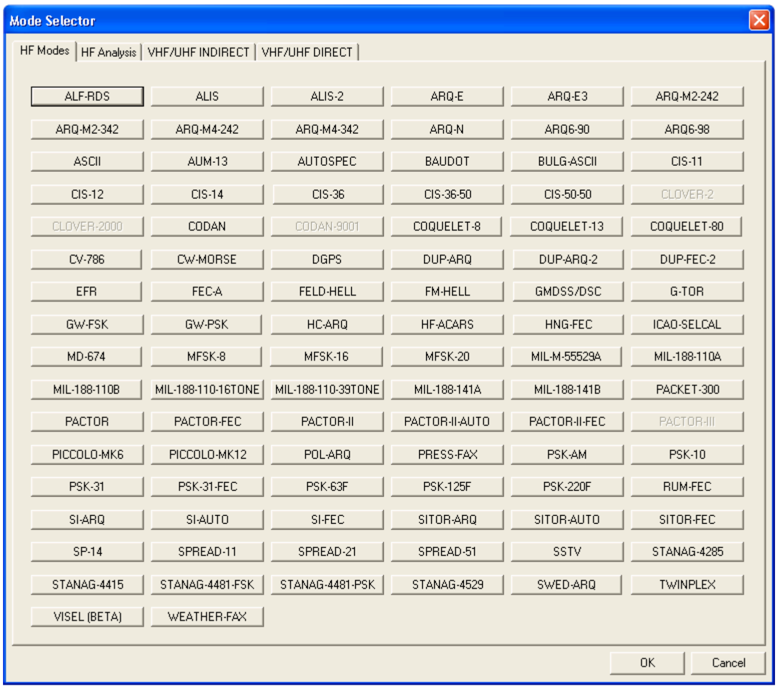
Mode Selector

Full-screen menus are available for modes and analysis tools. Click on the **Mode Selector Button** in the toolbar to open this menu. Modes are available in alphabetical order. Click on a mode to start it. From the top row tabs analysis tools may also be selected.

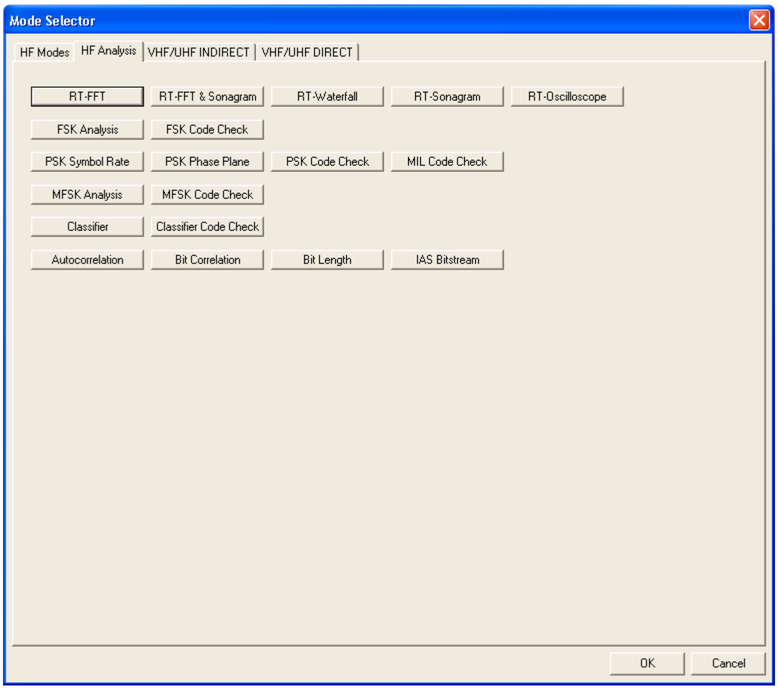
If a mode is already active it will not be terminated or halted by opening the full-screen menu. Click on **Cancel** or the WINDOWS **Close** button to leave the menu.

The descriptions of the operating modes in another section of this manual are arranged in alphabetical order.

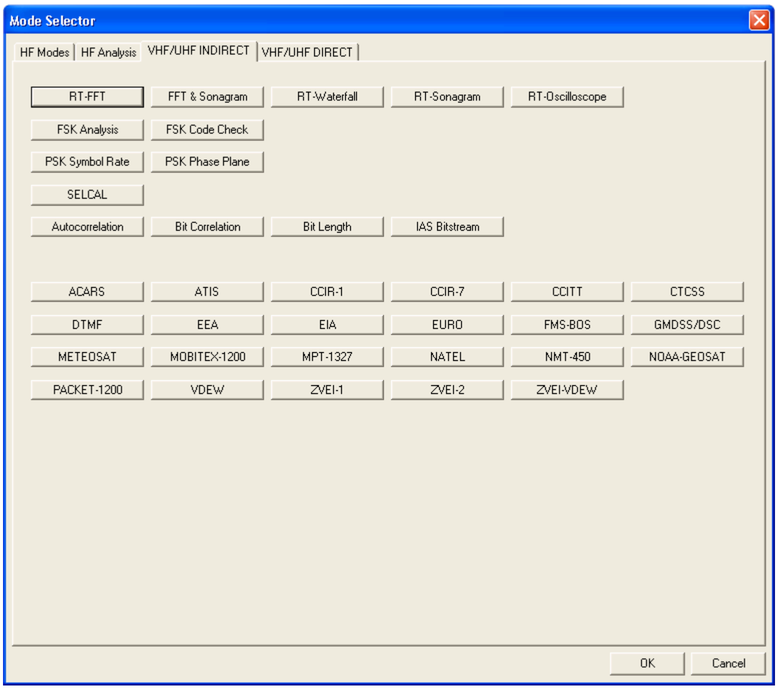
HF-Modes



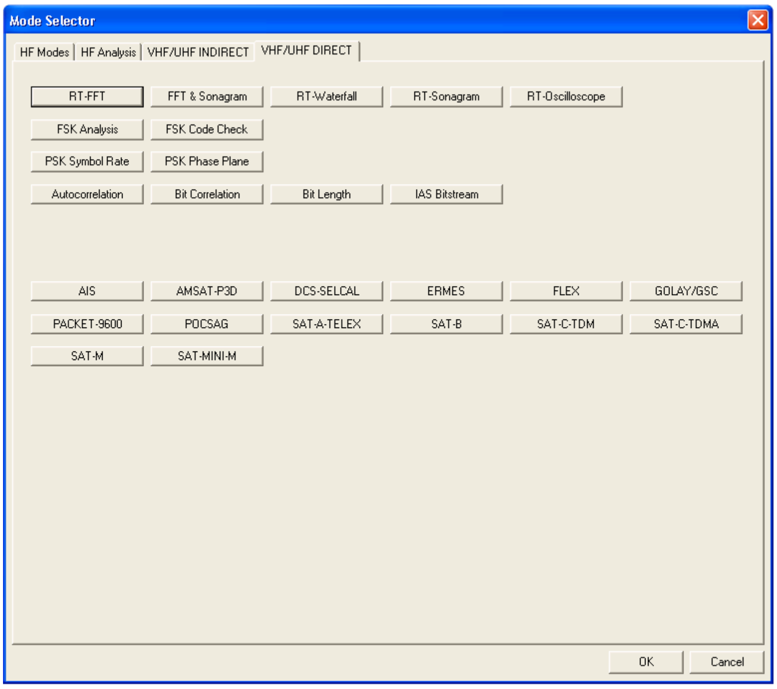
HF Analysis



VHF/UHF INDIRECT



VHF/UHF DIRECT

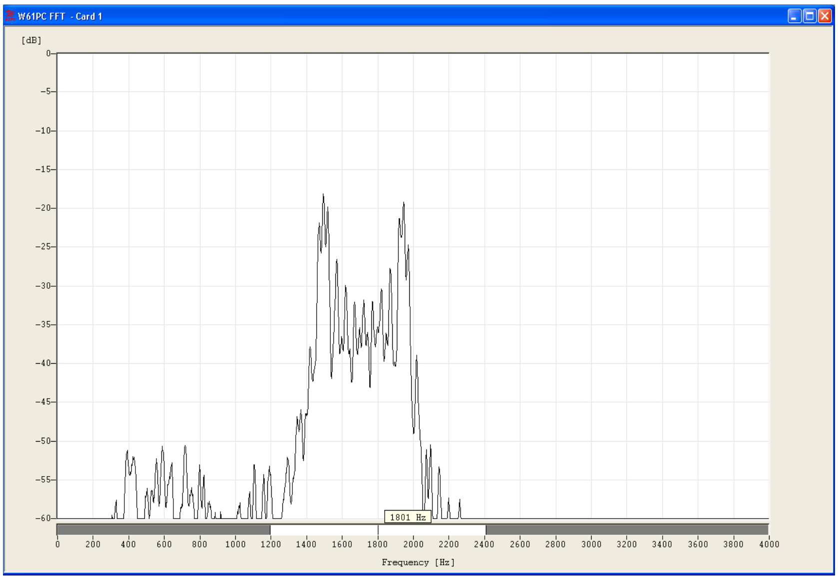


REAL-TIME FFT

Real-time FFT analysis is a powerful spectrum analysis tool based on Fast Fourier Analysis (FFT) in real time with a 4096 pixel resolution. Briefly explained the signal is digitized, saved and its frequency spectrum calculated and displayed.

The measurement is started by selecting a bandwidth. The display of the frequency spectrum has a linear scale and covers a dynamic range of 60 dB. The internal dynamic range is considerably higher due to the 16 bit A/D converter used, but the configured display resolution has proved better in practical use.

The frame refreshment frequency averages 10 to 20 pictures per second, allowing even fast signal changes to be displayed. The frame refreshment frequency is however dependent on the CPU power of the PC and its video system.



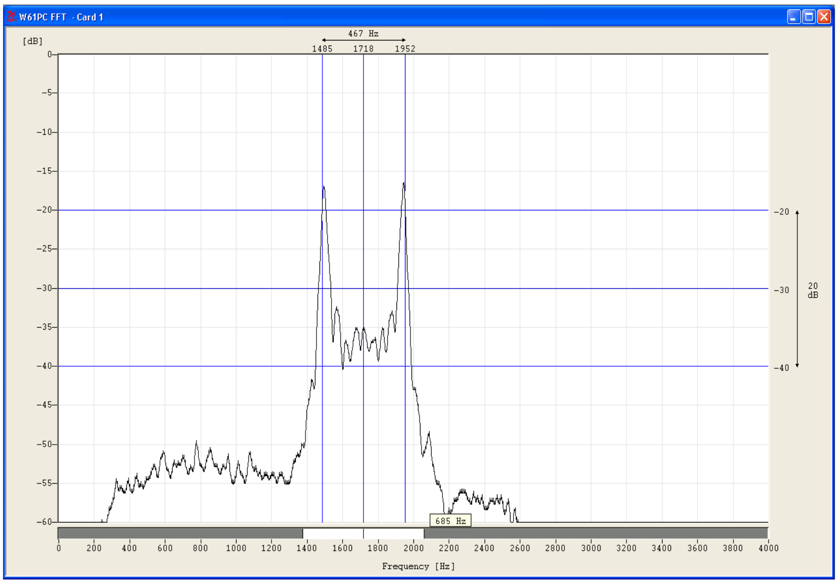
To start real-time FFT click on the **RT-FFT** button or use **Analysis/Real-time FFT** from the HF or VHF modes menus.

To select a display bandwidth use **Demodulator/Bandwidth** or double-click on the **Bandwidth:** field on the demodulator status bar. Real-time bandwidths of 0.5, 1.0, 2.0, 4.0, 24, 48 and 96 kHz are available.

To activate the measurement cursors, click inside the FFT graphics window. The left and right cursors may be moved around using the mouse. The cursor positions are displayed as absolute frequency values. The center cursor automatically displays the center value.

To remove the cursors click on the graphics window again.

When the cursors have been placed in the desired positions they may be moved right or left by moving the center cursor. The measurement of frequency spacing in MFSK and FDM systems is hence significantly facilitated.



After choosing an **Average Factor** from the **Options** menu, up to 64 measurements may be displayed as an average value. A value of "1" turns averaging off. The averaged display of several measurements is very helpful when monitoring MFSK and FDM transmissions or during heavy fading. The average function may also be selected by double-clicking the **Avg:** field in the upper status bar.

From **Options/Window Type** four window functions **Rectangle**, **Hamming**, **Hanning** and **Blackman** may be selected. The selection of a window type influences the accuracy of the signal spectrum measurement. Good amplitude resolution is obtained using the rectangular window, but on the other hand this window type also causes heavy distortions. Each window type has its own characteristics as listed below.

The user should be aware that changes in the received signal can cause the display of spurious spectral lines or aliasing ("false" frequency display) in FFT measurements. Depending on the keying frequency and the magnitude of the frequency shift, the aliased frequencies may even be stronger than the desired signal.

Window Type	Signal Type	Frequency Resolution	Spectral Leakage	Amplitude Accuracy
Blackman	Random	Poor	Best	Poor
Hamming	Random	Good	Fair	Fair
Hanning	Random	Good	Good	Fair
Rectangular	Transient	Best	Poor	Poor

Several **Color schemes** are available through the right-click menu.

Adjustment of the Translation Frequency

A FFT spectrum calculation can be done from 0 Hz to the selected maximum range.

The translation frequency for decoding of **DIRECT FSK** transmissions e.g. POCSAG, GOLAY/GSC, or ERMES must be adjusted to the effective center frequency of the signal, e.g. 455 kHz.

A bandwidth of 24 kHz from **455 kHz to 479 kHz** is sufficient for the measuring range of the FFT. Therefore the translation frequency must be offset to half of the bandwidth. The translation frequency adjustment is calculated as the IF output frequency **(455 kHz)** minus half of the selected FFT bandwidth **(24/2 kHz)** = Translation **(443 kHz)**. The measurement range is now 443 kHz - 467 kHz.

For the 455 kHz receiver IF output of a shortwave receiver (e.g. HF-1000), the translation frequency is first adjusted to 453.3 kHz to obtain the standard center frequency of 1,700 Hz. The HF-1000 BFO must now be adjusted to 1,700 Hz. Thus it is unnecessary to change the translation frequency for FFT measurements. Neither is a change necessary for AF (**INDIRECT FSK**) signals.

HF REAL-TIME FFT

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a HF mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See “Preferences... on page 42”.

TUNING FFT

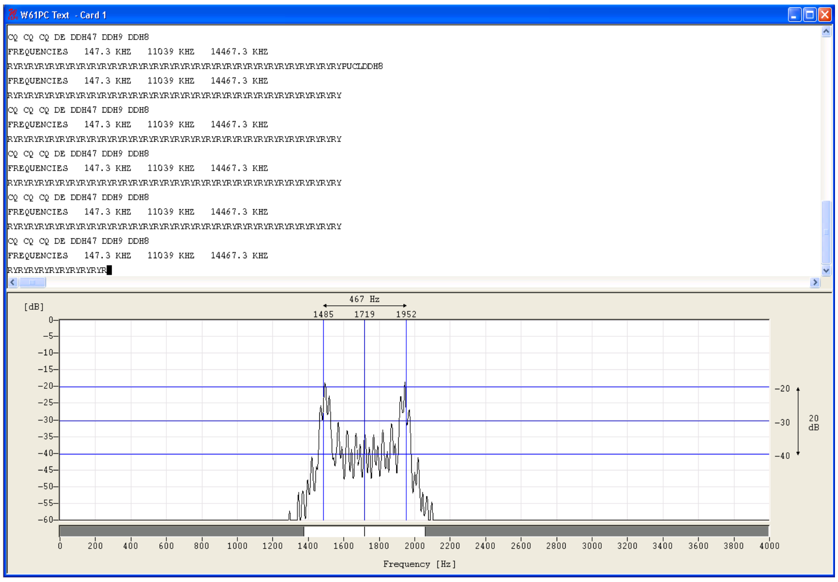
In some modes a **Tuning FFT** is available. After launching the mode, the first step is to look for a valid signal in the spectrum:

Like in the standard FFT the following options can be set using the **Options** menu or the right mouse button:

- Average Factor
- Window Type
- Peak Hold

For more details, see "HF REAL-TIME FFT on page 57".

Tuning FSK Signals

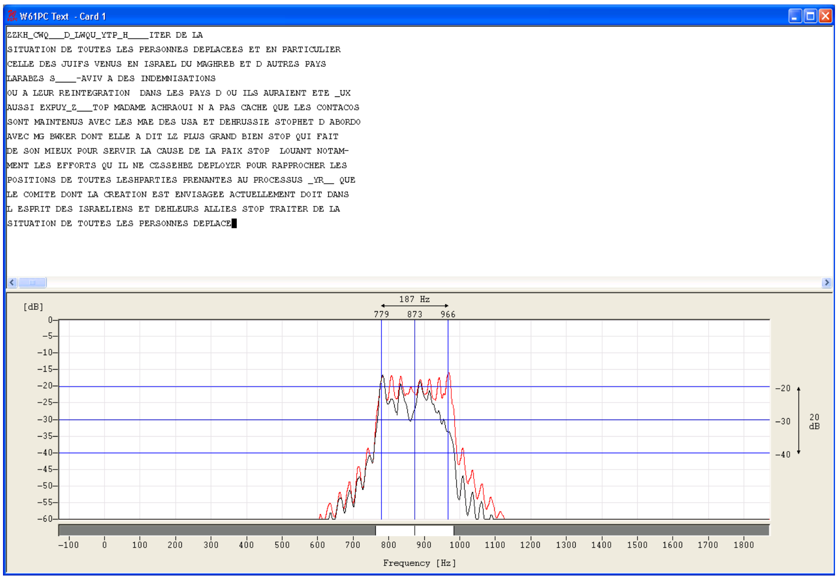


Mark and Space are selected with the right and left cursor. **The precision of the center frequency is very important and directly influences the performance of the decoding.**

After every change, the center frequency and shift is automatically updated.

Automatic tuning is also available. It works perfect as long as you have just one signal in the received spectrum.

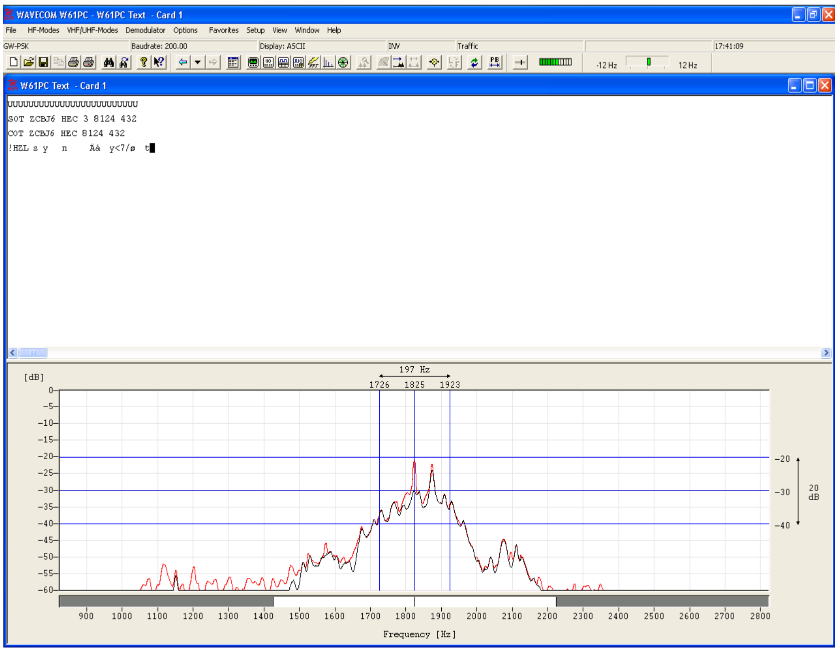
Tuning MFSK Signals



The highest and lowest tone of the signal is selected with the right and left cursor. **The precision of the center frequency is very important and directly influences the performance of the decoding.**

After every change, the center frequency and shift is automatically updated.

Tuning PSK Signals



The upper and lower frequency boundaries of the signal is selected with the right and left cursor. With the center cursor, the center frequency may be set more precisely. **The precision of the center frequency is very important and directly influences the performance of the decoding. I**

After every change, the center frequency is automatically updated and the bandwidth of the signal is set according to the received mode...

VHF INDIRECT REAL-TIME FFT

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF indirect mode was active. The parameters are only available, if in the **Preferences...** menu the **"Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

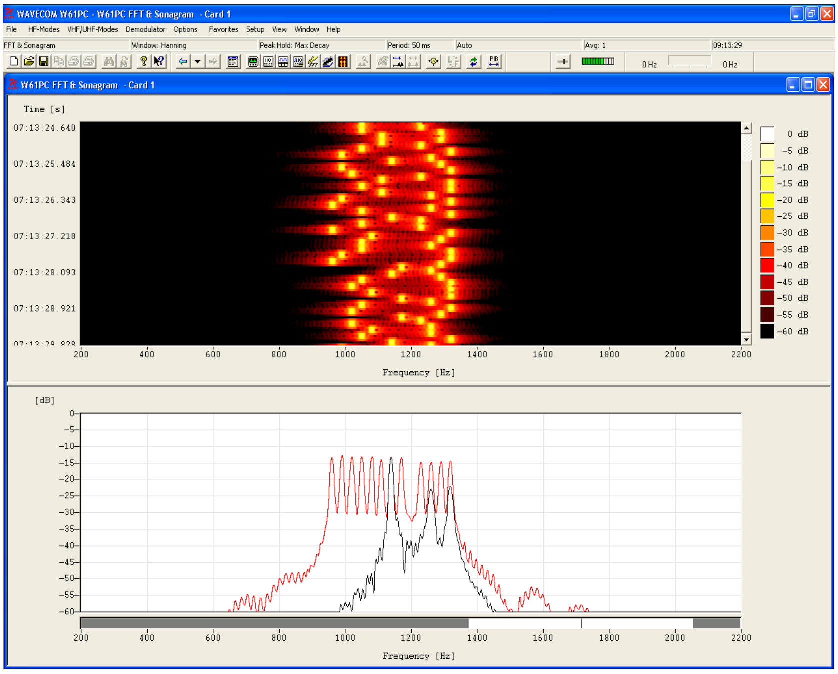
VHF DIRECT REAL-TIME FFT

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF direct mode was active. The parameters are only available, if in the **Preferences...** menu the **"Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

FFT and SONAGRAM

This analysis tool combines the common real-time FFT analysis and the common real-time sonagram modes.

Detailed information for each of those analysis tools can be found in the corresponding descriptions.



HF FFT and SONAGRAM

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a HF mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See “Preferences... on page 42”.

VHF INDIRECT FFT and SONAGRAM

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF indirect mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See "Preferences... on page 42".

VHF DIRECT FFT and SONAGRAM

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF direct mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See "Preferences... on page 42".

REAL-TIME WATERFALL

The real-time waterfall analysis produces a three dimensional display of a FFT spectrum in time, frequency and amplitude. The waterfall display aggregates many single measurements with altogether 40 graphically displayed values. An updated measurement in the two-dimensional real-time FFT display only shows a fraction of the data, depending on the modulation method. In contrast the FFT waterfall display also displays data in the time domain

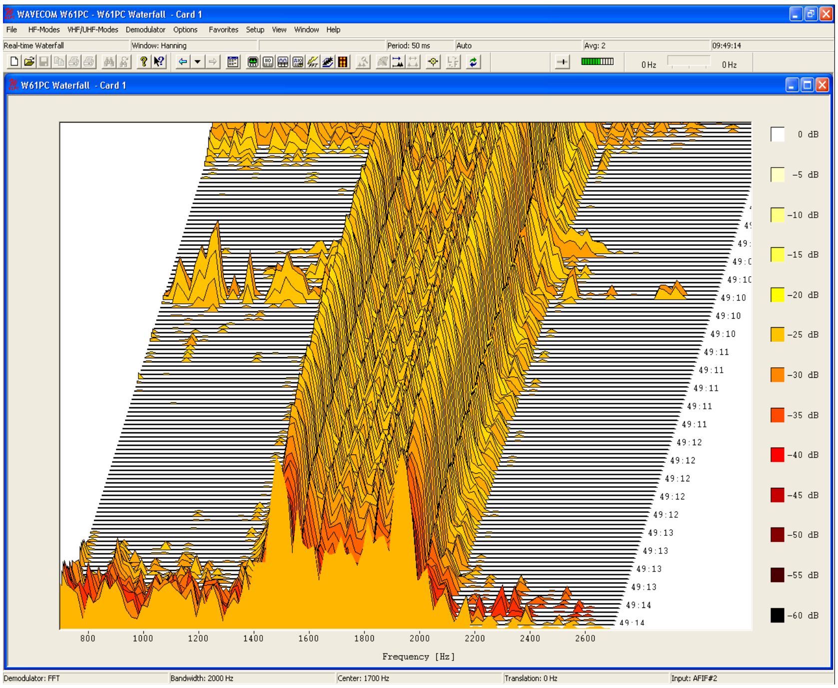
Waterfall analysis is started by clicking on a desired bandwidth **BW 500 Hz**, **BW 1000 Hz**, **BW 2000 Hz, BW 4000 Hz**, **BW 24 kHz**, **and BW 48 kHz or BW 96 kHz**.

A time histogram is displayed on the right-hand side of the display.

The options **Average Factor** and **Window Type** are identical to the corresponding real-time FFT functions.

From the **Options/Period** menu the time unit per measurement may be selected. The lowest value is 50ms corresponding to a sampling rate of 20 pictures/s. For the highest value of 10,000 ms a measurement is done once every 10 seconds, giving a total time span of more than 400 seconds.

By clicking on the graph, the display will be paused and measurement cursors appear.



Several **Color schemes** are available through the right-click menu.

HF REAL-TIME WATERFALL

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a HF mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See "Preferences... on page 42".

VHF INDIRECT REAL-TIME WATERFALL

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF indirect mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See "Preferences... on page 42".

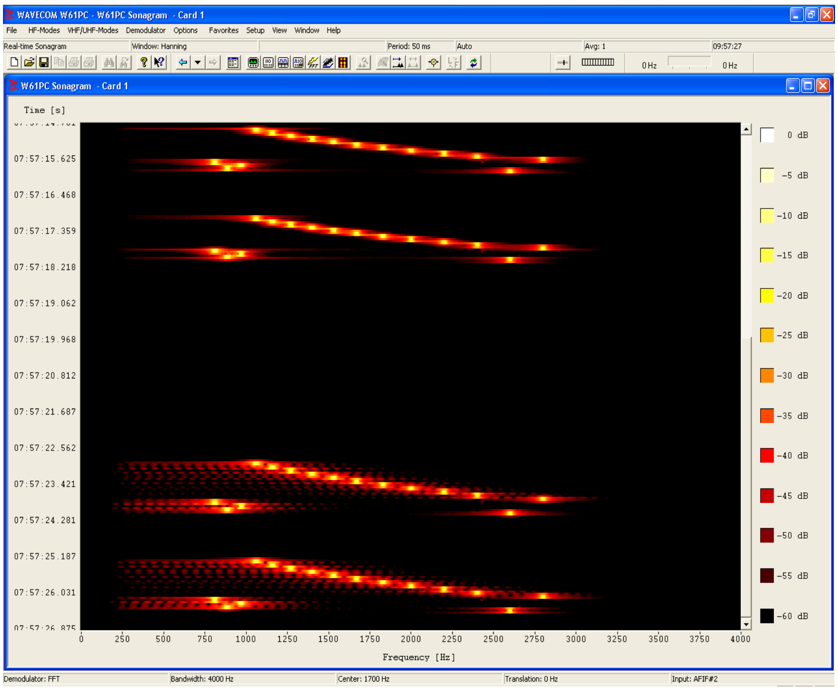
VHF DIRECT REAL-TIME WATERFALL

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF direct mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See "Preferences... on page 42".

REAL-TIME SONAGRAM

A second widespread method for FFT display is the real-time sonagram which also displays the frequency, amplitude and time domain parameters of the signal. A sonagram is a graphical display of an acoustical structure. In the sonagram the signal amplitude is displayed in color coded dB steps.

This amplitude related spectrum analysis mode offers many hints to the distribution of a signal spectrum.



The operation is identical to the real-time waterfall analysis.

HF REAL-TIME SONAGRAM

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a HF mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See “Preferences... on page 42”.

VHF INDIRECT REAL-TIME SONAGRAM

When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF indirect mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See “Preferences... on page 42”.

VHF DIRECT REAL-TIME SONAGRAM

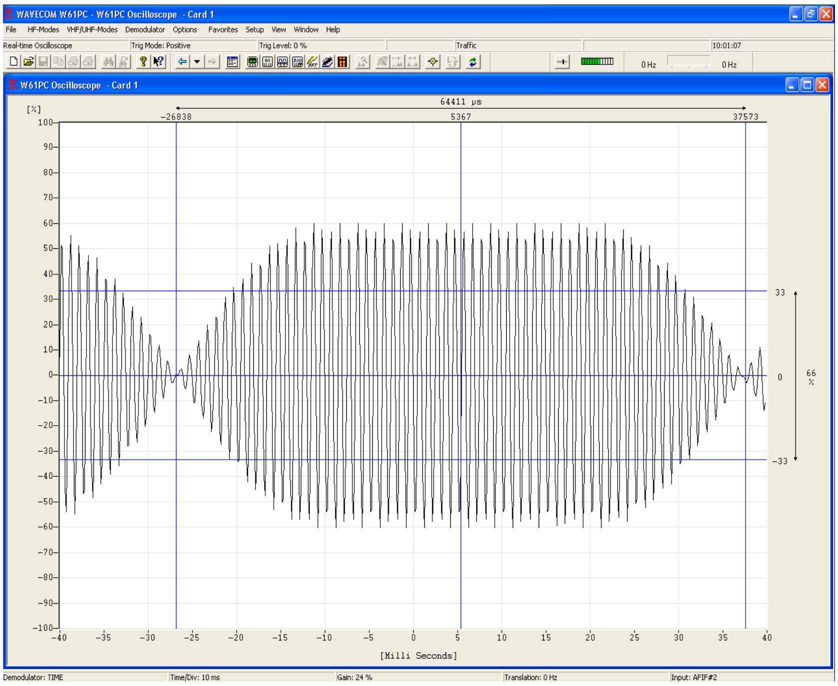
When enabled this analysis mode starts up with the input, gain, translation frequency and other parameters used the last time a VHF direct mode was active. The parameters are only available in the **Preferences...** menu and the **When selecting the toolbar "Analysis Buttons" start HF analysis mode** menu item is disabled. See “Preferences... on page 42”.

REAL-TIME OSCILLOSCOPE

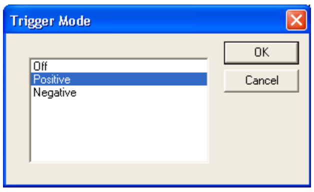
In general an oscilloscope is used to measure voltage and time. However, the real-time oscilloscope displays a relative and un-calibrated value. After having obtained the measured time, frequency can be determined.

By clicking on the graph the display will be paused and measurement cursors appear for both axis.

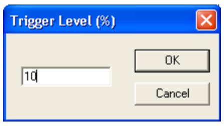
Several **Color schemes** are available through the right-click menu.



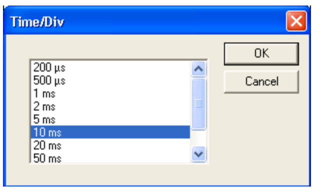
The option **Trigger Mode** allows the real-time oscilloscope to trigger on the **Positive** or the **Negative** slope or to be switched **Off**.



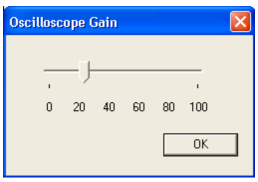
The **Trigger Level** option allows conventional level driven triggering to be set. The un-calibrated input voltage range is from +99% to –99%.



The vertical sensitivity may be set with the option **Time/Div**. Nine predefined values are available covering a range from 200 µs to 100 ms per division.



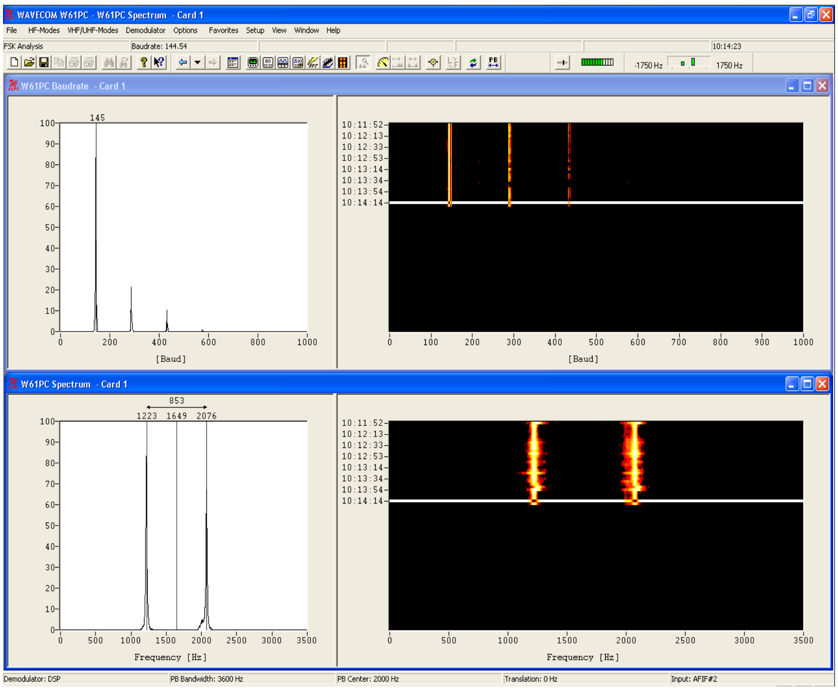
Using the **Oscilloscope Gain** option, the horizontal un-calibrated input voltage sensitivity may be adjusted from 0% to 100%.



FSK ANALYSIS

The FSK analysis mode is an important tool to measure the baud rate and frequency shift of FSK transmissions. The magnitude of these properties may help identify the transmission being monitored.

To open the FSK analysis window go to the **HF-Modes**, and select **Analysis/FSK Analysis** from the menu, or use the **FSK Analysis** button. The baud rate and spectrum window will open, but NOT the waterfall window. After a few seconds the baud rate and spectrum window are updated.



The FSK analysis window consists of four panes:

- A baud rate graph pane
- A baud rate waterfall pane
- A spectrum graph pane
- A spectrum waterfall pane

Baud Rate and Spectrum Window

The baud rate and spectrum window are two-dimensional displays of the monitored baud rate measured in Baud and the spectrum of the transmission measured in Hz against a relative scale from 0 to 100. The displays are updated in intervals of about 5 seconds. The calculated baud rate, center frequency and frequency shift values of the latest sample are stored to be used whenever a decoding mode is selected.

Two pairs of cursors may be placed in the baud rate and spectrum graph windows to assist in manual measurements. The values to which they point, and the difference between the two cursor values, are shown above the cursors. When a pair of cursors is placed in one of these windows, graph display updating is halted, but signal sampling continues and is displayed in the waterfall window. The time cursor in the waterfall window is placed on the selected sample.

Methods exclusively based on bit length measurement are unreliable for baud rate measurements. The baud rate measuring process employed by the decoder is therefore based on a new method employing auto-correlation and subsequent Fast Fourier Transformation (FFT) presentation. Using this method, FSK transmissions may be analyzed without problems. Be aware that when measuring the baud rate of codes using code words having a non-integral number of bits, e.g. asynchronous 7.5 bits ITA-2, the indicated baud rate will increase by a factor two.

Waterfall Window

To open the waterfall window move the mouse to the left of the extreme right of the graph window. The normal cursor will turn into a splitter - two parallel lines with arrows perpendicularly attached. Now, hold and drag to place the boundary between the windows where you wish, when the mouse button is released.

The waterfall windows are two-dimensional displays of baud rate and spectrum versus time. The color intensity of the displays represents the energy density of the spectrum and the value of the relative occurrence of a baud rate - for gray scale values, white is the higher intensity and black the lower one. A time stamp points to the latest sample taken. The latest sample is color inverted to distinguish it from the previous samples.

If the user wishes to examine a particular sample, it may be selected in the waterfall window. The sample is marked with the time cursor, cursors are placed in the graph window and updating is halted in that window.

FSK Analysis Options

To assist the measurement of noisy signals, a peak measurement function and an averaging function is available. When one of these options is selected a time span of five samples from the inverted sample and backwards in time in the waterfall window will be used for calculations. The result is displayed in the graph window. The user may also select a larger time span as basis for calculations from anywhere in the waterfall window.

MEASURE PEAK AND AVERAGE VALUES

Select the function you wish to use from the **Options** menu. A checkmark is shown to the left of the option selected and five samples are inverted in the waterfall window selected to indicate the number of samples used for the calculations.

If you wish to use more or less samples in the calculation, place the mouse on the waterfall sample from which calculation should start and hold and drag the mouse over as many samples as you want to use.

The marked samples will be color inverted, cursors will appear in the graph window and the graph display will show the average or the peak value of the marked samples.

To disable peak or average measurement, reselect it from the **Options** menu. The checkmark and the cursors will disappear, only one sample is marked in the waterfall window and updating of the graph window will restart.

EXAMINE SAMPLE, DISPLAY CURSORS

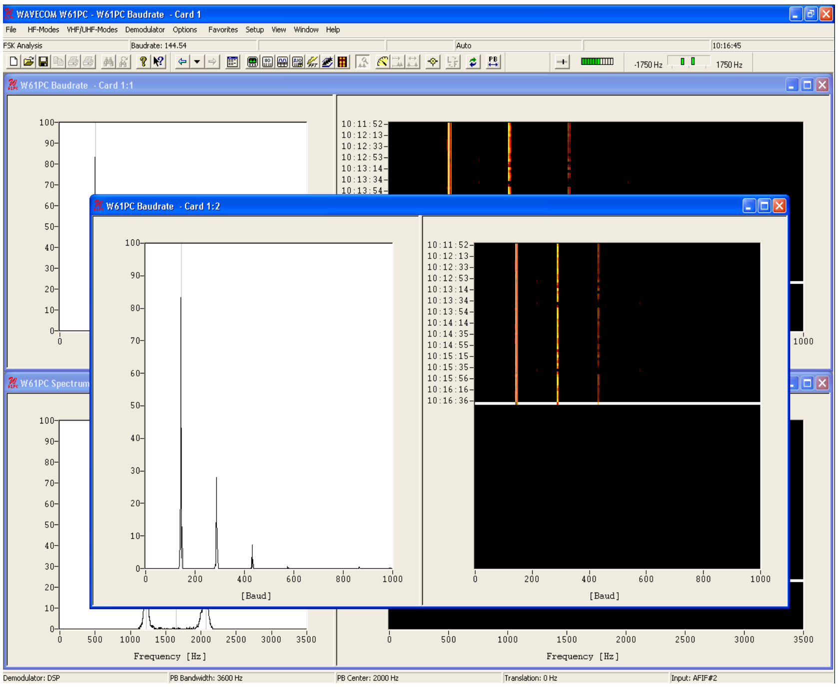
Click on the baud rate or the spectrum graph window to display the cursors. Or click on the sample in the waterfall window, you wish to examine. Graph window updating will stop and a pair of cursors appears.

You may move the cursors along the x-axis in normal Windows fashion. The matching waterfall sample is marked with the time cursor.

Click on the graph window again to remove cursors and restart graph window updating.

Display of Single FSK Analysis

Click on **New Window** in the **Window** menu to change a field of the FSK analysis window into a full-screen window. The larger display facilitates tuning.



The active field is now displayed as a full-screen **Spectrum** or **Baud rate** window.

HF FSK ANALYSIS

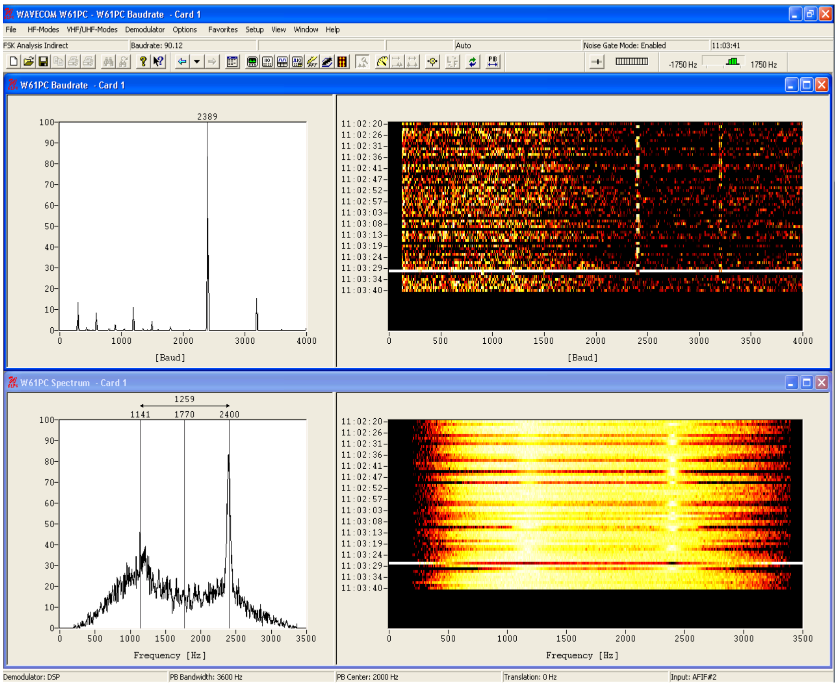
HF FSK analysis is started with the values of input, gain, translation frequency etc. which were used, last time an HF mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

VHF INDIRECT FSK ANALYSIS

The FSK analysis indirect mode is an important tool to measure the baud rate, center frequency and frequency shift of VHF Indirect signals, e.g. ACARS and MPT. The magnitude of these properties may help identify the transmission being monitored.

Analysis is started with the values of input, gain, translation frequency etc. which were used, last time a VHF Indirect mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

To open the FSK analysis window go to **VHF/UHF-Modes/Analysis INDIRECT/FSK Analysis** or use the **FSK Analysis** button. The baud rate and spectrum windows will open.



Because this kind of signals is not continuous, there is a need for a noise gate. The status of the noise gate is displayed in the status bar. The noise gate examines the input signal and tries to find out, if a valid signal is available which can be processed or if the input consists only of noise.

If the noise gate has found a valid signal the baud rate and spectrum windows are updated.

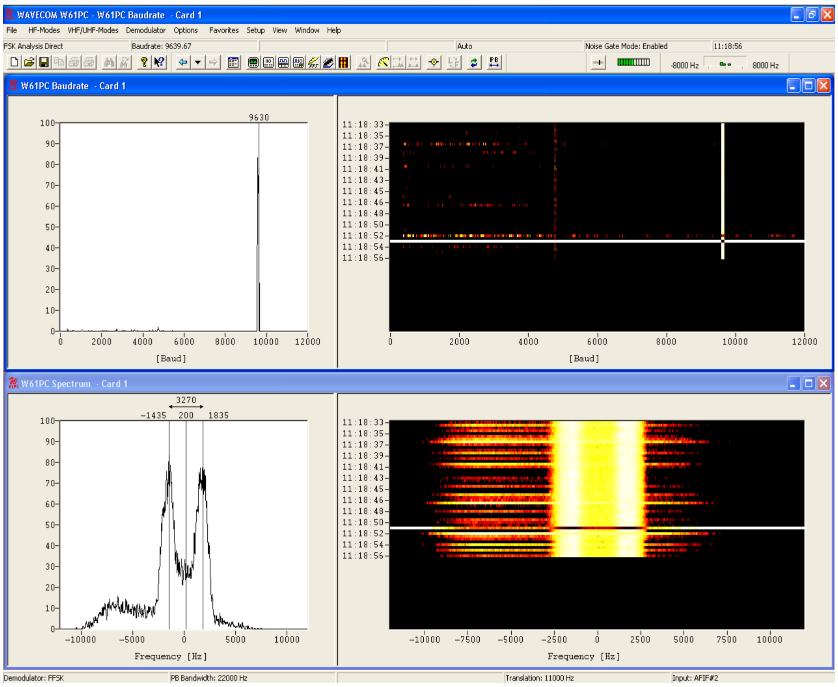
VHF DIRECT FSK ANALYSIS

The FSK analysis direct mode is an important tool to measure the baud rate and frequency shift of VHF direct signals like POCSAG and FLEX. The magnitude of these properties may help identify the transmission being monitored.

Analysis is started with the values of input, gain, translation frequency etc. which were used, last time a VHF direct mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See “Preferences...” on page 42”.

To open the FSK Analysis window go to **VHF/UHF-Modes/Analysis DIRECT/FSK Analysis** or use the **FSK Analysis** button. The baud rate and spectrum windows will open.

Because this kind of signals is not continuous, there is a need for a noise gate. The status of the noise gate is displayed in the status bar. The noise gate examines the input signal and tries to find out, if a valid signal is available which can be processed or if the input consists only of noise.



If the noise gate has found a valid signal the baud rate and spectrum windows are updated.

FSK CODE CHECK

HF FSK CODE CHECK

The purpose of the HF FSK code check is to automatically identify the mode of transmission, baud rate, frequency shift and center frequency.

FSK code check is started in automatic mode by selecting the **Code Check** button or from **HF-Modes/Analysis/FSK Code Check**. This function has a high degree of accuracy when determining baud rate, frequency shift and center frequency of HF FSK systems.

Analysis is started with the values of input, gain, translation frequency etc. which were used, last time an HF mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

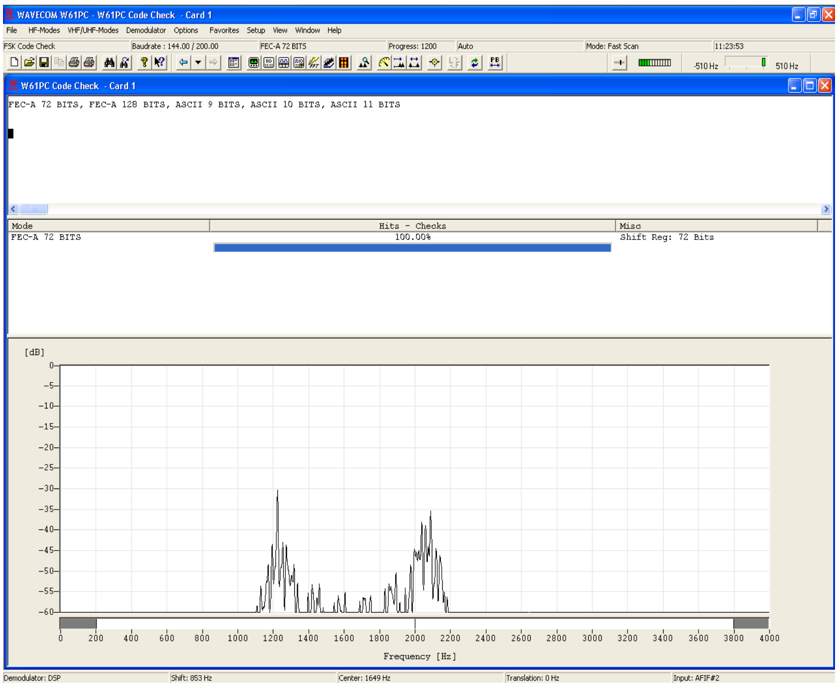
As an additional help FSK code check also offers an option to start the analysis manually after user entry of baud rate, frequency shift and center frequency. To utilize this option the **Auto** button must be deselected. The software will then start data acquisition using the pre-selected parameters. If a pre-selected parameter has been changed data acquisition is restarted by double-clicking **Auto**.

The selection of baud rate, frequency shift or center frequency is done by clicking on the status bar fields or using the **Demodulator** menu.

If the FSK code check cannot identify a mode, the code check should be repeated. Data acquisition is continuously performed as a background task. Heavy fading or other disturbances during data acquisition may prevent the identification of a mode.

The 1.5 stop elements used in many Baudot transmissions will often prevent the correct determination of the signal baud rate or the baud rate will be calculated to have twice its actual value. Distorted stop elements may also lead to totally false baud rate calculations. To prevent this malfunction, measurements of Baudot transmissions take place using the standard speeds of 45.45, 50, 75, 100, 150 and 180 Baud in addition to the actually measured baud rate.

If a mode is uniquely identified, the software will switch to the identified mode and decoding is initiated with the measured values of mode, baud rate, frequency shift and center frequency.



If two or more different systems are identified or if more than five proven transmission errors occur an automatic switch to a mode will not take place. In the current versions, text is not displayed in the data field in the mode table.

After starting the FSK code check the frequency shift, center frequency and the baud rate are determined. The values of these parameters are displayed in the appropriate fields after the measurement has completed.

The software then proceeds with code and system analysis. The incoming bit stream is tested against known modes. For some modes using a high interleaving depth (e.g. RUM-FEC) large quantities of input data are required. These modes therefore require longer to test and are tested last.

The name of each identified system is displayed in the output window. The decoded text is simultaneously displayed in upper and lower case in two lines. An identified system may be immediately started by double-clicking the system in the output window – for instance double-clicking ARQ-E in the figure above will interrupt FSK code checking and immediately start ARQ-E.

The **Hits-Checks** will show you how often during checking a mode was successfully determined. If multiple modes are listed this will indicate which mode should be tried.

Some modes are very difficult to distinguish, especially when the system is in idle mode. The decoded text including text representations of the special characters IDLE ALFA, IDLE BETA and RQ are important additional classification aids in determining the mode under examination.

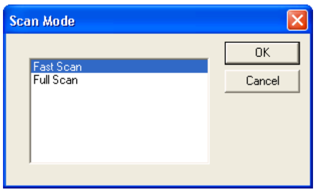
In the case of ITA-5 (ASCII) systems only one data line is displayed as the ITA-5 alphabet does not include case shift characters.

Fast Scan / Full Scan

The software proceeds to create a list of modes to check, which is displayed in the **Code Check** window. The content of this list depends on the selection of the **Fast Scan** or **Full Scan** options. In **Fast Scan** mode, the list only contains the modes, which are known to use the measured baud rate. In **Full Scan** every mode is listed, which is suitable for a FSK code check.

It is possible to switch between **Fast Scan** and **Full Scan** in two ways:

- **Menu Options**, **Scan Mode**
- Click in the mode field on the decoder status bar



Fast Scan does not evaluate all possible combinations, but performs a pre-evaluation according to an internal list to reduce evaluation time.

In **Full Scan** all possible combinations are evaluated.

VHF INDIRECT FSK CODE CHECK

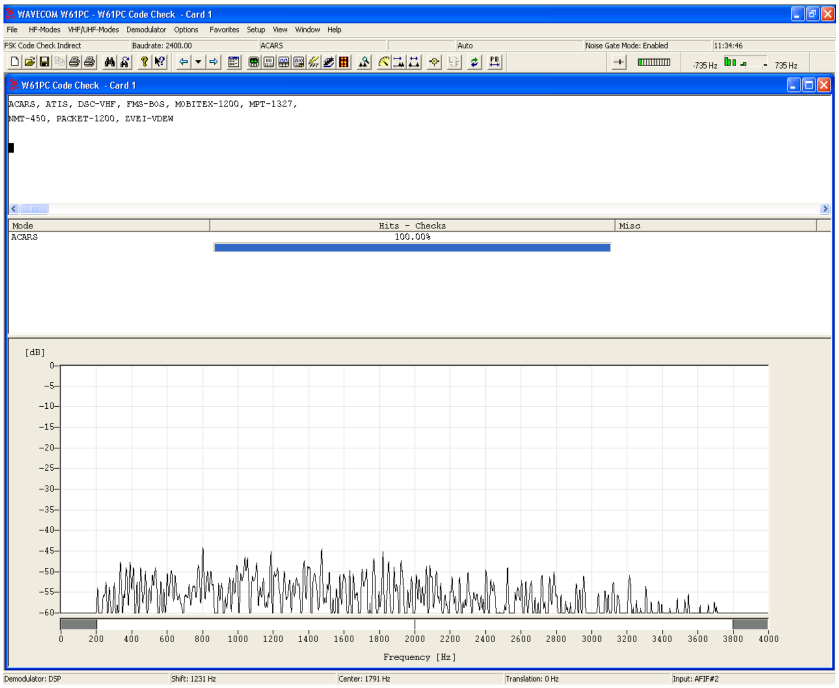
The VHF indirect FSK code check is started in automatic mode by selecting the **Code Check** button or from **VHF/UHF-Modes/Analysis INDIRECT/FSK Code Check**.

Analysis is started with the values of input, gain, translation frequency etc. which were used, last time a VHF indirect mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See “Preferences... on page 42”.

As an additional help the VHF indirect code check also offers an option to start the analysis manually after user entry of baud rate, frequency shift and center frequency. The software will then start the analysis using the pre-selected parameters.

VHF indirect FSK code check is a continuous process. If the baud rate, the center frequency and the frequency shift are correctly determined, there is no need to restart the analysis, even in case of strong disturbances during signal sampling. In such a case, the determination of a mode needs more time.

Because this kind of signals is not continuous, there is a need for a noise gate. The status of it is displayed in the status bar. The noise gate examines the input signal and tries to find out, if a valid signal is available which can be processed or if the input consists only of noise.



After starting the VHF indirect FSK code check the frequency shift, center frequency and the baud rate are determined. These values are displayed in the appropriate fields after the measurement has completed.

The software then proceeds to creating a list of the modes to check, which is displayed in the **Code Check** window.

The incoming bit stream is now continuously tested against the pre-selected modes.

The name of each identified system is displayed in the **Detected modes** window. An identified system may be immediately started by double-clicking the system in the **Detected modes** window.

The **Hits-Checks** will show you how often during checking a mode was successfully determined. If multiple modes are listed this will indicate which mode should be tried.

If two or more different systems are identified or if more than five proven transmission errors occur an automatic switch to a mode will not take place. In the current versions, text is not displayed in the data field in the mode table.

VHF DIRECT FSK CODE CHECK

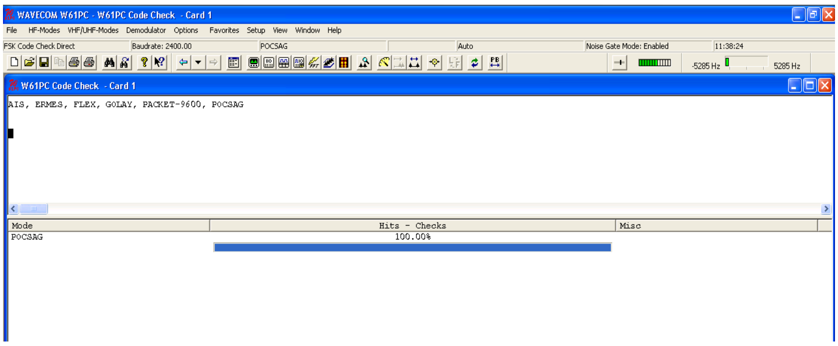
The VHF direct FSK code check is started in automatic mode by selecting the **Code Check** button or from **VHF/UHF-Modes/Analysis DIRECT/FSK Code Check**.

Analysis is started with the values of input, gain, translation frequency etc. which were used, last time a VHF indirect mode was active. The adjustment of these parameters must however be done from the **Preferences...** menu and **When selecting the toolbar "Analysis Buttons" start HF analysis mode** is disabled. See "Preferences... on page 42".

As an additional help VHF direct FSK code check also offers an option to start the analysis manually after user entry of baud rate and frequency shift. The software will then start the analysis using the pre-selected parameters.

VHF direct FSK code check is a continuous process. If the baud rate and the frequency shift are correctly determined, there is no need to restart the analysis, even in case of strong disturbances during signal sampling. In such a case, the detection of a mode needs more time.

Because this kind of signals is not continuous, there is a need for a noise gate. The status of it is displayed in the status bar. The noise gate examines the input signal and tries to find out, if a valid signal is available which can be processed or if the input consists only of noise.



After starting the VHF direct FSK code check the frequency shift and the baud rate are determined. These values are displayed in the appropriate fields after the measurement has completed.

The software then proceeds to create a list of the modes to check, which is displayed in the Code Check window.

The incoming bit stream is now continuously tested against the pre-selected modes.

The name of each identified system is displayed in the **Detected modes** window. An identified system may be immediately started by double-clicking the system in the **Detected modes** window.

The **Hits-Checks** will show you how often during checking a mode was successfully determined. If multiple modes are listed this will indicate which mode should be tried.

If two or more different systems are identified or if more than five proven transmission errors occur an automatic switch to a mode will not take place. In the current versions, text is not displayed in the data field in the mode table.

If a mode is uniquely identified, the software will switch to the identified mode and decoding is initiated. If two or more different systems are identified an automatic switch to a mode will not take place.

PSK SYMBOL RATE and PSK PHASE PLANE

The phase analysis tool is used for analyzing the characteristics of phase modulated signals, and to a limited extent, m-ary PAM (Phase Amplitude Modulation) signals.

The phase analysis tool contains three components:

- Asynchronous mode phase plane display
- Synchronous mode phase plane display
- Phase modulation symbol rate display

When starting signal analysis, one is trying to determine the characteristics of an unknown signal. The normal starting point for this is real-time FFT.

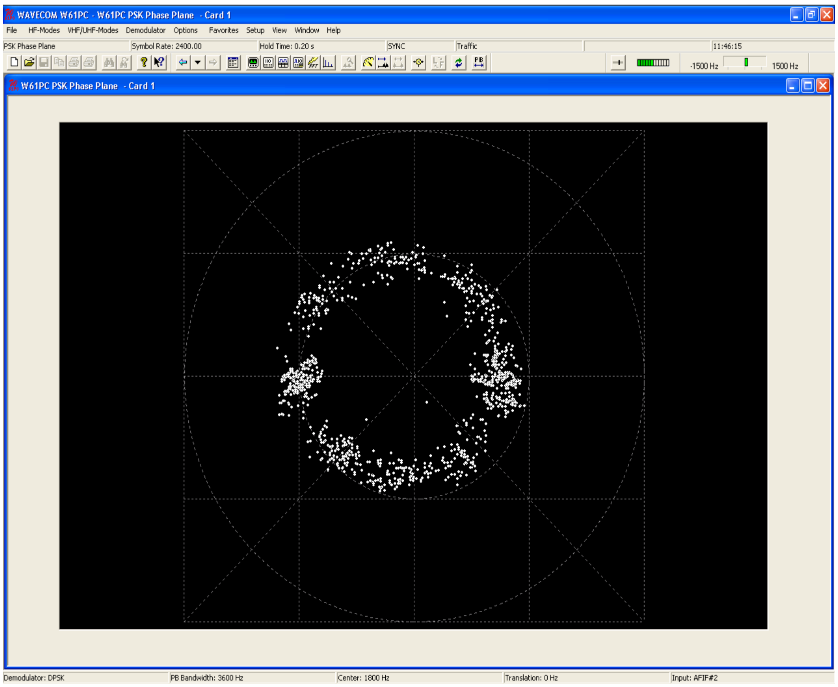
The real-time FFT is used for determining an estimate of the signal center frequency and signal bandwidth. This must be done by adjusting the measurement cursors. The phase analysis tools inherit the information determined by the measurement cursors, and use this information to configure the center frequency and bandwidth. This in turn sets up a pre-filter, allowing the tools to be used for signals disturbed by out-of-band interference, or when more concurrent channels are present.

The display can be started and stopped by clicking the display. If stopped **Paused** is indicated.

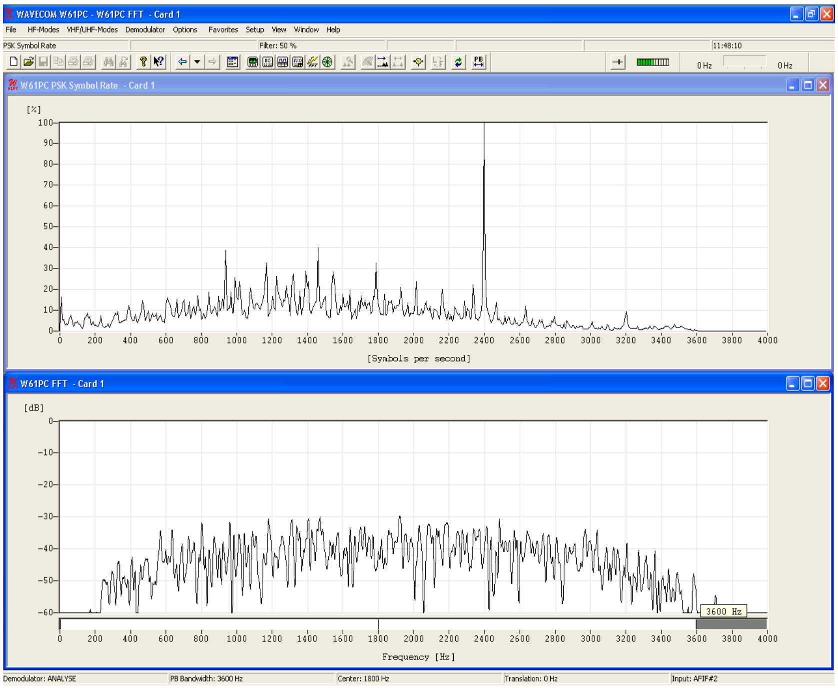
There are two modes for the PSK phase plane analysis:

- **Sync**hronous mode
- **Async**hronous mode

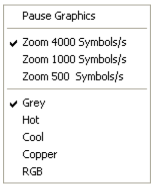
SYNCHRONOUS mode uses an existing demodulator (BPSK, QPSK or DPSK) to decode the signal, and produces a phase plane display of the output of the demodulator. For BPSK and QPSK, this provides a check on the quality of the signal. When using DPSK, this provides an indication of which level of phase modulation is used, i.e. 2-PSK to 16-PSK. For synchronous mode, the symbol rate is equal to the baud rate of the signal, thus the baud rate must be known to configure the demodulator.



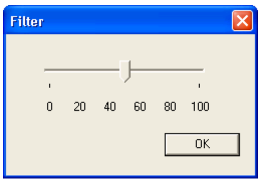
To determine the symbol rate, a PSK symbol rate analysis tool is provided. This tool provides a spectrum display (with three zoom levels) and allows the measurement of the symbol rate using cursors. A PSK signal will normally produce multiple peaks. Normally (but not always) the symbol rate (or baud rate) will be a distinctive peak at the highest amplitude. The other peaks are normally fractions of the true symbol rate.



For signals with low symbol rates, select a different zoom factor by using the menu, which appears when right-clicking the display. Note that the lower scales have a higher precision, but at the expense of a lower display rate.



The **Filter** adjusts the filtering on display. Depending on the signal data contents, it may be found that more filtering is required to clearly see the peaks.

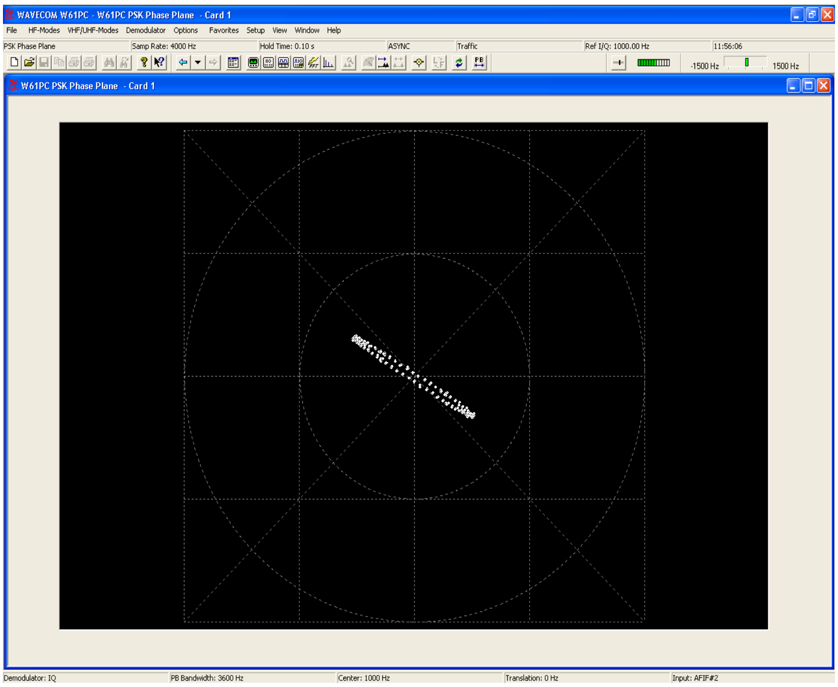


Once you are satisfied you have the correct symbol rate, determined with the measurement cursors, start the PSK phase plane analysis tool.

The **Center: ...** allows the center frequency for the demodulator to be adjusted. A center frequency error normally results in a phase plane that is rotating with a speed proportional to the frequency error.

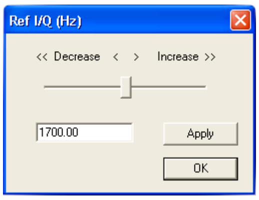
The **Hold Time** adjusts the number of points displayed on the screen. Increasing the hold time increases the amount of time a dot will remain in the image before being overwritten by a new value.

In **ASYNCHRONOUS** mode, the signal is not demodulated at all. Instead, the phase of the signal is visually 'compared' with a reference signal. Providing the correct reference signal is selected, this will result in a phase display that provides an indication of the type of PSK or PAM signal. The points will trace the path taken as the signal phase change. At the nominal signal mapping points, there is normally an accumulation of data points, providing a visual clue to the overall signal mapping.



Multi-channel DPSK signals often have a very narrow channel signal bandwidth. This results in the phase of the signal never remaining constant, and so the accumulation of signal points in the phase plane is not visible. To quantify such signals use **SYNC** mode.

The frequency of the reference signal is set using the **Ref I/Q: ...** option. Note that if the reference frequency is incorrect, the display rotates at a rate that is the difference between the reference frequency and the true carrier frequency of the signal. When adjusting the reference signal, the changes are 'live'. This means that changes you make immediately take effect, and the resulting change in the phase display is immediately visible on the display.



For **ASYNCHRONOUS** mode, the symbol rate measurement is not required. The sampling rate is independent of the symbol rate. Three sampling rates are selectable. For low baud rate signals, better results are obtained with a lower sampling rate. The **Mode** menu item is disabled in the **Demodulator** menu.

Several **Color schemes** for both tools are available through the right-click menu.

In summary, the basic steps for analyzing a suspected (D)PSK signal are as follows:

Use the **Real-time FFT** tool to characterize the signal. Use the cursors to configure the estimate of the center frequency and bandwidth.

Use the **PSK Symbol Rate** analysis tool to measure and select the symbol rate of the signal.

Try and view the phase plane of the signal using the **SYNC Mode**, using the DPSK demodulator. If the signal is a PSK signal, the phase plane should be visible.

If the **SYNC Mode** failed to produce a meaningful display, try the **ASYNC Mode**. This requires accurate adjustment of the reference signal to produce a meaningful display. The **ASYNC Mode** will also produce a useful display for many PAM signals.

HF PSK CODE CHECK

PSK code check is started by selecting the **PSK Code Check** button or from **HF-Modes/Analysis/PSK Code Check.**

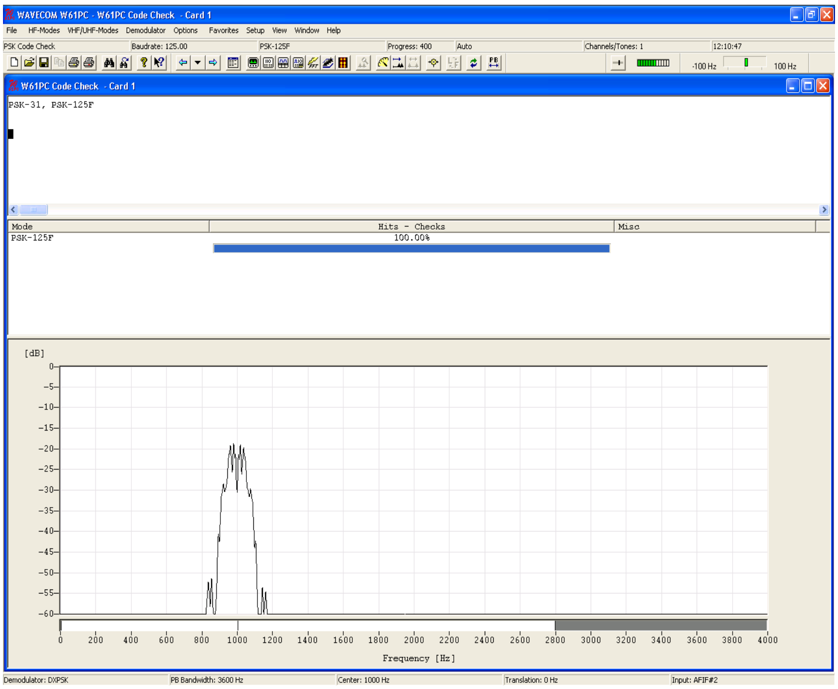
The PSK code check is initialized with default values. In many cases the user needs to set up the appropriate center frequency, baud rate and number of channels. The center frequency setup can be done by using the cursors in the **FFT Window as shown** below or by selecting **Center** in the **Demodulator** menu. The baud rate can also be configured.

The number of channels is set to one for all single channel modes and to two for two channel modes like PACTOR **II** / **II**-FEC. Modes with more than one channel need the shift settings in addition to the center frequency.

Note: The accuracy of the center frequency and shift settings is very important and directly influences the performance of the decoding.

After each configuration change, the PSK code check automatically restarts with the new values. The values of these parameters are displayed in the appropriate fields after the setting has completed.

If two or more different systems are identified or if more than five proven transmission errors occur, an automatic switch to a mode will not take place.



The software then proceeds with code and system analysis. The incoming bit stream is tested against known PSK modes.

The name of each identified system is displayed in the output window. An identified system may be immediately started by double-clicking the system in the output window – for instance double-clicking PSK-31 in the figure above will interrupt PSK code checking and immediately start PSK-31.

The **Hits-Checks** will show you how often during checking a mode was successfully determined. If multiple modes are listed this will indicate which mode should be tried.

Some modes are very difficult to distinguish, especially when the system is in idle mode.

MIL/STANAG Code Check

Requires Professional Version.

The MIL/STANAG code check analysis tool is used to determine whether a signal is one of the following MIL/STANAG and similar transmission modes:

- HF-ACARS
- MIL-188-110A
- MIL-188-110B
- MIL-188-141B
- STANAG-4285
- STANAG-4529

STANAG-4415 is a sub mode of MIL-188-110A and is detected in this mode. STANAG-4481 is a sub mode of STANAG-4285 and is detected in this mode.

This analysis can be started from the menu **HF-Modes/Analysis/ MIL/STANAG Code Check** or from the **Mode Selector** button, the **HF Analysis** tab and the **MIL/STANAG Code Check** button.

The center frequency can be set by the user. The default value for the code check is 1800 Hz as shown in the user interface. The center frequency of HF-ACARS – 1440 Hz – can be selected from a list. After the center frequency is set, the code check searches the mode within a range of +/- 100 Hz of the center frequency. Although HF-ACARS may have a center frequency of 1440 Hz, it can also be detected when the code check is set with center 1800 Hz.

Except HF-ACARS which has a baud rate of 1800, all other MIL and STANAG modes operate at 2400 baud. However, the code check can automatically determine modes with different baud rates.

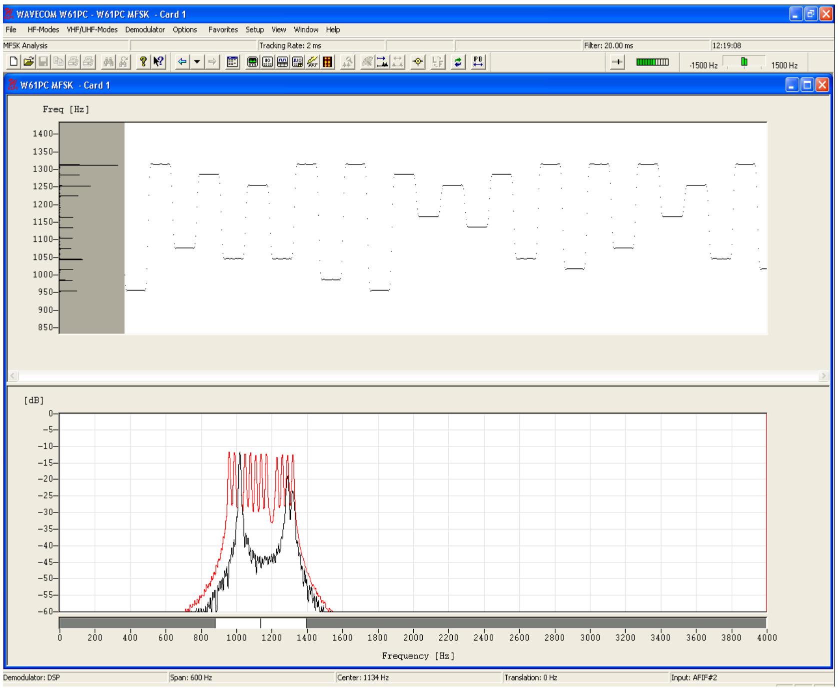
After the code check has determined a mode, the mode name is displayed in the text window. The confidence parameter shows how good the match is, the highest possible value is 100%. When confidence is greater than 90%, the code check automatically switches to the corresponding mode decoder using the corrected center frequency.

MFSK ANALYSIS

The MFSK analysis for the HF range employs a graphical display in two dimensions, frequency (y axis) and time (x axis). Both values may be preset. This tool was originally developed for the analysis of analogue tone call systems, but is equally suitable for evaluation of FSK and MFSK systems. In particular the frequency and element duration is well displayed.

After starting **MFSK Analysis** the detected frequency values are displayed as pixels.

A monitored MFSK signal is easily recognized as stable lines. To stop the horizontally scrolling display, click on the display. Measurement cursors for both the time axis and the frequency axis appear. The display may be searched backwards to the maximum extent of 15 seconds when tracking rate is set to 1 ms. However, if tracking rate is set to 15 ms, a range of 225 seconds may be searched.



Tracking rate determines the sampling rate. The range is 1 - 15 ms, default is 2 ms.

Double-clicking **Filter** inserts a low pass filter for filtering the tones. The value of the filter should be adjusted to avoid serious tone distortion. A rule-of-thumb value is 1.6 times the baud rate. The actual value may be calculated so:

- tfilter [ms] = (2*1000)/(Baudrate*1.6)

The filter range is 1 - 100 ms.

Using the **Span** menu, the resolution of the frequency axis may be increased. The steps are 3,000 Hz (for analogue selective calling systems), 1,500, 600 and 300 Hz.

From the **Center** menu, the center frequency may be adjusted. It is important to readjust the center frequency whenever the frequency (**Span**) axis is increased.

Several **Color schemes** are available through the right-click menu.

HF MFSK CODE CHECK

MFSK code check is started by selecting the MFSK **Code Check** button or from **HF-Modes/Analysis/MFSK Code Check**.

The MFSK code check starts with default values. In many cases the user needs to setup up the appropriate center frequency, baud rate and number of tones. The center frequency setup can be done by using the cursors in the **FFT Window** as shown below or by selecting **Center** in the

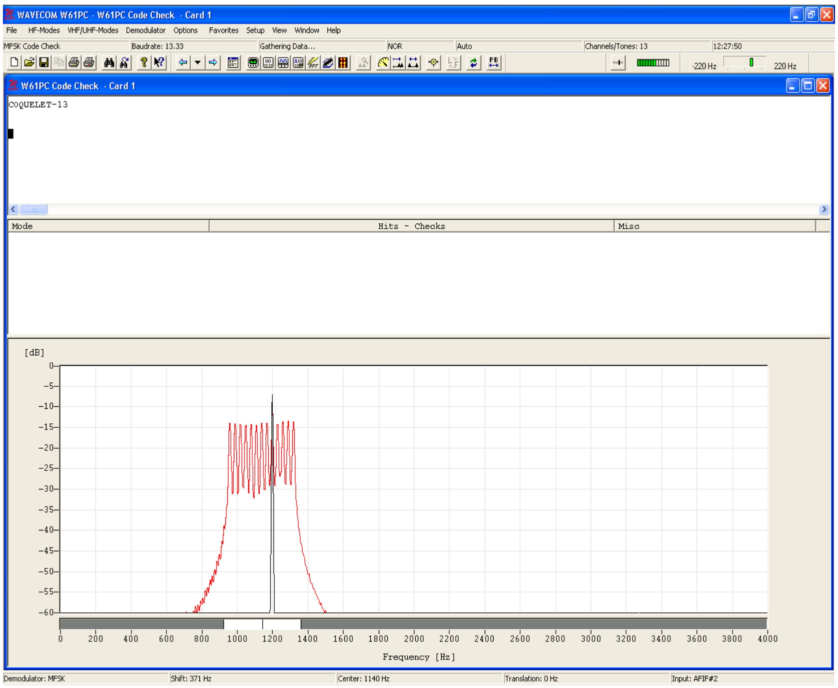
Demodulator menu. The baud rate and the **Number of Channels/Tones** can also be configured.

For easy tuning, switch on **Peak Hold** in the **Options** menu on. The tone spectrum appears in the FFT window after a short delay and the frequency range can be changed as required using the cursors as shown below.

Note: The accuracy of the center frequency and shift settings is very important and directly influences the performance of the decoding.

After each configuration change, the MFSK code check automatically restarts with the new values. The values of these parameters are displayed in the appropriate fields after the settings has completed.

If two or more different systems are identified or if more than five proven transmission errors occur, an automatic switch to a mode will not take place.



The software then proceeds with code and system analysis. The incoming bit stream is tested against known MFSK modes.

The name of each identified system is displayed in the output window. An identified system may be immediately started by double-clicking the system in the output window – for instance double-clicking COQUELET-13 in the figure above will interrupt MFSK code checking and immediately start COQUELET-13.

The **Hits-Checks** will show you how often during checking a mode was successfully determined. If multiple modes are listed this will indicate which mode should be tried.

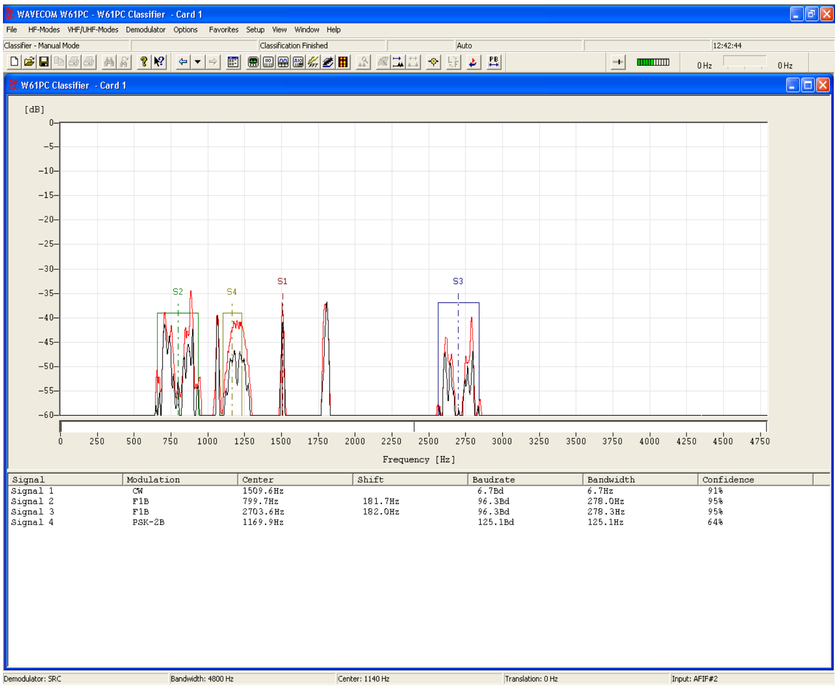
Some MFSK modes are very difficult to distinguish, especially when the system is in idle mode.

Classifier (Option)

The classifier is an important analysis tool for classifying unknown signals. The purpose is to determine the modulation type, baud rate, frequency shift and bandwidth of one or more signals. The classifier uses a maximal bandwidth of 8 kHz.

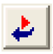
Currently the classifier can detect:

- Carriers
- FSK signals from 2FSK up to 34FSK
- FSK F7B variant
- PSK signals, DBPSK, DQPSK, D8PSK and D16PSK A and B variants
- CW signals

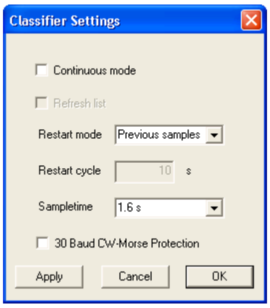


The HF classifier user interface consists of two windows:

- A FFT window
- A classification result window

Start/Stop Classifier Button

The classifier is started in automatic mode by selecting the **HF Classifier** menu from **HF-Modes/Analysis/Classifier**. Two classification modes are provided: A manual mode and a continuous mode. In the manual mode the classifier can be manually restarted by pressing the **Start/Stop Classifier** button in the tool bar above. During the classification the button is disabled. In the continuous mode, the classifier continuously classifies signals, depending on the **Restart Cycle** selected in the classifier settings. All the settings are set up in the **Options/Classifier Settings** menu.



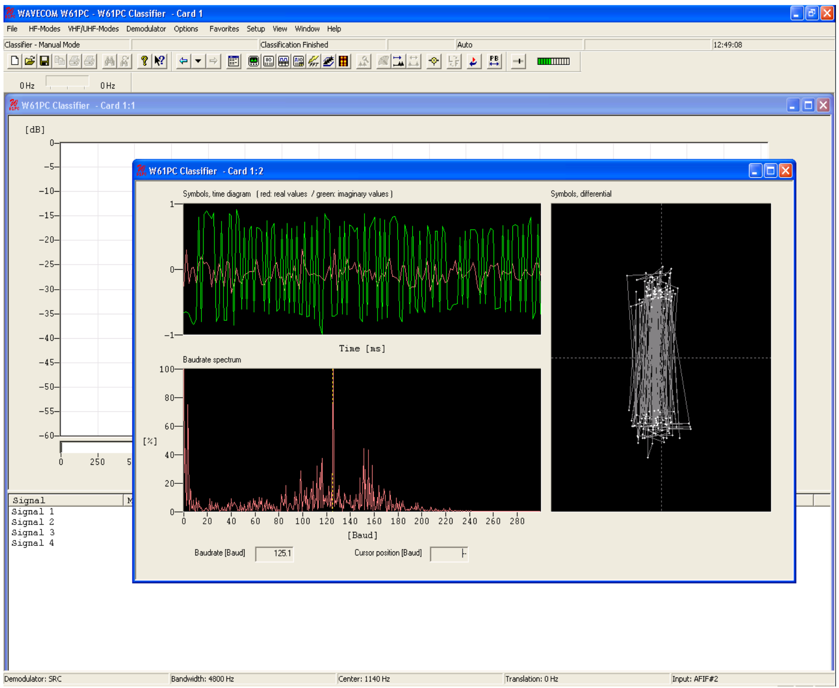
Restart cycles ranging from 4 s to 3,600 s are valid. If **Refresh List** is checked, the list will be cleared after every classification attempt. Continuous mode can be stopped by pressing the **Start/Stop Classifier** button. The classifier allows only one classification attempt at a time.

Samples are available from two sources:

- Samples taken before the classifier was started
- Samples taken after the classifier was started

After a few seconds (depending on the complexity of the signal) the result of the classification attempt is displayed in the result window. Each signal is numbered and corresponds to the signal marker in the FFT window. The last classifier state is visible in the status bar, even if signals were not classified. After each restart the result window will be cleared.

For further analysis, PSK signals can be shown in an additional graphical view by double-clicking on the desired signal.



To select the display bandwidth use **Demodulator/Bandwidth** or double-click on the **Bandwidth:** field on the demodulator status bar. Bandwidths of 500 Hz, 1 kHz, 2 kHz, 4.8 kHz and 9.6 kHz are available.

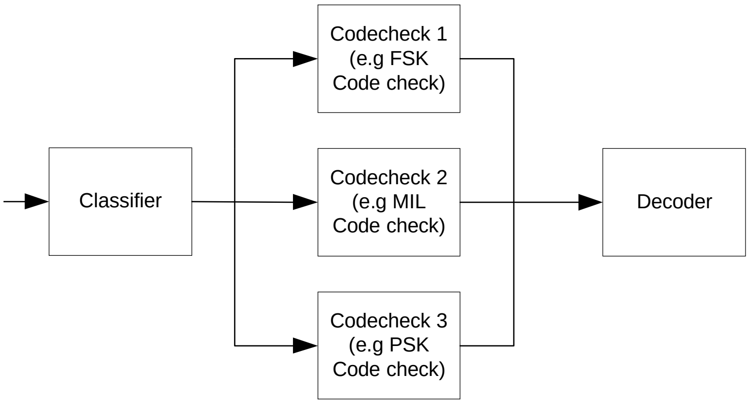
Use **Demodulator/Center** for selecting frequencies within the 500 to 3500 Hz range.

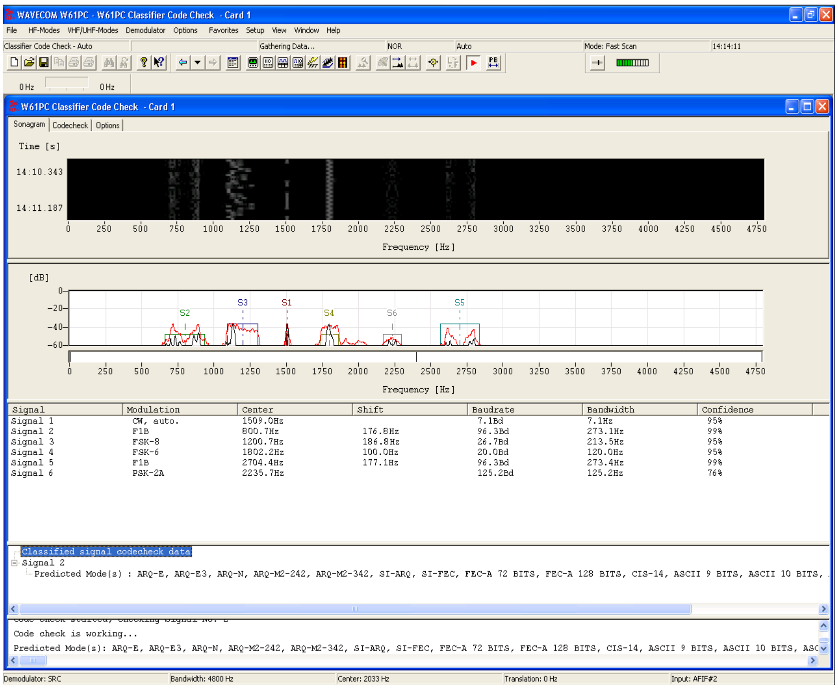
The **Average Factor** and **Window Type** options are identical with the real-time FFT functions.

HF Classifier Code Check (Option)

The HF Classifier Code Check is a comprehensive analysis tool for classifying unknown signals combined with an advanced code check to determine the mode under observation (protocol). The Classifier Code Check has a maximal bandwidth of 5 kHz and has the ability to check several signals at the same time.

Overview:





The **HF Classifier Code Check** user interface consists of five sections:

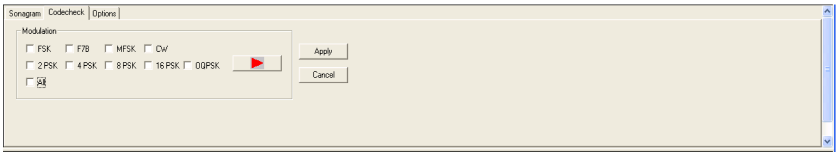
- A sonagram and code check options window selectable by tabs
- A FFT window
- A list of classified signals
- A tree view of the classified signal code check
- A text status window

Fast start:

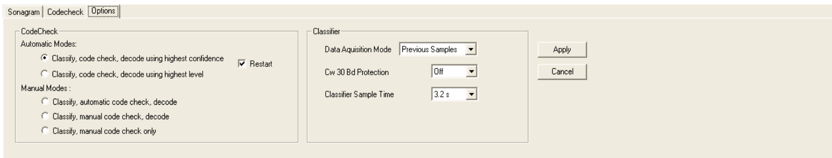
HF Classifier Code Check starts by default in automatic mode by selecting the **HF Classifier Code Check** from the **HF-Modes/Analysis** menu. It can be stopped or restarted manually by pressing the **Start/Stop** button in the toolbar above. After a successful classification has been achieved, code check starts and switches to the detected mode, if a valid mode is found. During the classification process the start/stop button is locked.

Note: The FSK and PSK code checks have built-in automatic polarity detection. For MFSK and MIL or STANAG signals it is necessary to select the appropriate polarity before the **Classifier Code Check** starts.

Additional settings:



By pressing the **Code check** tab the modulation types available are displayed. Check the desired modulation types and click on the start button.



Press the **Options** tab to see the code check and classifier options available.

Automatic Modes:

- **Classify, code check, and decode using highest confidence.** This mode classifies by choosing the signal with the highest confidence. After a valid mode is found, the classifier code check switches to the detected mode
- **Classify, code check decode, using highest level.** The second mode is identical to the first mode, but uses the signal with the highest signal level.

Restart is used only for the automatic modes. If no signal is classified, the classifier automatically restarts after a few seconds and continues so until a signal is classified.

Manual Modes:

- **Classify, automatic code check, decode.** Classifies and checks all available signals listed in the signal list. If all code checks are completed, the user must choose by double click the desired mode by double clicking.
- **Classify, manual code check, decode.** The user must manually choose a signal by double clicking the desired signal in the classifier list. After the signal is recognized, the determined modes are inserted into the code check data tree. The user must manually select the determined mode by double clicking the mode...
- **Classify, manual code check only.** This mode works in the same manner as the previous mode, except that the decoder is not started

Classifier:

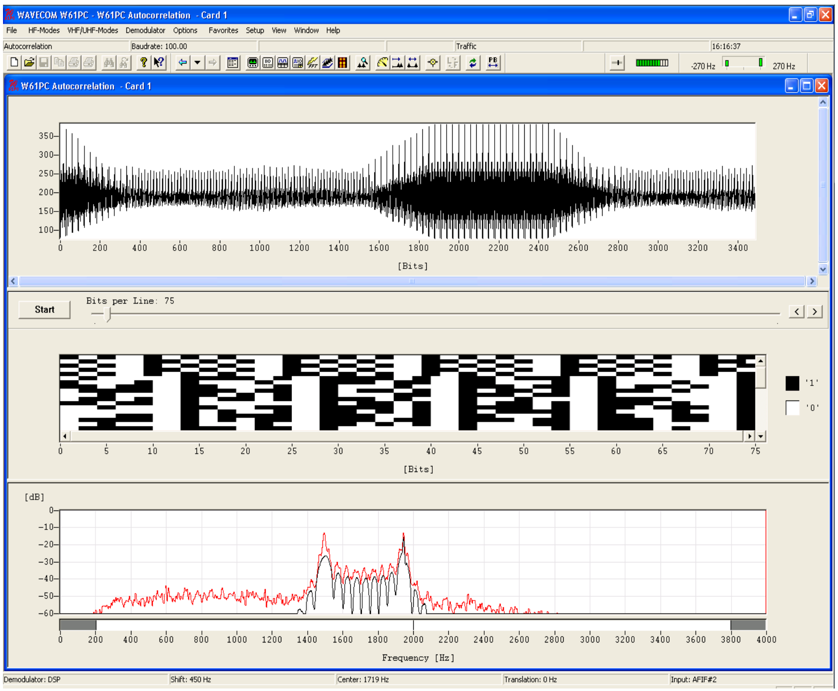
- **Data Acquisition Mode** is available as **Previous** and **New Samples** mode. In **Previous** mode all available samples are fetched from a ring buffer. When **New Samples** is selected the ring buffer is cleared and all new samples are read before classification starts. The time used to collect new samples depends on the classifier bandwidth and the sample time. Default setting: **Previous Samples**.
- **CW 30 Bd Protection. T**his option prevents a CW signal with a speed of more than 30 Baud from being misinterpreted as a F1B signal. This may occur especially at the edges of the spectrum. Default Setting: **Off.**
- **Classifier Bandwidth** is set to 4 kHz. This option is for future versions of the software.
- **Classifier Sample Time** can be set to 1.6 s or 3.2 s. For burst and MFSK signals with low baud rates this option must be set to 3.2 s for better classifier results. Default Setting: 3.2 s.

To apply any of these options press the **Apply** button.

AUTOCORRELATION

Autocorrelation is used for determining the periodicity of bit patterns. Periodicity implies a constant repetition of a specific bit pattern. If a station transmits the idle pattern 0010011011 0010011011..., the periodicity is said to be 10 bits. HNG-FEC and RUM-FEC have a periodicity of 15 and 16 bits respectively. The periodicity could also be 11250 bits, i.e. after 11250 bits the same constantly repeated pattern occurs again. Periodicity becomes very important in the classification of unknown transmissions and the analysis of unknown modes and systems.

First of all, the **Auto** option from the **Demodulator** menu field or the **Auto** button should be used to determine the exact baud rate and frequency shift. If the exact baud rate is unknown, the IAS measurement function can be used for this purpose with an accuracy of 0.001 Baud. This is done by activating the **IAS** setting in the **Demodulator** menu field. Autocorrelation is then initiated by selecting and programming the baud rate menu field. If the baud rate deviates by more than 0.5 Baud, a bit slip may occur and therefore the autocorrelation must be restarted with the exact baud rate.



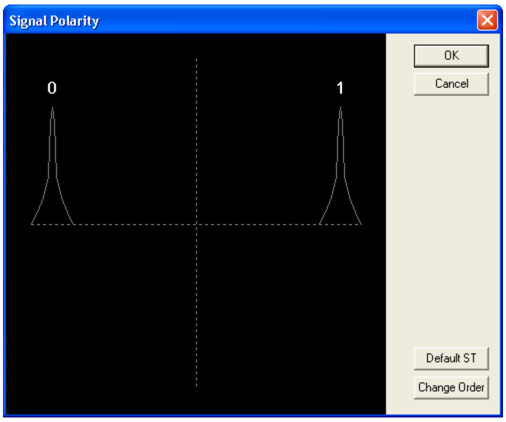
To start the sampling process, press the **Start** button. The number of sampled bits is continuously displayed. Autocorrelation can currently process up to 200,000 bits.

By pressing the **Correlate** button, the actual computation of the autocorrelation is started. Results are graphically displayed. If a large number of bits were sampled and the graph indicates a low periodicity the computation may be stopped by pressing the **Stop** button. Periodicity is indicated by distinct peaks in the graphic display which may exhibit various characteristics:

- A large number of closely spaced vertical lines indicates a very small period (7 to 15 bits)
- Small and asymmetric peaks indicate that a distinct periodicity is not present. The presence of such small peaks may however be an indication of a very long period
- In the case of a very "noisy" graph, periodicity cannot be determined without the zoom function. Such measurements indicate the fact that the system is transmitting data (traffic state). One should then wait for an idle state or for some request (RQ) cycles for closer examination
- The graphic display only shows approximate wave forms. This peculiarity is often evident in the case of simplex systems, but an approximate determination is however still possible
- In the case of a horizontal line without any peaks or deviations, no periodicity may be deduced or the period is much larger than the total number of sampled data bits

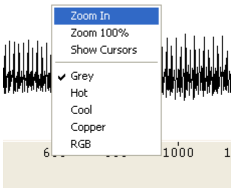
Each mode and each signal can produce very different displays. Often it is possible to determine a periodicity with the zoom function.

Signal polarity is changed from the **Options** menu by selecting the **Signal Polarity** item and then using the buttons in the window shown.

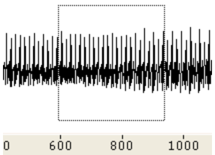


Pressing **Change Order** will reverse the polarity of the signal and pressing **Default ST** will restore the default value.

By right-clicking on the display a menu appears.

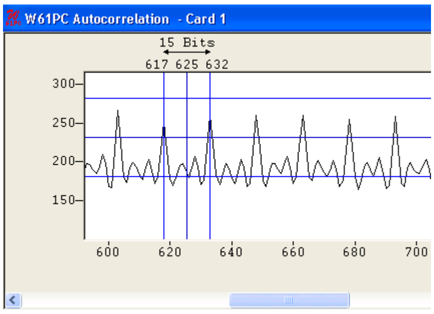


By selecting **Zoom In,** the mouse cursor changes its shape. By clicking and dragging, a field can be enlarged or reduced horizontally and vertically. The field should be sized in such a way that the peaks fill out the zoom field optimally.



After the zoom field has been sized, release the mouse button. An enlarged section of the autocorrelation trace is displayed.

The distance between recurring, equidistant peaks gives the periodicity of the signal under investigation.



By selecting **Zoom 100%** the full screen display will reappear.

Several **Color schemes** are available through the right-click menu.

BIT CORRELATION

The bit correlation and bit length analysis tools serve the measurement of bit length. Bit length analysis relies on a statistical evaluation of many individual measurements, whereas the bit correlation function displays the data of the V1 channel graphically.

The data for bit correlation is sampled and displayed with respect to time. Thus pulse and tone duration lengths as well as bit bias may be measured. The bit correlation analysis also allows the accurate determination of baud rates in the case of asynchronous systems with bit errors and propagation dependent distortions.

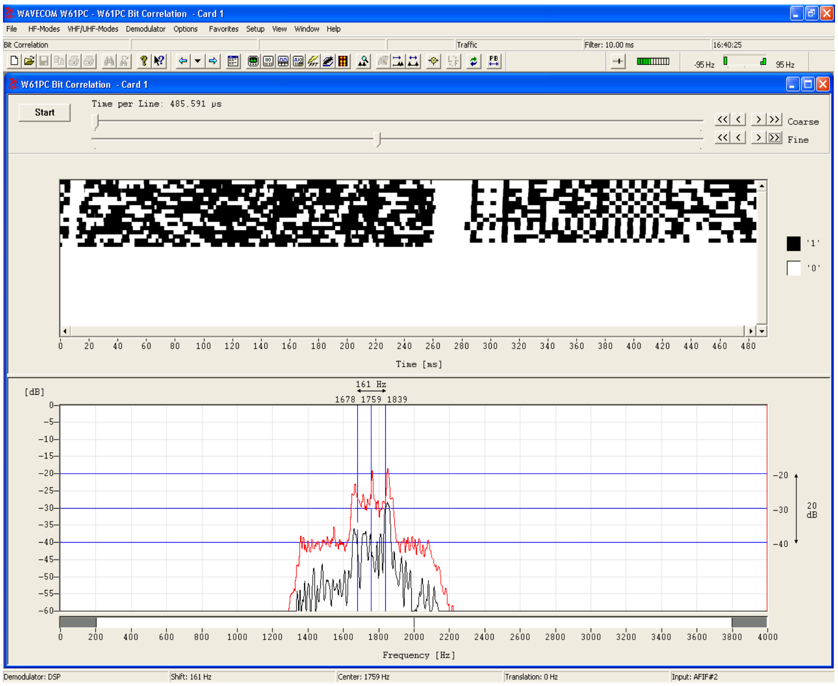
The time duration of a video line and thus the display resolution is set with the sliders in **Time per Line**. The range is 20,000 µs (0.02 s) to 10,000,000 µs (10 s) per graphical line and sampling takes place in steps of 14 µs. One graphical display line corresponds to the preset time.

Selecting the **Start/Stop** button controls the effective data sampling.

By moving the mouse cursor a text field is displayed. The value of the positioned segment is continuously displayed in microseconds (µs) and in Bauds (Bd) with the graphical cursor. The graphical representation of V1 channel polarity (mark or space) corresponds to the value of the displayed time and the converted baud rate.

Also the correlation can be determined by using bit correlation. The number of time units per line set in **Time per Line** in addition to the baud rate, constitute the preset values for the correlation.

The following example shows a correlation of 111 bits. The baud rate is 228.66 baud. Hence the calculation of the total system cycle length is (1/228.66) x 111 = 0.4854369 s.



By right-clicking on the display a menu appears. By selecting **Zoom In** the mouse cursor changes its shape. By clicking and dragging a field can be enlarged or reduced horizontally and vertically. After the zoom field has been sized, release the mouse button. An enlarged section of the bit correlation is now displayed.

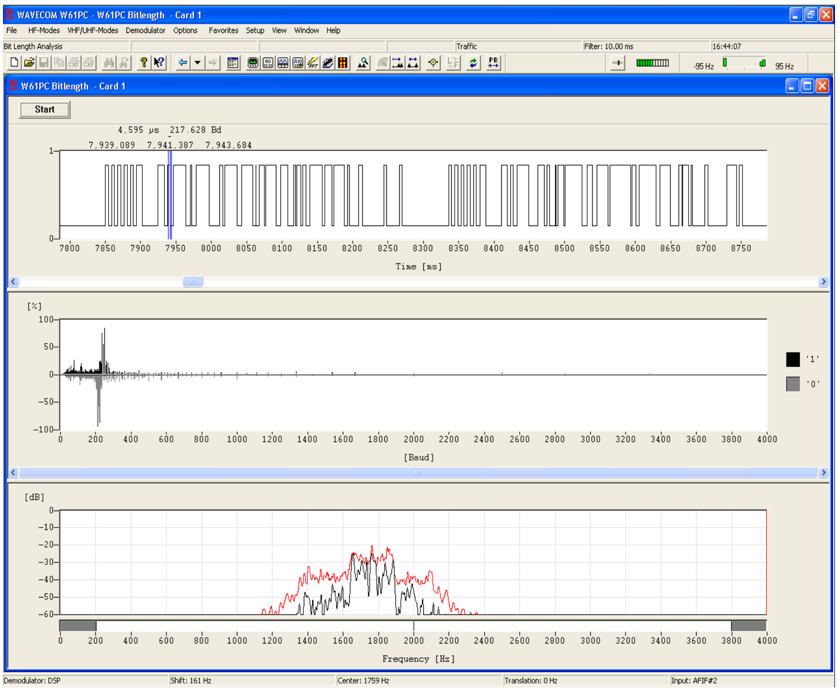
Additionally, several **Color schemes** are available through the right-click menu.

BIT LENGTH ANALYSIS

Bit length analysis serves to determine baud rate distributions, tone duration or bit length distributions.

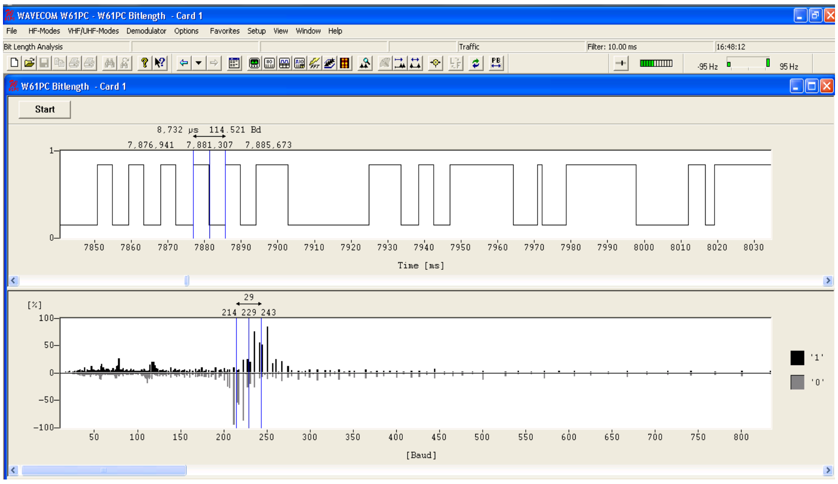
The resolution offered by the sampler option is 14 µs (72,000 samples per second). After the demodulator has been correctly set up either manually or by using the auto function, sampling is initiated by pressing the **Start** button. To stop sampling, the **Stop** button is pressed. Captured data may then be further analyzed.

A screen with two graphs is displayed. The following example shows a typical bit length display screen.



The bit length analysis screen consists of a window for graphs of the two bit length distribution functions for binary 0 and 1 as well as a window containing a graph of the raw, binary data.

By right-clicking on one of the two displays a menu appears. By selecting **Zoom In** the mouse cursor changes its shape. By clicking and dragging, a field can be enlarged or reduced horizontal and vertical. After the zoom field has been sized, release the mouse button. An enlarged section of the raw data or the bit distribution is displayed. By selecting **Zoom 100%** the full screen display will reappear.



Several **color schemes** are available through the right-click menu.

By clicking on the displays graphic cursors may be used to move over the graph to allow measurement of data.

The bottom window shows the distribution of bit lengths as computed from the sampled data.

It should be noted that reception in the HF band may be subject to distortions. In such cases the distributions for the "0" and "1" values should be averaged.

In the top window a graphic representation of the binary data "0" and "1" is performed. The resolution may be set using the zooming function. Practical values are between 1,000 µs and 10,000 µs. In general the resolution is controlled by the smallest parameter to be measured. In MFSK cases this corresponds to tone changes and with RTTY to data transitions (bits).

Using the scroll bar the binary bit pattern may be continuously moved left or right. This allows easy location of the bit or tone duration to be measured.

The example shows the lower section of the screen display after using the zooming function. The cursors may be moved across the bit pattern. The individual positions of the cursors as well as the difference between the two cursors are continuously displayed in µs and Baud.

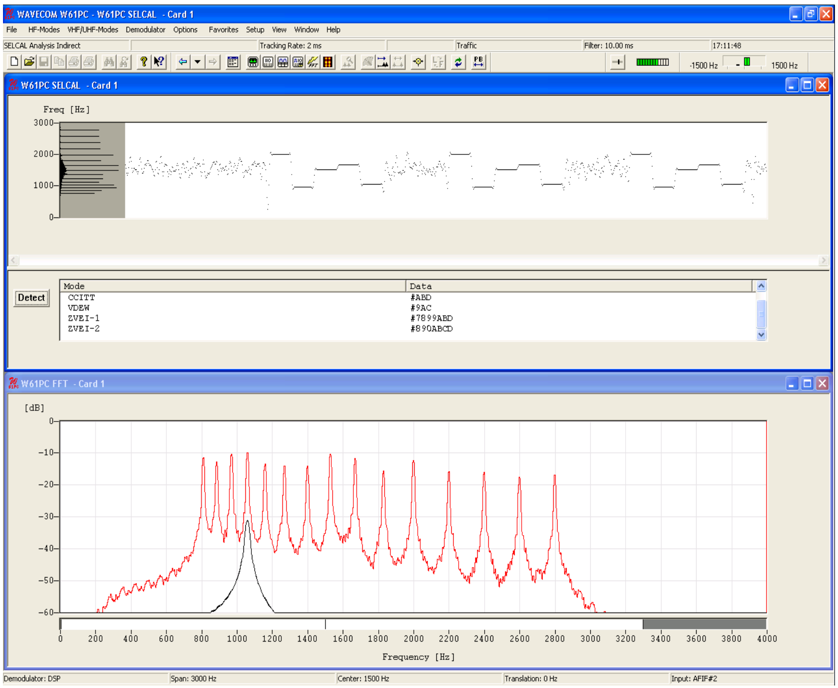
When measuring binary 0s or 1s (mark or space) it should be noted that the two levels may be subject to severe distortions depending on the quality of the received signal. Using the average value over a number of measurements improves the accuracy of results. Some transmission modes are modulated in terms of bit length or bit position (Pulse Width and Pulse Position Modulation).

SELCAL ANALYSIS

The SELCAL analysis for the VHF/UHF range employs a graphical display in two dimensions, frequency (y axis) and time (x axis). Both values may be preset. This tool was developed for the analysis of analogue sequential single tone call systems.

After starting **SELCAL Analysis** the detected frequency values are displayed as pixels.

A SELCAL signal is easily recognized as stable lines. To stop the horizontally scrolling display, click on the display. Measurement cursors for both the time axis and the frequency axis appear. The display may be searched backwards up to 15 seconds, when the tracking rate is set to 1 ms. However; if the tracking rate is set to 15 ms a range of 225 seconds may be searched.



Tracking rate determines the sampling rate. The range is 1 - 15 ms, default is 2 ms.

Double-clicking **Filter** inserts a low pass filter for filtering the SELCAL system tones. The value of the filter should be adjusted to avoid serious tone distortion. A rule-of-thumb value is 1.6 times the baud rate. The actual value may be calculated so:

- tfilter [ms] = (2*1000)/(Baudrate*1.6)

The filter range is 1 - 100 ms.

Using the **Span** menu the resolution of the frequency axis may be increased. The steps are 3,000 Hz (for analogue SELCAL systems), 1,500, 600 and 300 Hz.

From the **Center** menu the center frequency may be adjusted. It is important to readjust the center frequency whenever the frequency (**Span**) axis is increased.

Pressing the **Detect** button starts the SELCAL analysis mode. The monitored signal buffer is searched for valid tone data. Testing is sequential and the name of the system under test is displayed. Recognized systems are identified below the graphics window. Decoding of an identified system may be immediately started by double-clicking the system in the output window.

When evaluating analogue tone call systems, be aware that some systems are almost technically identical or only differ in the allocation of tones (e.g. ZVEI-1 and ZVEI-2) and thus a certain degree of tolerance must be shown when testing analogue SELCAL systems. Be prepared for double or multiple identifications.

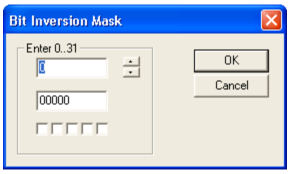
Several **Color schemes** are available through the right-click menu.

Bit Inversion Mask

One or several data bits may be inverted by using the **Bit Inversion Mask** item in the **Options** menu.

The **Bit Inversion Mask** can be entered in three different ways:

- In the top input box a decimal number between 0 and 31 may be entered
- In the center input box the same number may be entered in binary format with the least significant bit to the right
- In the bottom check boxes a logical "1" is entered with the mouse by clicking in the check box



Bit Inversion is only implemented for ITA-2 (Baudot) based bit streams.

Code Statistic

For five bit alphabets a code statistic window can be shown below the text window. In the **Options** menu chose **Code Statistic** to switch the statistic window on or off.

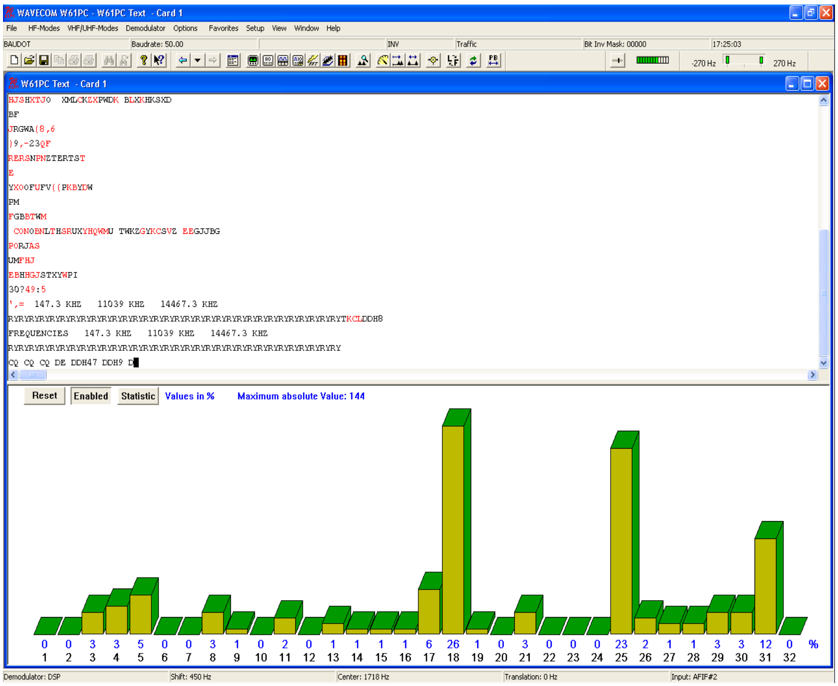
The bottom row shows the decimal value of the characters. The row above displays the number of characters as a percentage.

The statistic is graphically displayed with the height of 3D-bars proportional to the number of instances of a given character.

Click on the **Reset** button to reset all counters to zero.

Press the **Enabled** button to toggle sampling of the received characters for the statistic on and off.

Using the **Statistic** button the data can be showed ordered by quantity.

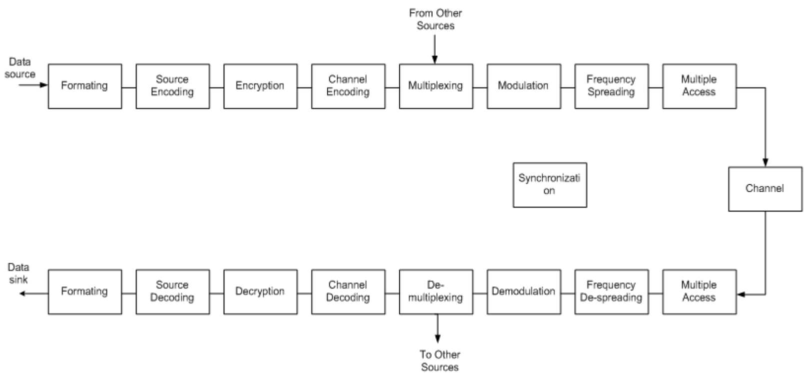


Five bit alphabets are used in the following modes:

- ALIS
- AUTOSPEC
- BAUDOT
- CIS-11
- CIS-14
- CIS-36
- COQUELET-8
- COQUELET-13
- COQUELET-80
- DUP-ARQ
- HC-ARQ
- HNG-FEC
- PICCOLO-MK6
- SPREAD-11
- SPREAD-21
- SPREAD-51

Transmission Modes

Fundamentals of Radio Data Transmission



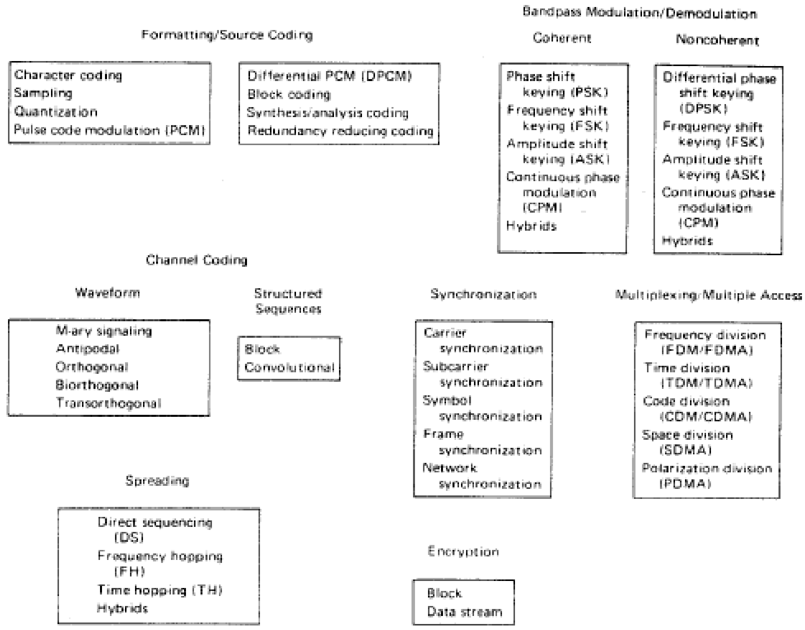
The drawing above illustrates the various transformation processes digital information may undergo from source to sink. The box labeled “Channel” represents the media through which data must pass (adapted from Bernard Sklar, “Digital Communications – Fundamentals and Applications”, Prentice Hall, 2001).

A basic understanding of how digital information is transferred by land line or radio links is necessary to fully exploit the many features of the WAVECOM decoder. It is assumed that the user is familiar with the general working of telecommunication systems, in particular radio systems. The overview below deliberately avoids the mathematical descriptions and proofs which underlies modern communication theory and practice.

By **digital information** we mean information which is represented by discrete states of the transmission medium. In contrast to this **analog** information is represented by an infinite continuum of states. For example live music is analog information, whereas the same music recorded on a CD has been transformed into digital information imprinted in the surface of the disc. Digital information or data is not only text, it is also speech, music or images.

A land line, short wave link, satellite link or any other way of connecting two points for communications is called a **channel**.

The tremendous development within electronics and computer science in the latest decades has led to enormous improvements in the reliability and robustness of the transmission of digital data through the wireless medium, which has especially benefited the HF spectrum users. The HF frequency range is a specially hostile environment to communications as it is prone to both natural and manmade disturbances of a time-varying nature, e.g. heavy industrial noise, fierce solar storms, interference from other spectrum users and severe fading. The ever increasing CPU power has been harnessed through the techniques of Digital Signal Processing (DSP) and is exploited in improved coding and modulation methods as turbo codes, adaptive equalization, m-ary modulation and powerful and innovative demodulation and decoding methods. Further improvement has been achieved in the field of automation of operations and in the size, power consumption and features of modern integrated circuits.



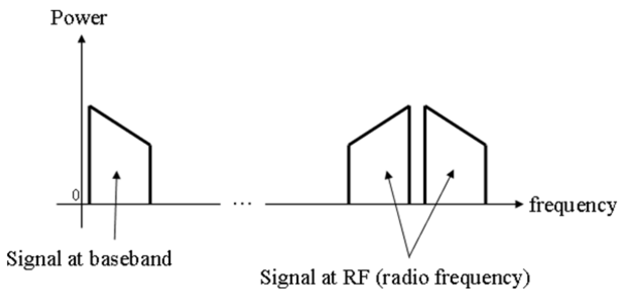
Basic digital communication transformations (from B.Sklar, “A Structured Overview of Digital Communications”, IEEE Commun. Mag, August 1983).

Telegraph speed, Bit rate, Baud rate, Symbol rate

The **bit rate** is the number of bits transmitted per second, measured in **bps**.

The **symbol rate** formerly known as the **telegraph speed** or the **baud rate** is the inverse of the duration of one channel signaling unit and is measured in **symbols/sec** or Baud (Bd). So if one channel signaling unit has a duration of 10 ms, then the telegraph speed is equal to 1/0,01 = 100 Bd. If the channel has only two signaling levels, e.g. 0 V and +5 V, bit rate is equal to baud rate, i.e. 100 bps. If four levels were used, the baud rate would still be 100 Bd, but now the bit rate would be doubled to 200 bps, each baud representing two bits.

By signaling levels is meant the different values a signaling unit may assume - for binary signaling it is two levels, but many systems utilize more than two levels. For radio transmission the levels may be represented by frequency, phase or amplitude levels (see the sections on channel coding and modulation).



A baseband channel or low pass channel (or system, or network) is a channel (e.g. a telecommunications system) that can transfer frequencies that range from or are equal to or very near zero, i.e. DC. and to the highest signal frequency Examples are serial cables and local area networks (LANs). Baseband signals may be used to modulate carrier frequencies.

Formatting and Source coding

Formatting is the process whereby source data is or prepared for the ensuing digital processing. Sometimes this process is included in the functionality of source coding. The purpose of source coding is to reduce the amount of redundant or unnecessary information from the formatted source data.

The basic building block of data and telegraph signaling is the **bit**, a word derived from "binary digit", so called because it can assume only one of two states, **Current** (logical '1', Mark or low frequency, positive voltage) or **No Current** (logical '0', Space or high frequency, negative or zero voltage).

On the channel one or more bits may be represented by a signaling unit called a **Baud (Bd)** or a **symbol**.

Bits are assembled into patterns or **code words** with a certain length which is expressed in number of bits. The code words represent all or a part of the entire alphabet including letters, numbers, special characters and control codes, or represent the pixels of a fax or samples of digitized speech.

Code words are assembled into **alphabets** or **codes**. In some codes the code words are of unequal length. A distinction should be made between **source coding**, which is the coding used to communicate between a data source or sink (a teleprinter, a PC) and data communication equipment, e.g. a modem or a decoder, and **channel coding**, which is the coding used on the channel between the transmitting and receiving data communication equipment. Sometimes the source code is also used as the channel code.

The Morse code is an **unequal-length** code. Code words are composed of dots - the smallest unit -, dashes and spaces, one dash being equal to three dots. "E" is the shortest character represented by a dot equal to one (1). Zero (0) is the longest code word represented by "dash-dash-dash-dash-dash" equal to 19 dots, '1110111011101110111' in binary notation. The reason for the unequal length of the code words was the desire to reduce the amount of work for the operator when transmitting many messages. Samuel Morse found by visiting a Philadelphia printing office, that the compositors had sorted the lead types in such a way that the types most frequently used were the ones most easily accessible.

An example of an equal-length, but non-integral code is the Baudot or ITA-2 alphabet, which was formerly in use on the majority of the world's land lines and radio links. It is still the base for many codes constructed later, as compatibility to existing equipment and networks was essential.

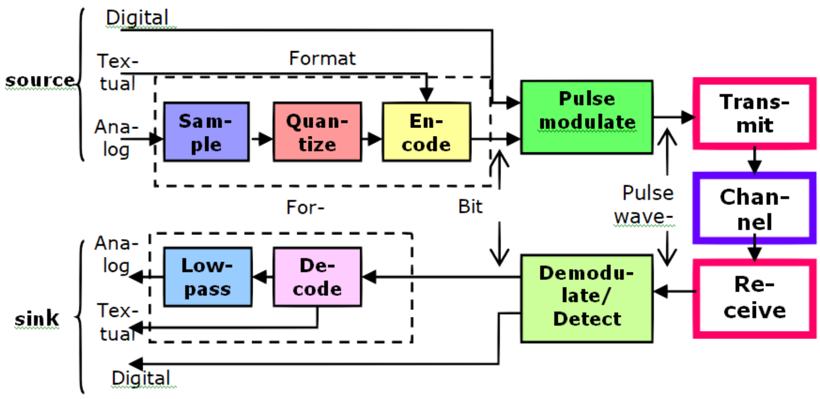
In the ITA-2 code a character is represented by five bits. For instance the letter "D" is represented by the codeword '10110'. As we have five bits which can assume one of two possible states we are able to represent $2^5 = 32$ characters. However, the number of all letters, figures, and special characters add up to more than 32. Therefore a trick is employed: ITA-2 makes distinction between two cases, lower (letters) case and upper (figures) case. Shifting between these cases is accomplished by special shift characters. In this manner it is possible to transfer (2 x 32) - 6 = 58 characters (the last six are subtracted because they have same functions in either case). Shift characters are also used to toggle between Latin and non-Latin alphabets in the same transmission, e.g. Latin-Cyrillic and Latin-Arab alphabets.

The alphabet most widely used in modern data communication is the **ASCII** code (**American Standard Code for Information Interchange)** which is internationalized as ITU ITA-5. The alphabet is originally based on 7 bit words, but normally 8 bits are used either to expand the alphabet or to include a parity bit. Because of the number of bits available for each codeword, it is unnecessary to use special case shift characters as for ITA-2. Also both capital and miniscule letters can be accommodated as well as non-printing commands, and if 8-bit words are used completely transparent binary data.

Bits				5	0	1	0	1	0	1	0	1
				6	0	0	1	1	0	0	1	1
1	2	3	4	7	0	0	0	0	1	1	1	1
0	0	0	0		NUL	DLE	SP	0	@	P	'	p
1	0	0	0		SOH	DC1	!	1	A	Q	a	q
0	1	0	0		STX	DC2	"	2	B	R	b	r
1	1	0	0		ETX	DC3	#	3	C	S	c	s
0	0	1	0		EOT	DC4	$	4	D	T	d	t
1	0	1	0		ENQ	NAK	%	5	E	U	e	u
0	1	1	0		ACK	SYN	&	6	F	V	f	v
1	1	1	0		BEL	ETB	'	7	G	W	g	w
0	0	0	1		BS	CAN	(	8	H	X	h	x
1	0	0	1		HT	EM	)	9	I	Y	i	y
0	1	0	1		LF	SUB	*	:	J	Z	j	z
1	1	0	1		VT	ESC	+	;	K	[	k	{
0	0	1	1		FF	FS	,	<	L	\	l	|
1	0	1	1		CR	GS	–	=	M	]	m	}
0	1	1	1		SO	RS	.	>	N	∧	n	~
1	1	1	1		SI	US	/	?	O	–	o	DEL

NUL	Null, or all zeros	DC1	Device control 1
SOH	Start of heading	DC2	Device control 2
STX	Start of text	DC3	Device control 3
ETX	End of text	DC4	Device control 4
EOT	End of transmission	NAK	Negative acknowledge
ENQ	Enquiry	SYN	Synchronous idle
ACK	Acknowledge	ETB	End of transmission block
BEL	Bell, or alarm	CAN	Cancel
BS	Backspace	EM	End of medium
HT	Horizontal tabulation	SUB	Substitute
LF	Line feed	ESC	Escape
VT	Vertical tabulation	FS	File separator
FF	Form feed	GS	Group separator
CR	Carriage return	RS	Record separator
SO	Shift out	US	Unit separator
SI	Shift in	SP	Space
DLE	Data link escape	DEL	Delete

7-bit ASCII code. Normally eight bits are transmitted with the 8th bit either set to 1 or 0, used for odd or even parity or to expand the alphabet.



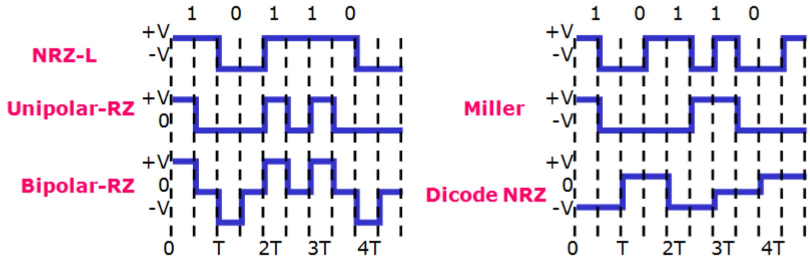
An example of source coding for analogue input is the process of transforming analogue voice to digital bits by way of sampling the input signal, the quantizing it into discrete amplitude levels and finally converting the quantized signal into 8-bit data words. This process is used for the conversion of ordinary analogue telephone speech into standard PCM (Pulse Coded Modulation) digital signals used globally in the Public Switched Telephone Network. Other examples for voice coding is the coding used for GSM mobile telephones or LPC (Linear Predictive Coding) used for narrow band digital voice.

To reduce redundancy, i.e. to use the transmission medium more efficiently, the formatted data is further processed through **compression**. As we saw above some codes, e.g. the Morse code inherently has the ability by statistical observation of the source data to reduce redundancy. Statistical reduction is also the basis for Huffman coding used in fax communication where the most frequently occurring bit combinations are transformed into symbols having the lowest number of bits. Huffman coding is thus an example of variable-length coding.

The degree of compression achievable, the **compression ratio**, is related to the properties of the data to be compressed.

Other examples of compression codes are ARJ, Lempel-Ziv, JPEG and MPEG, the later ones used for video, voice and music compression.

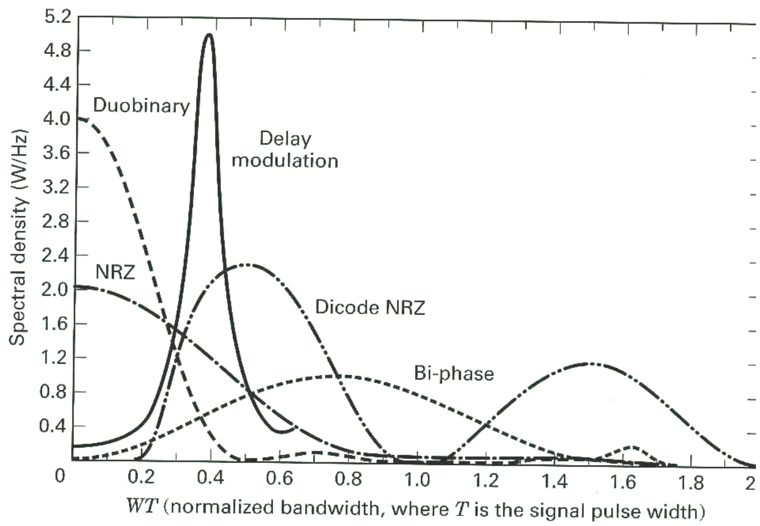
PACTOR and G-TOR are examples of the use of redundancy removal source coding for radio communication.



Baseband waveforms can be formatted in various ways. The most common method is called **Non-Return-To-Zero (NRZ-L)** meaning that the bits will have one of two voltage levels. **NRZ-M** also called **differential encoding,** uses a change in level for a logical one and no change for a logical 0. **NRZ-S** is complementary to NRZ-M. **Unipolar-RZ** represents a logical 1 with a positive half-bit wide pulse and a logical 0 with no pulse, i.e. at 0 level. **Bipolar-RZ** has opposite half-bit wide pulses for 1 and 0. The **Manchester** code or **Biphase-φ-L** is a subtype of NRZ coding and has a level transition at mid pulse, negative going for 1s and positive going for 0s. **Differential Manchester** omits the level transition for 1s and 0s respectively.

The exact waveform to be used depends on the application. For instance systems needing self-clocking would use Manchester coding because of transitions are always available even if the transmission consists of long rows of succeeding 1s or 0s. The BBC radio data system used on long wave utilizes Manchester coding as does Ethernet LANs. The AIS system used on VHF uses differential encoding to resolve polarity ambiguity and this encoding form is also commonly used in satellite transmission systems.

The illustration below depicts spectral density, i.e. efficiency, as a function of pulse bandwidth.



Encryption

To protect data transmissions against interception various methods are in use.

The encryption process basically processes clear text with a key and the transformed message is then transmitted over the insecure media. At the receiving end deciphering is achieved using the same key and the clear text message is recovered

Encryption may be **on-line** or **off-line**. On-line or **stream** encryption takes place at transmission time, whereas off-line or **block** encryption often is done before transmission, usually in the form of coding the clear text message into five letter or five figures groups. This is done by a key sequence.

Bit inversion inverts logical zeroes of a codeword with logical ones and vice versa either in a static pattern, e.g. bit 3 and bit 5 or in a dynamic pattern depending on the value of the codeword. The result of bit inversion is character **substitution** – the original clear text character is substituted with another character.

Character **transposition** or **permutation** replaces characters in one position in the clear text with characters in another position. One of the most famous implementation of permutation transformations is the German Enigma cryptographic machine in use before and during World War II.

Substitution and permutation of clear text messages is relatively easily broken using statistical methods and a knowledge of the frequency of characters in various languages.

Shift-register encryption, a stream encryption method, uses one or more shift-registers into which the clear language message is shifted and EXORed with a key or part of itself. Taps in various positions of the registers may feed bits back to the input to complicate decryption by interceptors. The shift-registers of the transmitting and receiving equipment must be initialized to the same value - the seed.

System security in conventional crypto systems depends on the safeguard of the key and on the length of the key. Generally speaking the longer the key the more difficult will the work of the cryptanalyst be. Unbreakable systems like the one-time pad will only use its key once and its key length is as long as the clear text message. Crypto messages are constructed by byte wise EXORing of the clear text message and the key. Kerckhoffs principle is the design criteria for modern crypto systems: “The security of a crypto system must not depend on keeping the algorithm secret. The security is only dependent on keeping the key secret.”

Modern crypto systems use the principles of **public keys**. Traditional systems use the same key for encryption and decryption and safeguard this key. Public key systems use two different keys, one for encryption and one for decryption, Public keys and the encryption algorithms are publicly available, but the decryption keys are secret and private. So the transmitting party will encrypt his message with the public key of the recipient. The recipient will decrypt the message using his private key.

Channel coding

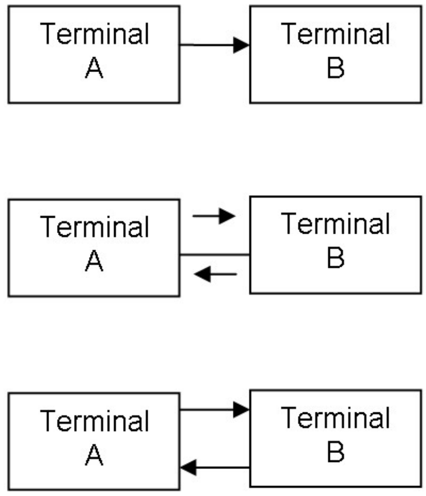
Due to the unstable nature of the radio media, especially in case of HF links a number of techniques have been designed to protect data and ensure a high degree of error free transmission. This is especially important for the transmission of encrypted information.

Channel coding is about improving performance by providing techniques which can be used to combat fading, jitter, noise and other perturbations which are properties of time-varying channels as radio channels.

To protect the data extra - redundant - information must be added to the (source encoded) data to be protected. Either bits are added to existing source code or the source alphabet is converted into a completely new alphabet before channel transmission. In addition certain procedures - **protocols** - are used for the exchange of information.

Depending on the nature of the radio link – simplex, half-duplex or duplex - channel coding and protocols have been devised to detect or correct transmission errors or to both detect and correct errors.

Traffic between users may be handled in a number of ways depending on requirements and equipment available.



Top – Simplex (one-way), transmission in only one direction

Middle – Half-duplex, transmission in either direction, not simultaneously

Down – Full-duplex, simultaneous transmission in both directions

ARQ is a technique by which the **Information Sending Station (ISS)** transmits information in such a way that the **Information Receiving Station (IRS)** is able to detect transmission errors and then ask for repetition of the character or block of characters in error. This technique is used in half-duplex and duplex channels.

Several methods are used for error detection and possible error correction. One method is the use of **parity-check codes**. One such code in international use for ARQ is the **balanced** ITA-3 code consisting of seven bits with a constant mark-space ratio of 3:4. A ratio different from 3:4 in a received codeword will be an error and a RQ (Request for Repetition) is issued This code has no correcting capability.

ASCII is also a parity checking code. The Russian CIS-36 mode combines m-ary modulation with parity checking. In this case the data to be sent is formed into blocks and parity is calculated for both rows and columns – horizontal and vertical parity check.

Another ARQ code is the ARQ-1A **parity code**. The code words of this code also consist of seven bits, 6 data and 1 parity bit. The parity bit is set to 1 or 0 depending on the number of logical '1's in the six data bits of the codeword.

The Bulgarian ASCII system uses yet another form of parity check called **block coding**. A checksum is calculated for a data block and appended to the transmitted block. The IRS calculates the checksum once again and compares the result with the checksum received. If the checksums are not equal a RQ is issued. The checksum calculation is often done using a method called a **Cyclic Redundancy Check (CRC)**.

In simplex systems there is of course no return channel so the IRS cannot request repetitions. Therefore the codes used must be very robust and be able to correct errors at the receiving end - **Forward Error Correction (FEC)** is used.

Intensive research has led to the discovery of s number of block codes with superior error detection and correction features, e.g. Hamming, BCH, Golay and Reed-Solomon codes,

One of the worst enemies of simplex links is burst noise which may damage many succeeding bits. To combat this type of noise **bit spreading** or **bit interleaving** is used. The bits of succeeding code words are spread in time. In this way burst errors will only influence a few bits of each codeword and the error correcting code may have a decent chance to correct the errors. The HNG-FEC and RUM-FEC channel codes use this method.

Another method is **codeword repetition** in which a code word is repeated several characters later in the transmission. To improve error detection and correction the repeated character may be bit-inverted. The original character and the repeated character are then compared at the IRS. SI-FEC and SITOR-B are examples of this type of code.

One code type has been successful in particular. That is the **convolutional code** in which the value of the parity bits depends of the values of a number of preceding data bits. The data bits are shifted through a shift-register with taps. The output at the taps is EXORed to form the value of the parity bits. After convolution the bits are interleaved to further improve noise immunity. FEC-A uses such a code. Convolutional coding and the related Viterbi decoding have found widespread use in satellite communication.

Modern communication systems often utilize a combination of coding schemes to obtain higher invulnerability against errors at a lower complexity level. Thus in satellite communication codes are **concatenated**, that is a convolutional **inner code** towards the modulator is concatenated with a Reed-Solomon **outer code** with an interleaver inserted in between. Recent research has refined the concatenated coding and added an iterative decoding algorithm to achieve what is called **turbo coding**. Further research has led to the discovery of so called **Low Density Parity Codes (LDPC),** the use of which has enabled communicators to come very close to the theoretical bandwidth limit of a communication channel.

Modern technology has enabled more sophisticated approaches to combat the challenges of radio communication. Inter-symbol interference is one such challenge. Due to the time-varying nature of fading channels one symbol may delayed in such a way that it interferes with the next symbol at the receiving end. By shaping the digital pulses in certain patterns the level of ISI may be reduced. The raised cosine pulse shape is the shape most frequently used in conjunction with equalization.

Equalization

To combat the perturbations introduced during the transmission via time-varying communication channels, modern digital communication systems employ a technique called **equalization. Preset equalization** transmits a **training sequence** which is compared to a similar sequence at the receiving end. The difference between the received and local sequences is used to adjust a special filter. **Adaptive equalization** continually measures the characteristics of the channel from the data received and dynamically adjusts the filter. The precondition to exploit the powerful features of equalization is dependent on good channel error performance.

The equalizer sits between the demodulator and the detector.

Synchronization

To enable the receiving end of a data or telegraph link to interpret the received code words in a meaningful way, the receiver must first be **synchronized** to the incoming bit stream by finding the bit level transitions, and next achieve code word **phase**. Basically the receiver will search for a certain bit pattern in the bit stream and when found transmitter and receiver are synchronized.

Before the widespread use of electronic circuits all telegraph devices were of electro-mechanical nature and therefore prone to mechanical wear and tear. This in turn necessitated comparatively large tolerances and made stable synchronization over even short periods difficult. To overcome this serious problem, the ITA-2 alphabet adopted what is known as **start-stop** or **asynchronous** operation, which achieves synchronism for each codeword.

In start-stop systems a codeword is wrapped into an "envelope" consisting of a leading **start bit** (logical '0') and one or more trailing **stop bits** (logical '1') - for ITA-2 the code words are 1 + 5 + 1.5 = 7.5 bits long. Bit synchronization is then achieved by detection of the start element. The stop element(s) serve(s) the purpose of telling the receiver to reset its detection mechanisms and wait for the next start bit. To ensure proper operation of the mechanical devices the stop bit was extended to have 1.5 times the length of a data bit, which accounts for the term "non-integral" earlier in this section.

In **synchronous** systems there is continuous synchronization between the sending and receiving devices either by special non-printing control characters being inserted into the messages at regular intervals or the code words themselves being constructed to facilitate synchronism. To maintain synchronism special idle or sync characters are transmitted when no traffic is transmitted. In contrast to start-stop systems only elements having a duration of an integral multiple of the duration of the minimum signal element are used – **isochronous** sequence.

For burst mode or packet transmissions a leading preamble of either a sequence of alternating zeros and ones and a repeated fixed pattern – in satellite transmission called a **Unique Word** - is often used for synchronization purposes. A very common way of combined synchronization and packet delimiting is to pre-cede and terminate the data packet with so called **flags**, i.e. unique bit patterns, not being a part of the data proper. Flags are characteristics of HDLC (High-level Data Link Control) which is used in amateur radio packet communication and in AIS.

Multiplexing and Multiple Access

Another method is to transmit more than one channel on a radio link. This may be achieved either in the frequency or time domain or a combination hereof. When the aggregation of channels is done before the modulation process it is called multiplexing. When independent stations access a medium it is called multiple access. A well known example of multiple access is Ethernet LANs where all nodes have access to the same medium.

In **frequency multiplex (FDM)** or **frequency division multiple access (FDMA)** a carrier frequency is modulated with a number of sub-carriers. Each sub-carrier carries a data signal. The sub-carriers may be amplitude, frequency or phase modulated. The more common is narrow shift frequency modulation. Each channel is independent of the other ones and may transmit with a different speed or use a different alphabet or system. One such system used in HF communications is the CODAN 16 carrier QPSK system.

In **time multiplex (TDM)** or **time division multiple access (TDMA)** each data source is allowed access to the **aggregate channel** (line or radio link) in well-defined time slots. To keep pace with the incoming bit stream, the aggregate channel speed must be the sum of the speed of the individual channels. All channels must have identical speeds. However, a channel subdivision scheme has been standardized so that up to four sub-channels may share one channel. An example is the ARQ-M2 and M4 modes.

In satellite systems a combination of FDMA and TDMA is often used to optimize channel usage. DAMA (Demand Assigned Multiple Access) satellite systems are an example of this type of multiple access.

Polarization division multiplexing is in satellite communications whereby differently polarized signals use the same frequency leading to frequency reuse. Inmarsat earth station – satellite links in C-band uses this type of multiplexing.

The overwhelming majority of radio data systems will transmit the individual bits of a codeword one after the other in **serial transmission**. But real-time or high volume data systems like digitized secure voice, computer network access and image or file transfer often uses **parallel transmission**. The serial code words are fed to a serial-to-parallel converter and then to the sub-carrier modulators of a FDM.

Modulation

Modulation is the process whereby the digital baseband signal or waveform is superimposed on a carrier. The carrier may be manipulated in amplitude, frequency and phase.

The most frequently used modulation techniques are 2FSK using two frequencies, MFSK with four or more tones and differential phase modulation methods as 2DPSK, 4DPSK, 8DPSK or 16DPSK. On satellite links phase modulation methods as BPSK or QPSK are used. Other modulation types include AM, FM or phase sub-carrier modulation of a FM, AM or phase shift main carrier.

Modulation methods which directly manipulate the carrier may be decoded using the receiver IF output or for smaller shifts in case of FSK also the AF output. In addition many VHF/UHF receivers also have a direct discriminator output, which may be used.

In contrast modulation methods using sub-carrier modulation must be decoded using the receiver AF output. Decoding indirect modes can only take place using the receiver AF output. The receiver serves as demodulator of the FM or AM carrier, while the decoder demodulator processes the sub-carrier modulation.

ASK (Amplitude Shift Keying)

The simplest way to impress the digital information on a carrier is to key the carrier on and off representing the two levels of binary information. This was the earliest keying method as is still used for many Morse links.

As most noise encountered at radio frequencies is amplitude noise, this modulation method is very noise vulnerable.

FSK (Frequency Shift Keying

As electronic equipment became more refined – frequency stability improved - and the demands for error free communication increased, frequency shift keying (FSK) was introduced. In this mode the transmitter is continuously on, but transmits alternately on two different frequencies, one representing Mark level and the other one Space level. As amplitude noise is additive it can be eliminated by clipping all spikes above the carrier level. The difference between the two frequencies (the frequency deviation) is called the shift and may for instance be 170, 425 or 850 Hz.

For many years FSK was the mainstay of digital radio communication.

PSK (Phase Shift Keying)

PSK manipulates the carrier phase information in conformance with the digital information to be transmitted by advancing or delaying the phase of the carrier.

As equipment sophistication evolved, phase keying became more common and is now in use on modern high-speed HF radio links, e.g. in MIL or STANAG based systems. In satellite communication PSK is the main modulation method. For instance Inmarsat C uses BPSK (2PSK) and other Inmarsat systems use QPSK (4PSK).

M-ary-FSK (MFSK), M-ary-PSK (MPSK)

Modes in the HF bands are generated by frequency or phase modulation of a sub-carrier, which then in turn modulates a carrier using suppressed carrier SSB keying or by directly modulating a carrier. Decoding can be done from the receiver AF or IF output (USB, LSB, CW or FAX demodulator). Examples of this type of modulation are ordinary two-frequency FSK, four-frequency FSK (Twinplex) and the STANAG PSK modes. **M-ary** designates the number of modulation levels. **FSK** designates common two-frequency FSK.

MFSK systems deviate from the classical binary transmission of '0' (Mark) and '1' (Space), because in MFSK each tone has a higher information density. This is the reason for a very high increase of the element period in MFSK compared with binary transmissions having the same baud rate. This produces a substantial increase in the insensitivity to multi-path propagation and noise. Examples of MFSK systems are PICCOLO, COQUELET and CIS-36.

Due to intensive research and the availability of highly efficient hard- and software, the waveforms originally developed within the STANAG specifications of NATO have gained considerable influence in radio data communications. This has resulted in very efficient modems utilizing multiphase modulated single-tones combined with use of adaptive equalization and sophisticated coding and demodulation and decoding.

Satellite TV broadcasting utilizes QPSK or even 8PSK.

A special instance of m-ary modulation is QAM (Quadrature Amplitude Modulation) in which phase and amplitude modulation is combined. An example of QAM is digital broadcasting in the MF and HF bands (DRM).

OFDM (Orthogonal Frequency Division Modulation)

OFDM is a combination of multiplexing and modulation. The signal to be transmitted is first split into a number of separate channels modulated by the data and then re-multiplexed to create an OFDM carrier. HF modem research is ongoing to investigate whether this type of modulation is well-suited to combat selective fading which is a very destructive factor in HF data communication. OFDM is used for Wireless LANs and ADSL. When OFDM is combined with coding it is called Coded OFDM (COFDM) which is used in DAB-broadcasting to combat multi-path.

Bandwidth-efficient Modulation

Among newer modulations methods employed to make better use of the spectrum available are Offset QPSK (OQPSK), Minimum Shift Keying (MSK) and Gaussian FSK (GFSK). MSK is used in DGPS and in GSM systems. OQPSK is used in satellite communications and GFSK is used in various data modes.

INDIRECT FM

A frequency modulated carrier is modulated with an AF FSK sub-carrier. For decoding, the receiver FM demodulator output is required. Examples of INDIRECT modulation are PACKET-1200, ATIS, and analogue and digital tone call systems. Decoding is only possible from the receiver AF output.

INDIRECT AM

This modulation method uses AM carrier modulation, which in turn is modulated by an AF FSK sub-carrier. For decoding the receiver AM de-modulator output is required. At the time of writing, ACARS is the only known mode using this modulation method. Decoding is only possible from the receiver AF output.

FAX

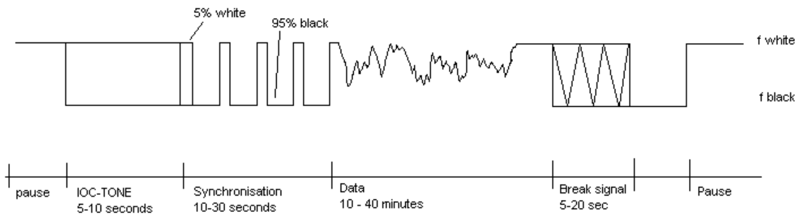
Weather charts to be transmitted are fastened to a revolving drum and il-luminated by a light source. The drum is then scanned by a light sensor moving along the axis of the drum. The voltage output from this sensor is converted into tone frequencies modulating the transmitter.

The number of revolutions per minute (RPM) is a measure of the speed of the drum on the transmitting side. The index of cooperation (IOC) is a measure of the speed with which the sensor moves along the axis of the drum.

A fax transmission begins with a tone of 300 or 675 Hz. The start tone has duration of 5-10 seconds and is very well suited for exact tuning pur-poses. The frequency of the tone determines the IOC value. Then 30 seconds of alternations between the frequencies representing black and white levels are transmitted, the switching frequency being 1-4 Hz. This sequence carries the RPM information and the receiver is now synchro-nized so that the picture will start in the right position. Subsequently the transmission of the picture proper begins.

At the end of transmission the stop signal is sent. This consists of a switch-off signal of 450 Hz having duration of 5 seconds followed by 10 seconds of the frequency representing black level.

FAX Transmission Sequence



Baud Rates, Speeds and Modulation Types

Mode	Speed	Modulation
ACARS	2400	AM/FM
AIS	9600	FSK
ALF-RDS	1187.3	PSK
ALIS	228.6	FSK
ALIS-2	240.82	8FSK
AMSAT-P3D	800	PSK
AUM-13	8 (125 ms)	13FSK
ARQ-E	46.2, 48, 64, 72, 75, 85.7, 96, 184.6, 192, 200, 288	FSK
ARQ-E3	48, 50, 72, 96, 100, 192, 200, 288	FSK
ARQ-N	48, 64, 72, 86, 96, 192	FSK
ARQ-M2-242	85.7, 96, 200	FSK
ARQ-M2-342	85.7, 96, 200	FSK
ARQ-M4-242	172, 192	FSK
ARQ-M4-342	172, 192	FSK
ARQ6-90	200	FSK
ARQ6-98	200	FSK
ASCII	50, 75, 100, 110, 150, 180, 200, 300, 600	FSK
ATIS	1200	FM/FSK
AUTOSPEC	62.3, 68.5, 102.63, 137	FSK
BAUDOT	45.45, 50, 70, 75, 100, 150, 180	FSK
BULG-ASCII	110, 120, 150, 180, 200, 300, 600	FSK
CCIR-1	10 (100 ms)	FM/16FSK
CCIR-7	10 (100 ms)	FM/16FSK
CCITT	10 (100 ms)	FM/16FSK
CIS-11	100	FSK
CIS-12	12 channels, 120	12 channels DBPSK, DQPSK
CIS-14	96	FSK
CIS-36	25, 50, 100	FSK
CIS-36-36	36, 50, 75, 100, 150	FSK
CIS-36-50	36, 50, 75, 100, 150	FSK
CLOVER-2	31.25	BPSK, QPSK, 8PSK, 16PSK,

		2ASK/8PSK, 4ASK/16PSK, DPSK
CLOVER-2000	62.50	BPSK, QPSK, 8PSK, 16PSK, 2ASK/8PSK, 4ASK/16PSK, DPSK
CODAN	100	FSK
CODAN-9001	16 channels, 75	16 channels DQPSK
COQUELET-8	13.33, 20, 26.66	12FSK
COQUELET-13	20, 26.66	12FSK
COQUELET-80	13.33, 20, 26.66	12FSK
CTCSS	10	FM/FM
CW-MORSE	0 – 400 BPM	CARRIER KEYING, AM or FSK
DCS	133, 133.7, 134.4	FM/FM
DGPS	100, 200	FSK
DTMF	14.28 (70 ms)	FM/FM
DUP-ARQ	125	FSK
DUP-ARQ-2	250	FSK
DUP-FEC-2	125, 250	FSK
EEA	25 (40 ms)	FM/16FSK
EFR	200	FSK
EIA	33 (33 ms)	FM/16FSK
ERMES	3125	4-PAM/FM
EURO	10 (100 ms)	FM/16FSK
FEC-A	96, 144, 192	FSK
FELDHELL	122.5	CW or AM
FLEX	1600, 3200	FSK
FM-HELL	122.5	FSK
FMS-BOS	1200	FM/FSK
GMDSS/DSC-HF	100	FSK
GMDSS/DSC-VHF	1200	FM/FSK
GOLAY/GSC	300/600 adaptive	FSK
G-TOR	100/200/300 adaptive	FSK
GW-PSK	200	DQPSK, D8PSK
GW-FSK	100, 200	FSK
HC-ARQ	240	FSK
HF-ACARS	300, 600, 1200, 1800	M-PSK
HNG-FEC	100.05	FSK
ICAO SELCAL	1 (1000 ms)	
METEOSAT	240 RPM, IOC 288	FM/AM
MFSK-8	7.81	8FSK
MFSK-16	15.625	16FSK
MFSK-20	10, 20	20FSK
MIL-188-110A	2400	8PSK
MIL-188-110A/B	39 channels, 44.44	39 channels, QDPSK
MIL-188-110A	16 channels,	16 channels, DPSK

MIL-188-110B (Appendix C)	2400	8PSK/16QAM, 32QAM,64QAM
MIL-188-141A	125	FSK
MIL-188-141B (Appendix C)	2400	8PSK
MPT-1327	1200	FM/FSK
NATEL	14.28 (70 ms)	FM/16FSK
NMS-450	1200	FM/FSK
NOAA-GEOSAT	120 RPM, IOC 576	FM/AM
PACKET-300	300, 600	FSK
PACKET-1200	600, 1200	FM/FSK
PACKET-9600	2400, 4800, 9600	FSK
PACTOR	100/200 adaptive	FSK
PACTOR-II	100	2 channel DBPSK, DQPSK, D8PSK, D16PSK adaptive
PACTOR-II-FEC	100	2 channel DQPSK
PACTOR-III	100	DBPSK, DQPSK, 2, 6, 14, 16 or 18 tones
PICCOLO-MK6	40, 20	6FSK
PICCOLO-MK12	40, 20	12FSK
POCSAG	512, 1200, 2400	FSK
POL-ARQ	100, 150, 200	FSK
PRESS-FAX	120 RPM	FSK
PSK-10	10	DBPSK
PSK-AM	10, 31.25, 50	DBPSK
PSK-31	31.25, 62.5, 125	DBPSK, DQPSK
PSK-31-FEC	31.25	DBPSK
PSK-63F	62.5	DBPSK
PSK-125F	125	DBPSK
PSK-220F	220	DBPSK
RUM-FEC	164.48, 218.30	FSK
SAT-A-TELEX	1200	BPSK
SAT-B	6000/ 24000	BPSK/O-QPSK
SAT-C	1200	BPSK
SAT-M	6000/8000	BPSK/O-QPSK
SAT-mM	6000/5600	BPSK/O-QPSK
SI-AUTO	96, 192, 200	FSK
SI-ARQ	96, 192, 200	FSK
SI-FEC	96, 200	FSK
SITOR-ARQ	100	FSK
SITOR-FEC	100	FSK
SP-14	7.5	14FSK
SPREAD-11	62.3, 68.5, 102.63, 137	FSK
SPREAD-21	62.3, 68.5, 102.63, 137	FSK
SPREAD-51	62.3, 68.5, 102.63, 137	FSK
SSTV	8 – 180 s	FSK
STANAG 4285	2400	BPSK, QPSK, 8PSK

STANAG 4415	2400	8PSK
STANAG 4481 PSK	2400	BPSK
STANAG 4481 FSK	75, 100, 150, 300, 600	FSK
STANAG 4529	1200	BPSK, QPSK, 8PSK
SWED-ARQ	100	FSK
TWINPLEX	100	4FSK
VDEW	10 (100 ms)	FM/16FSK
WEATHER-FAX	60, 90, 120, 180, 240 RPM	FSK
ZVEI-1	14.28 (70 ms)	FM/16FSK
ZVEI-2	14.28 (70 ms)	FM/16FSK
ZVEI-VDEW	1200	FM/FSK

Speed is given as the channel speed in Bauds. For two level modulation types this equals the raw user bit rate, for four level s the bit rate is doubled, for eight levels it is tripled etc.

ACARS

Parameter	Value
Frequency range	VHF
System	CSMA/CD packet ARQ system
Center frequency	1800 Hz
Shift/Bandwidth	1200 Hz
Speed	2400 Baud
Modulation	AM/FSK
Receiver settings	AM, narrow
Input(s)	AF-IN
Additional Info	ITA-5 with parity and block coding Frequencies Europe: 131.725, 131.525, 131.825 MHz Frequencies USA: 131.550, 130.025, 129.125, 131.475, 130.450, 131.125, 136.700, 136.750, 136.800 MHz Frequency Japan: 131.450 MHz

Aircraft **C**ommunications **A**ddressing and **R**eporting **S**ystem (ACARS) is a carrier sensing, multiple access packet radio system for aircraft communications. ACARS operates in the VHF band, mainly around 130 MHz, using 2400 bps NRZ**I** coded coherent audio frequency MSK (Minimum Shift Keying - a particular form of FSK) on AM to make use of standard aircraft AM communications equipment.

To receive ACARS an omni-directional 108-136 MHz antenna, a VHF AM receiver (scanner) with 13 kHz channel bandwidth and a corresponding AF output is necessary. As the ACARS packets are very short turn the squelch of the receiver OFF.

Speed selection is not available for ACARS as only one speed is in use (2400 Baud)...

ACARS Frame

Parameter	Value
Pre-key	16 characters All binary „ones„
Bit Sync	2 characters „+„ , „*„
Character Sync	2 characters SYN, SYN (16h)
Start of Heading	1 character SOH (01h)
Mode	1 character
Address	7 characters
Technical Acknowledgement	1 character
Label	2 characters
Block Identifier	1 character
Start of Text	1 character
	STX (02h) - if no text ETX (03h)
Text	220 characters maximum, printable characters only
Suffix	1 character, if single or terminal block ETX, else ETB (17h)
Block Check Sequence 16 bits	
BCS Suffix 1 character DEL (7fh)	

Messages may be single or multi-block. The pre-key sequence and the BCS have no parity bits.

ACARS communications are divided in Category A and Category B.

Using Category A an aircraft may broadcast its messages to all ground stations. This is denoted by an ASCII "2" in the Mode field of the downlink message. The WAVECOM software translates this character to "A".

Using Category B an aircraft transmits its message to a single ground station. This is denoted by an ASCII character in the range "@" to "]" in the Mode field of the downlink message.

The ground station may use either "2" or the range "‘" to "}" in the Mode field. All ground stations support Category A, but may uplink "‘" to "}" in the Mode field.

The WAVECOM software translates the ground station address (also called the Logical Channel Number) into a number in the range 0...29.

A station will transmit after having monitored the HF channel for traffic, otherwise it waits until the channel is clear. If a collision occurs between the packets of two stations transmitting at the same time, they will back-off and new transmission intervals will be set by random interval timers in the radio equipment.

At the receiving end a block check calculation is made and compared to the calculation appended to the packet by the transmitting station. If the downlink messages contains errors no response will be given and the transmitting station will retransmit the packet a number of times until a positive acknowledgement is received and the message can be deleted from storage or the aircrew be alerted to its non-transmission.

If an uplink message is found in error, the airborne equipment will generate a negative acknowledgement (NAK) which triggers an uplink re-transmission. Retransmission is also triggered by timeout.

Positive acknowledgement from the aircraft consists of the transmission of the Uplink Block Identifier of the correctly received block. Positive acknowledgement from the ground station consists of a similar transmission of the Downlink Block Identifier.

Acknowledgements are placed in the Technical Acknowledgement field.

The general response message label is "_DEL" (5fh 7fh). Messages with this label contain no information except acknowledgements and are used for link maintenance.

The traffic exchanged can be requests for voice communication, weather reports, access to airline computer systems, reading of aircraft automatic sensors, flight plans, messages to be routed to destinations in the international airline data network - in fact much traffic previously carried by voice, has been transferred to ACARS.

The text field of the ACARS packet is used for messages with a fixed format, free text or a mixture of formatted and free text. Standard 7 bit ASCII is used, bit 8 is an odd parity bit and LSB (bit 1) is transmitted first.

ACARS Downlink Message Example

(#8) 06-11-1996 18:43:32 M=06 ADDR= HB-INR TA=Q ML=Q0 B=6 MSN=0635 FID=SR6767

(Bold typeface indicates decoder generated characters)

Decoded	Interpretation
(#8)	Decoder generated message number
06-11-1996 18:43:32	Decoder generated timestamp (optional)
M=	Mode Category A = A,
	Category B = 0..29
ADDR=	Aircraft address
	(aircraft registration or flight identifier)
TA=	Technical acknowledgement
	(downlink 0...9, uplink A...Z, a...z, NUL (00h))
ML=	Message Label (message type)
B=	Uplink/Downlink Block Identifier
	(downlink 0...9, uplink A...Z, a...z, NUL (00h))
MSN=	Message Sequence Number
FID=	Flight Identifier

In this case record **#8** decoded at **18:43:32** contains a message from a Swiss aircraft with registration **HB-INR** using logical channel **06** to transmit and acknowledgement of uplink block **Q** and a link test (**Q0**) with block identifier **6** and message sequence number **0635** (here the time in minutes and seconds after the hour is used - other formats are also in use). The flight is Swissair **SR6767**.

A few examples of the more important or frequently seen ACARS messages:

M=06 **ADDR=** HB-IND **TA**=NAK **ML=**_□ **B=**3 **MSN=**2810 **FID=**OS005

Using logical channel **06** an unsolicited (TA=**NAK**) general response _□ without information is transmitted as block **3** from aircraft **HB-IND** on flight **OS005** with sequence number **2810**. General responses are mainly used for block acknowledgement purposes.

M=06 **ADDR=** □□□□□□□ **TA**=NAK **ML=**SQ **B=** 00XSZRH

This is a "squitter" - an id and uplink test message transmitted at regular intervals from ground stations. This one is a squitter **(SQ)** version 0 **(00)** from a SITA **(XS)** ground station in Zurich, Switzerland **(ZRH)**. The □ denotes the ASCII NUL character (00h) used for broadcast. A block identifier is not used.

M=06 **ADDR=** OY-MDS **TA**=5 **ML=**:; **B=**131125

This is a data transceiver auto tune message **(:;)** from ground station **06** commanding the ACARS transceiver of aircraft **OY-MDS** to change its frequency to 131.125 MHz. At the same time acknowledgement is given for the aircraft's downlink block **5**.

AIS

Parameter	Value
Frequency range	VHF
System	SOTDMA FEC
Speed	9600 Baud
Modulation	GMSK
Receiver settings	FM BW=15 kHz
Signal source(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

AIS also known as (Universal) Automatic Identification System (UAIS) is a worldwide radio system for ship collision avoidance and navigational advice. AIS equipped ships continuously transmit short messages containing information like position, course over ground, speed over ground etc. All information may be sent from ship to ship as well ship to shore. This is very useful for Vessel Traffic Systems (VTS) in congested areas as harbors, rivers and archipelagos.

Transmission is 9600 Baud GMSK modulation over 25 or 12.5 kHz channels using the HDLC packet protocol. Each station transmits and receives over two radio channels to avoid interference problems. Self-Organizing Time Division Multiple Access (SOTDMA) is used. One Time Division Multiple Access (TDMA) frame corresponds to one minute and contains 2250 slots.

Each frame contains an 8 bit ramp up and a 24 bit synchronization sequence. At the start and end of each frame, a HDLC flag (01111110) is sent. After the 8 bit preamble, 168 bits of data and a 16 bit CRC checksum are sent in a default packet (one slot). Long transmission packets may occupy two to five continuous slots. Bit stuffing and NRZI encoding is used.

Traffic can be monitored on the AIS1 Channel 87B 161.975 MHz and AIS2 Channel 88B 162.025 MHz

From Options/Display Mode, All frames or Error free frames may be selected.

ALF-RDS

Parameter	Value
Frequency range	HF
System	Broadcast FEC
Center frequency	
Shift/Bandwidth	
Speed	1187.5 Baud
Modulation	BPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

Additional Info	

ALF-RDS (**A**ccurate positioning by **L**ow **F**requencies) is a German system for the transmission of DGPS information on low frequencies (in this case 123, 7 kHz). Data is transmitted in RDS format. RDS (Radio Data System) is a one-way data transmission system used by FM broadcasters worldwide to broadcast program, time and traffic information on a 57 kHz BPSK DSB sub carrier with suppressed carrier and a bit rate of 1187.5 bps. In the case of ALF-RDS, the transmission is made in SSB with a decreased level pilot carrier to reduce bandwidth.

The RDS basic data unit is a group which consists of four blocks each having 16 data bits and 10 error detection and correction bits. Groups are divided into type A and B each containing 16 different groups.

In the upper window, a display mode can be selected. The default display mode is **All Blocks**, which displays the information of each block. **Raw Bits** will display the contents of a group in binary format.

In the lower window, other information like flags, time, program information and transmitted text is displayed.

ALIS

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	228.66 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with block coding

ALIS (**A**utomatic **Li**nk **S**et-up) is a simplex ARQ system and operates at a speed of 228.66 Baud on the radio link.

ALIS is described in report 551-2 of the ITU "Reports of the CCIR 1990 - Fixed Services at Frequencies below about 30 MHz".

The transmission block of the standard ARQ system consists of 2 identification bits, 30 data bits and 16 CRC bits. Data transmission is transparent for ALIS. Known systems are however structured around six ITA-2 characters.

The two identification bits indicate one of four possible system states. The CRC checksum enables detection and correction of transmission errors.

The acknowledgement block is 16 bits in length. The total transmit-receive cycle for ALIS is 111 bits, which corresponds to a duration of 485.4 ms. An error free transmission is equivalent to a terminal baud rate of 100 Baud.

The ALIS system automatically determines the optimal operating frequency after having received a CALL command. The station then sends a synchronization word, address, block counter and a status word. The receiving station correlates this bit sequence and synchronizes itself. If the data transmission link fails, ALIS will search for a new frequency to re-establish the link.

ALIS-2

Parameter	Value
Frequency range	HF
System	MFSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	240.82 Baud
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

ALIS-2 (**A**utomatic **Li**nk **S**et-up) is a simplex system operating with a baud rate of 240.82 baud.

ALIS-2 is described in the "Report of the CCIR 1990, Fixed Service at Frequencies below about 30 MHz" of the ITU.

ALIS-2 is 8-FSK modulated. The tone spacing is 240 Hz, and the tone duration is 4.15254 ms. The transmission block consists of 55 tri-bits, resulting in 165 bits per frame. In addition to the preamble of 21 bits, each block contains 126 data bits. The preamble includes an identification code, allowing different systems to be identified.

Two identification bits signal four operational states: Traffic, idle, RQ and binary data transfer. The 16 bit CRC-checksum serves the detection of transmission errors and error correction purposes.

The overall transmission and receive cycle of ALIS-2 is 354 bits, which is equivalent to 490 ms. In case of an error free data transmission the terminal bit rate is 720 bit/s.

ALIS-2 almost always uses the ITA-5 ASCII alphabet.

The ALIS-2 system automatically determines the optimum operating frequency after having received a CALL command. The station then sends a synchronization word, address, block counter and a status word. The receiving station correlates this bit sequence and synchronizes itself. If the transmission link is interrupted, ALIS-2 will search for a new frequency to re-establish the link.

If an ALIS-2 system is identified the status line will display **System:** XXXXXXXXh", where XXXXXXXXh denotes an eight digit hex id string.

AMSAT-P3D

Parameter	Value
Frequency range	VHF/UHF
System	FEC telemetry
Center frequency	
Shift/Bandwidth	560 Hz
Speed	800 Baud (with Manchester coding)

Modulation	PSK
Receiver settings	FM, BW=5 kHz
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

AMSAT (Radio Amateur Satellite Corporation) OSCAR-40 (AMSAT Phase 3D) is the latest satellite in the Phase 3 series of high altitude radio amateur satellites.

The satellite telemetry system may be monitored.

A complete telemetry frame consists of a 4 byte preamble, a 512 byte data set and a 2 byte CRC checksum. The 400 bps information is differentially encoded then exored with a 400 bps clock signal to create a Manchester coded PSK signal.

The P3 flight computer of AMSAT OSCAR-40 uses a radiation hardened Cosmac CDP-1802 microprocessor running at 100K instructions/sec. The operating system is called IPS, an acronym that translates as "Interpreter for Process Structures".

A small part of the computer’s 64 kBit memory is used by IPS as workspace. 256 bytes of data collected via a 128 channel ADC, and 128 bytes of digital data is stored in this area called the IPS "SysPage".

The "SysPage" covers a lot of measurement functions: Status, navigation, power and temperature.

The decoder is able to demodulate, decode, verify (CRC) and display the data content in binary or as text. The so called "A" or "E" packets are processed further and the information is displayed in four sections: Main status, temperatures, power and sensors.

The complete data set is also exported to a binary file called "amsatp3d.raw". The file contains the last hundred data sets and can be imported by programs like "AO40rcv" by selecting this file as the input source. If the data set contains a "SysPage" the content is mapped to status, navigation, power and temperature values.

From Options/Display Mode, All frames or Error free frames may be selected.

Selecting **Options/Display** offers the option of an **ASCII** or **RAW** bits display.

AUM-13

Parameter	Value
Frequency range	HF
System	Broadcast, unprotected
Center frequency	
Shift/Bandwidth	480 Hz
Speed	8 Baud
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

AUM-13 is a sequential 13 tone mode, which is optimized for the transmission of numeric codes. AUM-13 is similar to SP-14.

Each tone has been assigned a character:

- 10 tones are assigned to the numerals 0..9
- One tone is used as an idle character
- One tone is used as a space character
- One tone is used as a repetition indicator

A transmission is initiated with a start sequence, which identifies this mode and may be used for accurate tuning. This sequence is transmitted at 1 Baud, which makes it readable even during very unfavorable conditions.

The data proper is transmitted at a rate of 8 Baud. As the transmission rate is very low this mode is insensitive to fading and multipath propagation.

A MFSK IAS will retrieve symbol clock. In order to process both baud rates used by AUM-13, the IAS has to be configured to a baud rate of 16 Baud. Thus at a rate of 1 baud 16 symbols per transmitted symbol, and at 8 Baud two symbols per transmitted symbol, must be received with a certain tolerance. Even if for instance the same character is received 16 times in succession, error correction is impossible due to the fact that in case of repetition of numerals the numeral itself is followed by the repetition indicator.

ARQ-E

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	46.2 - 288.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with parity and identification bit

The ARQ-E duplex systems operate at speeds of 46.2, 48, 50, 64, 72, 86, 96, 144, 184.6, 192 and 288 Baud on the radio link.

ARQ-E synchronization may be started by the selection of a baud rate. An AUTO program start causes the automatic determination of the frequency shift and baud rate to be executed first. The signal polarity (USB or LSB sidebands) is automatically detected.

After synchronization to an ARQ-E system has been achieved, the detected repetition rate is displayed (4, 5 or 8 cycles). This parameter may give clues to the identity of the transmission.

If a continuously repeated character (often FFFF) is decoded whilst working in the ARQ-E mode, it is most likely an ARQ-E3 system being monitored. ARQ-E employs the ARQ-1A alphabet with parity checking which allows the detection of transmission errors.

Full duplex systems transmit a RQ character after having detected an erroneous character or in the presence of excessive signal distortions. The remote station subsequently repeats the last three, four or seven characters preceded by the RQ character.

To maintain synchronization between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic is transmitted.

ARQ-E3

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	46.2 - 288.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-3

ARQ-E3 systems often operate at speeds of 48, 50, 96, 192 and 288 Baud on the radio link.

ARQ-E3 synchronization may be started with the selection of a baud rate. An AUTO program start causes the automatic determination of the frequency shift and baud rate to be executed first. The signal polarity (USB or LSB sidebands) is automatically detected.

After synchronization to an ARQ-E3 system has been achieved the detected repetition rate is displayed (4 or 8 cycles). This parameter may give clues to the identity of the transmission.

If the same continuously repeated character (often FFFF) is decoded whilst working in the ARQ-E3 mode, it is most likely an ARQ-E system which is being monitored. ARQ-E3 employs the ITA-3 alphabet (balanced 3:4 mark-space ratio) for data transmission and error detection.

Full duplex systems transmit a RQ character after having detected an erroneous character or in the presence of excessive signal distortions. The remote station subsequently repeats the last three or seven characters preceded by the RQ character.

To maintain synchronization between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic is transmitted.

ARQ-N

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	96-192 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

Additional Info	ITA-2 with parity and identification bit

Known ARQ-N systems operate exclusively at a speed of 96 Baud on the radio link.

The synchronization phase for the ARQ-N mode of operation may be initiated via the AUTO function or by manual selection of the baud rate.

ARQ-N uses the ARQ-1A alphabet (as does ARQ-E). Character inversion (as in the case of ARQ-E or ARQ-E3) is not defined for ARQ-N. The lack of inversion makes it impossible to automatically determine the length of the RQ cycle. However, known systems operate exclusively with a single RQ character and three repeated characters.

Signal polarity (USB or LSB sidebands) is automatically detected.

Full duplex systems transmit the RQ character after having detected an erroneous character or in the presence of excessive signal distortions. The remote station subsequently repeats the last three characters preceded by the RQ character.

To maintain synchronization between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic data is transmitted.

ARQ-M2-342 and ARQ-M2-242

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ TDM
Center frequency	
Shift/Bandwidth	
Speed	96, 87, 200 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-3

ARQ-M2-342 and ARQ-M2-242 systems operate at speeds of 85.7, 96 or 200 Baud on the radio link.

These operating modes also known as TDM or ARQ-28, conform to CCIR recommendations 342-2 and 242. Two 50 Baud Baudot channels are interleaved to form a time multiplexed aggregate bit stream. Multiplex frames of 28 and 56 bits are used.

The ITA-3 7 bit alphabet is used allowing error detection. The ITA-3 alphabet is a balanced code in which each character has a mark-space bit ratio of 3:4. ARQ-M2-342 and ARQ-M2-242 systems are full duplex systems.

Full duplex systems send a repeat request (RQ) character to the remote station if a character error has been detected or the distortion or fading becomes excessive. This results in the re-transmission of the last 3 or 7 characters preceded by the RQ request control character.

According to the CCITT recommendation, the repetition cycle may span 4 or 8 characters, as is the case with ARQ-E. The longer RQ-cycle of 8 characters has never been monitored.

In addition to the time multiplexing of several channels (division channels); each division channel may be further subdivided into sub-channels resulting in a multitude of possible modes of operation. At present however no transmissions with sub-channel division are known. Systems employing sub-channel division may be recognized by a rhythmic blinking of the Error indication (system state) in the decoder status bar.

ARQ-M4-342 and ARQ-M4-242

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ TDM
Center frequency	
Shift/Bandwidth	
Speed	96-200 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-3

ARQ-M4-342 and ARQ-M4-242 systems operate at a speed of 172 or 192 Baud on the radio link.

These operating modes also known as TDM or ARQ-56, conform to the CCIR recommendations 342-2 and 242. Four 50 Baud Baudot channels are interleaved to form a time multiplexed aggregate bit stream. Multiplex frames of 56 bits are used.

The ITA-3 7 bit alphabet is used allowing error detection. The ITA-3 alphabet is a balanced code in which each character has a 3 to 4 ratio between mark and space bits (balanced code). ARQ-M4-342 and ARQ-M4-242 are full duplex systems.

Full duplex systems send a repeat request (RQ) character to the remote station if a character error has been detected or the distortion or fading becomes excessive. This results in the re-transmission of the last 3 or 7 characters preceded by the RQ request control character.

According to the CCITT recommendation, the repetition cycle may span 4 or 8 characters, as is the case with ARQ-E. The longer RQ-cycle of 8 characters has never been monitored.

In addition to the time multiplexing of several channels (division channels); each division channel may be further subdivided into sub-channels resulting in a multitude of possible modes of operation. At present however no transmissions with sub-channel division are known. Systems employing sub-channel division may be recognized by the rhythmic blinking of the Error indication (system state) in the decoder status bar.

ARQ6-90 and ARQ6-98

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	

Speed	200 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	SITOR

ARQ6-90 and ARQ6-98 operate at a speed of 200 Baud on the radio link.

ARQ6-90 and ARQ6-98 systems transmit 6 characters of 7 bits each in every data block resulting in a total of 42 bits. The SITOR alphabet with a mark-space ratio of 3:4 is used.

Both systems operate on the ARQ principle. Using the ARQ method, a data block of 42 bits is transmitted. The SITOR alphabet is used to protect the transmitted data. After each transmission the direction of transmission is reversed and the remote station acknowledges error-free data or requests a repetition of data received in error.

The two systems only differ in the duration of the request cycle interval.

A complete cycle for ARQ6-90 has duration of 450 ms of which the data block is 210 ms an interval is 230 ms.

A complete cycle for ARQ6-98 has duration of 490 ms of which the data block is 210 ms an interval is 280 ms.

ASCII

Parameter	Value
Frequency range	HF
System	FSK, Asynchronous
Center frequency	
Shift/Bandwidth	
Speed	50 - 1200 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

For ASCII mode standard baud rates from 110 to 300 Baud are available. Non-standard baud rates may be selected using the **Baudrate** menu item.

The ASCII code, which is internationally adapted as the CCITT ITA-5 alphabet, is used in all kinds of data transfer of information between computers or computer based equipment. Only the 7-bit values 0 – 127 are internationally defined and standardized. For asynchronous transmissions, the code consists of a start bit, 7 or 8 data bits, one parity bit (optional) and 1 or 2 stop bits.

The parity bit allows error detection. The number of "1"s is counted. If an odd number is found and parity has been defined as ODD, then the parity bit should be "1", otherwise an error has occurred. If parity has been defined as EVEN and an even number of "1"s is found, then the parity bit should also be "1".

The ASCII code does not distinguish between a "Letters" or "Figures" case as does Baudot because 7 or 8 data bit ASCII has 128 or 256 possible bit combinations. This covers most symbol requirements.

ASCII based transmissions are finding their way into radio data communications because of the compatibility with computer communications thus avoiding time and resource consuming code conversions.

From **Options/Frame length** and **Parity** the various code word lengths and parity options may be selected.

ATIS

Parameter	Value
Frequency range	VHF/UHF
System	FEC
Center frequency	1700 Hz
Shift/Bandwidth	800 Hz
Speed	1200 Baud
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	7 Bit decimal code with redundancy

ATIS is an abbreviation of "Automatic Transmitter Identification System". ATIS is used in the VHF-UHF radio systems on the river Rhine and automatically generates the identification signal at the end of each period of speech transmission. In case of lengthy transmissions, the ATIS signal is required to be transmitted at least once every five minutes.

ATIS conforms in certain aspects to the CCITT Recommendation 493-3. The specifications are directed at all river Rhine nautical radio installations, fixed as well as mobile stations and has been in use there since 1994 and from 1995 also internationally.

The ATIS signal sequence is transmitted using the FSK with space and mark frequencies of 1300 Hz and 2100 Hz and a modulation rate of 1200 Baud. The higher frequency corresponds to the B-state of the signal and the lower to the Y-state.

The ATIS sequence consists of a country identifier and a four digit callsign, e.g. PE 1234 for a Dutch vessel or HB 6235 for a Swiss vessel.

All sequences are transmitted twice (DX and RX positions). A 10 bit code is used in this synchronous system. Bits 8, 9 and 10 are a binary representation of the number of bits in the B-state. The error check character corresponds to a modulo-2 sum of the corresponding information bits.

ATIS Country Identification Code

Code	Country	Code	Country	Code	Country
Z	Albania	O	Austria	O	Belgium
L	Bulgaria	D	Germany	F	France
9	Croatia	H	Hungary	P	Netherlands
H	Liechtenstein	L	Luxemburg	S	Poland
Y	Romania	O	Slovak Rep.	H	Switzerland
O	Czech Rep.	T	Turkey	U	Ukraine
U	Russia Feder.	Z	Macedonia	Y	Latvia
E	Estonia	L	Lithuania	S	Slovenia

Y	Yugoslavia				

AUTOSPEC

Parameter	Value
Frequency range	HF
System	FSK, FEC
Center frequency	
Shift/Bandwidth	
Speed	68.5-137 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	10-Bit Bauer Code

The standard baud rate for AUTOSPEC is 68.5 Baud.

The parity dependant repeat transmission of the 5 data bits is easily recognized by ear for certain character combinations. The IDLE signal also has a distinctive sound.

The Bauer code is used for error detection and correction purposes. Each codeword consists of 10 bits. The five leading bits are a character of the ITA-2 alphabet and the trailing 5 bits are a direct repetition of the first five bits. If even parity is present, the last five bits are inverted before transmission.

The Bauer code can correct single bit errors and corrected characters are displayed in red on the screen display. Characters which have been found to contain more than a single bit error are represented by the underline symbol. Error correction may be enabled or disabled by selecting **ECC** (Error Correction Control).

BAUDOT

Parameter	Value
Frequency range	HF
System	FSK, Asynchronous
Center frequency	
Shift/Bandwidth	
Speed	45.45 - 300.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2

For the BAUDOT the **Auto** option starts the process of automatically setting up the demodulator and determining the baud rate and signal polarity.

The **Baudrate** item in the **Demodulator** menu allows a manual start of signal decoding with polarity determination remaining automatic. The user may also enter a baud rate of his choice. Setting the demodulator up for correct shift and center frequency must also be done manually via the **Demodulator** menu.

In the case of a manual start, the polarity is also determined and the signal is tested for a valid asynchronous data format. If valid parameters are detected, the output of text is started. Even in the case of a break in the received signal, the software does not attempt automatic synchronization. This prevents the premature termination of data capturing in the presence of transient interference to the signal.

The **Auto** mode will automatically cause a return to synchronization if lengthy periods of signal loss are experienced or a pre-defined error rate exceeded.

A Baudot code word consists of a start bit, 5 data bits and 1, 1.5 or 2 stop bits giving each character a length of 7, 7.5 or 8 bits. Baudot is an asynchronous code in which synchronization is performed for each character by the start and stop bits.

Baudot transmissions may be rendered unreadable by inverting one or several data bits. Using the **Bit Inversion** item in the **Options** menu any of the 32 bit inversion patterns may be pre-selected.

Isochronous or synchronous Baudot uses 7 bits and is especially used for on-line crypto systems.

The Baudot code has been the most common telegraph code used as a result of the widespread use of teleprinters, its place now being gradually taken over by ASCII.

Baudot is internationally approved as CCITT alphabet ITA-2, but several national modifications to ITA-2 exist as do completely different character assignments, e.g. Arabic alphabets Bagdad-70 and ATU-80, Russian M2, and alphabets using a third shift to accommodate the shift between Latin and another character set.

Baudot is the basis for many codes in use on radio circuits due to the need for easy compatibility with teleprinter networks and equipment.

BULG-ASCII

Parameter	Value
Frequency range	HF
System	FSK, Asynchronous duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	50 – 1200 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

For BULG-ASCII the standard baud rates 110 to 600 Baud may be directly selected. Other baud rates up to 1200 Baud may be selected using the variable baud rate option.

BULG-ASCII is a full duplex mode using go-back-7-frames ARQ and a variable data frame length. Frames are transmitted with a preceding frame counter for transmitted and received frames and an appended CRC check sum.

ASCII modes using iso-asynchronous start-stop bit patterns are frequently encountered in the HF bands. BULG-ASCII employs the standard ITA-5 alphabet, a national alphabet and transfers compressed and encrypted messages and files.

CCIR

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	CCIR
0	1981
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
A	2400
B	930
C	2247
D	991
E	2110
F	

TONE DURATION	100 ms

CCITT

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Modulation	INDIRECT-FM
Receiver settings	FM 12 kHz, narrow
Signal source	AF (only)

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	CCITT
0	400
1	697
2	770
3	852
4	941
5	1209
6	1335
7	1477
8	1633
9	1800
A	1900
B	2000
C	2100
D	2200
E	2300
F	
TONE DURATION	100 ms

CHU

Parameter	Value
Frequency Range	HF
System	FSK
Center frequency	2125 Hz
Shift/Bandwidth	200 Hz
Speed	300 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN
Additional info	Reference tone on 1000 Hz

CHU is a radio station operated by the National Research Council of Canada.

It broadcasts continuously time of day information on 3330 kHz, 7335 kHz and 16670 kHz.

It provides information on the Gregorian year, Julian date, UTC hour, minute and second. Further information is a leap second warning, DUT1, the difference between the International Atomic Time TAI and UTC and the code for the Canadian daylight time indication

The coded message is transmitted using Frequency Shift Keying.

The baud rate is 300 baud, mark-frequency is 2225 Hz and space-frequency 2025 Hz.

The display shows the information of each packet on a single line.

The first packet, sent at the 31st second of each minute, delivers the year, the delta-information and the daylight saving pattern code.

The following packets, sent between second 32 and 39, deliver day, hour, minute and actual second.

CIS-11

Parameter	Value
Frequency range	HF
System	PSK
Center frequency	
Shift/Bandwidth	
Speed	100 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with 4 bit parity

CIS-11 operates at a speed of 100 Baud on the radio link.

Synchronization for the CIS-11 mode is started with the selection of a baud rate. An **AUTO** start causes the automatic determination of the frequency shift and baud rate to be executed first. The signal polarity (USB or LSB sidebands) is automatically detected.

CIS-11 transmissions are mainly in the Russian M2 (3-SHIFT-CYR) adaptation of the ITA-2 alphabet. It is a full duplex system with two transmission frequencies.

The CIS-11 data format is 11 bits wide. Data bits 1 - 5 contain the M2 character. The data bits are arranged in reverse order if compared to normal M2 systems. Bits 6 and 7 specify the system state as well as the alphabet.

Bits 8 - 11 handle error detection. The four test bits allow the position of a bit in error to be computed and then to be corrected. The value of the parity bits is obtained by calculating the modulo-2 sum of the binary weights of the respective information bits.

To maintain synchronization between the two duplex stations, both transmitters operate continuously and transmit idle characters if no traffic is transferred.

CIS-12

Parameter	Value
Frequency range	HF
System	12-Channel-DPSK
Center frequency	1800
Shift/Bandwidth	
Speed	120 Baud
Modulation	DBPSK or DQPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	HEX and ASCII output are provided **Not available on W51**

CIS-12 is a multi-channel system using 12 channels each modulated with 120 Baud DBPSK or DQPSK. Each channel has a separation of 200 Hz to neighbor channels. An unmodulated pilot carrier is placed at +3300 Hz from the suppressed carrier.

Output may be selected as **Hex** or **ASCII**.

CIS-14

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ TDM
Center frequency	
Shift/Bandwidth	
Speed	96.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Cyrillic third shift with parity

CIS-14 employs a radio channel speed of 96 Baud.

Synchronizing to a CIS-14 signal may be initiated by selecting a baud rate or **Auto**. Starting **Auto** will automatically determine shift, center frequency and baud rate.

CIS-14 is a full duplex system using two frequencies.

As in the case for other time multiplex modes (TDM), e.g. ARQ-M2-242 and ARQ-M2-342, CIS-14 bit interleaves two channels into a frame of 14 bits.

The two first bits of the multiplex frame identify the channel state as IDLE or TRAFFIC. Then two bit interleaved M2 data code words follow. The last two bits are parity bits used for error detection. Parity is calculated depending on the position of '1' bits.

In **Code Check** the simple data format of CIS-14 with only two parity bits may unfortunately lead to unavoidable detection errors.

CIS-36

Parameter	Value
Frequency range	HF
System	MFSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	25, 50 or 100 ms
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	M2

CIS-36 is operating with speeds of 10, 20 or 40 baud which is equivalent to tone duration of 100, 50 or 25 ms.

Transmissions in CIS-36 are mostly in Russian using an ITA-2 alphabet. CIS-36 is a full duplex mode with two transmission frequencies, but can also be used in simplex mode.

CIS-36 is based on the older PICCOLO-MK1 system. However, the signal is not symmetric and uses three frequency groups with 10, 11 and 11 frequencies. The tone spacing is 40 Hz. The theoretical bandwidth is 1400Hz.

In on-line crypto traffic mode the control tones 1, 12, 24 and 36 are rarely sent so between the three frequency groups a spacing of 80 Hz seems to appear.

The adjustment has to be done to the center, between tone 18 and 19.

If not all tones are transmitted, take the center of the middle frequency group and try with an offset of ±20 Hz.

CIS-36 in error-correcting traffic mode is using a horizontal line- and vertical block-error-detection. Each block has ten data frames and a parity frame. Each data frame has five data characters and one parity character. In case an error is detected the receiving station starts ask for a frame repetition (NAK instead of ACK) from the last complete and correctly received frame.

The 10 Baud speed variant is used for manually transmitted operator messages and is mostly unencrypted. The automatic switching of the tone length is initialized by control sequences.

When message traffic has to be sent the system switches to 20 or 40 baud. This part is either coded or online encrypted in almost every transmission. Special control sequences are used for transmission control, call set up and clearance.

CIS-36 also has SELCAL and link establishment features.

CIS-36-50

Parameter	Value
Frequency range	VLF, HF
System	FSK, Simplex
Center frequency	
Shift/Bandwidth	
Speed	36, 50, 75, 100, 150 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

CIS 36-50, also known as BEE-36 or T600, is a synchronous system. Usually a 36 baud idle sequence is transmitted, followed by 50 baud traffic.

All traffic is encrypted.

A message begins with a bit synch sequence and a start-of-message preamble. Message data is sent with a 7 bit 3:4 ratio alphabet and ending with an end of transmission sequence containing at least 4 end-of-transmission characters.

The length of a message is variable. If a transmission contains more than one message, the start of message sequence is left out between messages.

Occasionally traffic with call signs in FSK CW is transmitted.

CIS-50-50

Parameter	Value
Frequency range	VLF, HF
System	FSK, Simplex
Center frequency	
Shift/Bandwidth	
Speed	50, 100, 150 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

CIS 50-50 is very similar to CIS 36-50, but uses different baud rates and shifts.

Idle dot reversals are transmitted at 50 baud, followed by traffic in 50 baud (more rarely in 100 Baud).

All traffic is encrypted.

A message begins with a bit synch sequence and a start-of-message preamble. Message data is sent with a 7 bit 3:4 ratio alphabet and ending with an end of transmission sequence containing at least 4 end-of-transmission characters.

The length of a message is variable. If a transmission contains more than one message, the start of message sequence is left out between messages.

Occasionally traffic with call signs in FSK CW is transmitted.

CLOVER-2

Parameter	Value
Frequency range	HF
System	Half-duplex ARQ
Center frequency	In the range (−3750, 3750) [Hz]; automatic frequency control (AFC): +/−50 Hz
Shift/Bandwidth	N/A
Speed	31.25 Baud
Modulation	PSK2A, PSK4A, PSK8A, PSK16A, ASK2PSK8, ASK4PSK16, 2DPSK2A; 4 tones
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 Optional Mode

CLOVER-2 is an adaptive modulation system with ARQ that uses Reed-Solomon (RS) coding to achieve a remarkable performance even under the worst HF propagation conditions. Data is modulated onto four tones spaced 125 Hz. The modulation rate of each tone is 31.25 Baud. The supported modulation techniques include binary phase-shift keying (PSK2A), quaternary PSK (PSK4A), 8-PSK (PSK8A), 16-PSK (PSK16A), binary amplitude-shift keying combined with 8-PSK (ASK2PSK8), quaternary ASK combined with 16-PSK (ASK4PSK16), and two-channel diversity binary PSK (2DPSK2A).

RS coding is utilized to correct transmission errors. Four coding levels (called RS Efficiency) are specified, which allow for more or less error correction within a block. The percentages in the following list of coding levels, relate the number of information symbols (user data) to the block length, a block comprises user data and parity check symbols:

- ROBUST: 60%
- NORMAL: 75%
- FAST: 90%
- OFF: 100% (i.e., no error correction)

The level of RS Efficiency is automatically detected by the demodulator.

After successful synchronization, it may take several tens of seconds before any text is output in the GUI.

CLOVER-2000

Parameter	Value
Frequency range	HF
System	Half-duplex ARQ
Center frequency	In the range (−3000, 3000) [Hz]; automatic frequency control (AFC): +/−50 Hz
Shift/Bandwidth	N/A
Speed	62.5 Baud
Modulation	PSK2A, PSK4A, PSK8A, PSK16A, ASK2PSK8, ASK4PSK16, 2DPSK2A; 8 tones
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 Optional Mode

CLOVER-2000 is an adaptive modulation system with ARQ that uses Reed-Solomon (RS) coding to achieve a remarkable performance even under worst HF propagation conditions. Data are modulated onto eight tones spaced 250 Hz. The modulation rate of each tone is 62.5 Baud. The supported modulation techniques include binary phase-shift keying (PSK2A), quaternary PSK (PSK4A), 8-PSK (PSK8A), 16-PSK (PSK16A), binary amplitude-shift keying combined with 8-PSK (ASK2PSK8), quaternary ASK combined with 16-PSK (ASK4PSK16), and two-channel diversity binary PSK (2DPSK2A).

RS coding is utilized to correct transmission errors. Four coding levels (called RS Efficiency) are specified, which allow for more or less error correction within a block. The percentages in the following list of coding levels, relate the number of information symbols (user data) to the block length, a block comprises user data and parity check symbols:

- ROBUST: 60%
- NORMAL: 75%
- FAST: 90%
- OFF: 100% (i.e., no error correction)

The level of RS Efficiency is automatically detected by the demodulator.

After successful synchronization, it may take several tens of seconds before any text is output in the GUI.

CODAN

Parameter	Value
Frequency range	HF
System	FSK, Digital Selcal
Center frequency	
Shift/Bandwidth	
Speed	100.0 Baud

Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITU R M.493 alphabet

CODAN SELCAL operates with 100.0 baud and can be started by selecting the mode.

A preamble of at least 100 dot reversals which are 50 changes between "0" and "1" (low and high bit) precedes the data block. This lead-in has a duration of 2.0 seconds. Digital MARK "1" is represented by a frequency of 1870 Hz and SPACE by 1700 Hz.

The dot pattern is followed by a word synchronization sequence called the "phasing preamble". The characters no. 125 and no. 108 are alternately transmitted for 1.2 seconds.

This sequence is followed by the data block with different control characters and the message. Each data byte consists of 7 data bits and 3 parity bits. Thus the duration of each character is 100 ms.

The mode was developed by the Australian CODAN PTY. and is very similar to GMDSS/DSC.

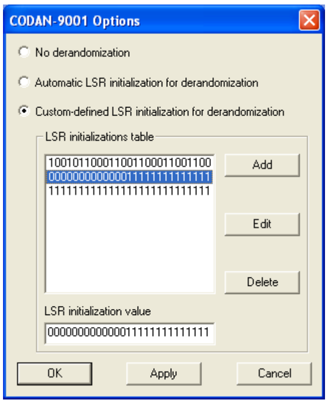
Selecting **Options/Display** offers the option of an **ASCII** or **RAW** bits display.

CODAN-9001

Parameter	Value
Frequency range	HF
System	Half-duplex asynchronous adaptive ARQ
Center frequency	In the range (−3100, 3100) [Hz]; automatic frequency control (AFC): +/−37.5 Hz
Shift/Bandwidth	N/A
Speed	16 x 75 Baud
Modulation	Differential PSK4A; 16 tones
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode ITA-5

CODAN-9001 is an asynchronous adaptive ARQ system. Data is modulated onto 16 tones spaced 112.5 Hz. The modulation rate of each tone is 75 Baud. The modulation type is differential quaternary phase-shift keying (differential PSK4A).

The demodulator output consists of a bit-stream that may have been derandomized if desired. In such a case, the required derandomization sequence is generated by a linear shift register (LSR) comprising 27 stages. The user can specify a 27-digit combination of 0s and 1s to be used for the initialization of the LSR. Alternatively, the initialization pattern can be determined automatically from the signal at hand. All options related to derandomization and initialization of the LSR can be set in the dialog “CODAN-9001 Options” (see below) which is accessed via “**Options, CODAN-9001 Options...**”

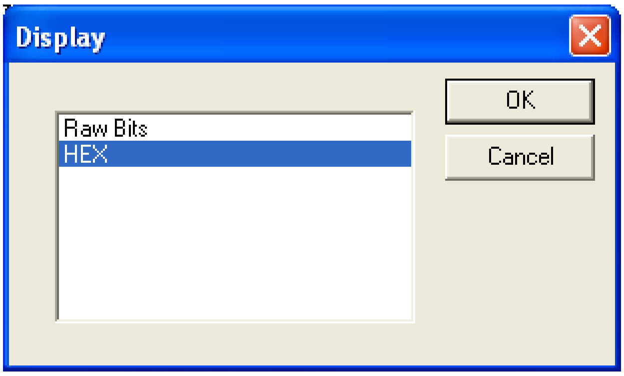


A bit-error rate (BER) measurement is performed, and the BER is displayed in the status line. Two different ways of BER measurement are available:

- BER is determined by considering only preamble- and sync-blocks
- BER is determined by considering preamble-, sync-, RQ-, and data-blocks

After successful synchronization, it may take several tens of seconds before the bit-stream (in hexadecimal format) is output in the GUI.

The output data can be displayed in one of two available formats: “Raw Bits” (0s and 1s) or “HEX” (hexadecimal numbers). The selection of the desired output format can be performed in the dialog “Display”, which is accessed via “**Options, Display...**”



The user can specify the polarity of the received signal, i.e. NOR(mal) or INV(erse).

COQUELET-8

Parameter	Value
Frequency range	HF
System	MFSK, Simplex
Center frequency	
Shift/Bandwidth	
Speed	37.5, 50.0 or 75.0 ms
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

Additional Info	ITA-2

COQUELET-8 is a MFSK (Multiple Frequency Shift Keying) system and like the PICCOLO system translates an ITA-2 character into a sequence of two tones.

The first group of tones contains 8 tones (1 - 8) and the second group the tones 5 - 8. Tones 1 - 4 of the second group are not defined.

Coquelet-8 is a synchronous system with a tone duration of 75.0 ms, 50.0 ms or 37.5 ms. One ITA-2 character is transmitted in 75 or 150 ms, which is equivalent to 50 or 100 Baud Baudot with 1.5 stop bit (codeword length 7.5 Bit).

An IDLE sequence is sent when no traffic is at hand. Transmissions start with a synchronization preamble, and end with several EOT characters.

Tone Assignment of COQUELET-8:

Tone Number	Frequency Hz	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5
First tone Group						
1	773			1	1	1
2	800				1	1
3	826					1
4	853			1		
5	880			1		1
6	907			1	1	
7	933				1	
8	960					
Second Tone Group						
5	880	1	1			
6	907	1				
7	933		1			
8	960					

COQUELET-13

Parameter	Value
Frequency range	HF
System	MFSK, Asynchronous simplex
Center frequency	
Shift/Bandwidth	
Speed	50.0 or 75.0 ms
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

COQUELET -13 is an asynchronous system and uses a start and idle tone of 1052 Hz. As for COQUELET -8 the first group contains 8 tones for keying and the second group 4 tones.

COQUELET -13 has a tone duration of 75 ms which is equivalent to a 50 Baud Baudot transmission with 1.5 stop bit. Two code tables are defined for this mode, **Code Table 0** and **Code Table 1**.

Tone Assignment of COQUELET-13:

Tone Number	Frequency Hz	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5
First tone Group						
1	812			1	1	1
2	842				1	1
3	872					1
4	902			1		
5	932			1		1
6	962			1	1	
7	992				1	
8	1022					
9	1052	idle or start tone				
Second Tone Group						
10	1082	1	1			
11	1112	1				
12	1142		1			
13	1172					

COQUELET-80

Parameter	Value
Frequency range	HF
System	MFSK, Simplex FEC
Center frequency	
Shift	
Speed	37.5, 50.0 or 75.0 ms
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

COQUELET-80 is a synchronous MFSK system with error correction (FEC). Various references note two different systems: COQUELET-80S and COQUELET-82S. COQUELET-82S can be used in both side bands and uses extended handshaking and synchronizing sequences (extended protocol).

COQUELET-80 is used with the ATU-80 (Arabic) or the ITA-2 (Latin) alphabet. As for COQUELET-8 a character is coded with two tone assignments from group 1 and group 2.

Error correction is done by transmitting every character twice with a specified time offset. The second transmitted character is mathematically reformatted (MOD 8). The leading (DX) and trailing characters (RX) always have the same ODD or EVEN parity.

At the beginning of a message the RX character positions are filled with IDLE sequences. This mode does only error recognition but no error correction.

Tone Assignment of COQUELET-80:

Tone Number	Frequency Hz	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5
First tone Group						
1	773			1	1	1
2	800				1	1
3	826					1
4	853			1		
5	880			1		1
6	907			1	1	
7	933				1	
8	960					
Second Tone Group						
5	880	1	1			
6	907	1				
7	933		1			
8	960					

CTCSS

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12
Input(s)	AF-IN
Additional Info	

The CTCSS selective calling system is defined according to EIA standard RS-220 and operates in the sub-audio range. Applying this **C**ontinuous **T**one **C**ontrolled **S**quelch **S**ystem stations may be selectively called either as a single user or as a group. A CTCSS controlled receiver only switches on, in case a carrier modulated with the pre-programmed CTCSS tone is received. For this system 52 tones are defined:

Tone Allocation

Tone no.	Freq. Hz	Tone no.	Freq. Hz	Tone no.	Freq. Hz
1	60.0	19	118.8	37	183.5
2	67.0	20	120.0	38	186.2
3	69.3	21	123.0	39	189.9
4	71.9	22	127.3	40	192.8

5	74.4	23	131.8	41	196.6
6	77.0	24	136.5	42	199.5
7	79.7	25	141.3	43	203.5
8	82.5	26	146.2	44	206.5
9	85.4	27	151.4	45	210.7
10	88.5	28	156.7	46	218.1
11	91.5	29	159.8	47	225.7
12	94.8	30	162.2	48	229.1
13	97.4	31	165.5	49	233.6
14	100.0	32	167.9	50	241.8
15	103.5	33	171.3	51	250.3
16	107.2	34	173.8	52	254.1
17	110.9	35	177.3		
18	114.8	36	179.9		

CV-786

Parameter	Value
Frequency range	HF
System	FSK
Center frequency	2000 Hz
Shift/Bandwidth	850Hz
Speed	50,75, 100 or 150 baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Async FSK only

CV-786 is an asynchronous FSK system and is based on ASCII. No error detection or error correction is implemented.

For CV-786 mode standard baud rates from 50 to 150 Baud are available. Non-standard baud rates may be selected using the **Baudrate** menu item.

From **Options/Display...** ASCII and BAUDOT are available as output formats.

CW-MORSE

Parameter	Value
Frequency range	HF
System	Simplex/Duplex ARQ, Broadcast
Center frequency	
Shift/Bandwidth	
Speed	20 - 400 BPM
Modulation	CARRIER KEYING or DIRECT-FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

Additional Info	

The **Auto** function will automatically detect Morse keying speeds within the range 20 - 400 BPM (characters per minute). The keying speed is continuously updated and displayed.

The **CW Speed** item in the **Demodulator** menu allows the user to enter a fixed speed. This option becomes useful when receiving machine generated transmissions of long duration. The fixed setting results in an improved immunity to propagation disturbances.

The **Bandwidth** may be set in the **Demodulator** menu to any value in the range from 50 Hz to 1200 Hz. For normal use setting of 300 – 500 Hz is recommended.

The center frequency can be set to any value between 500 and 3500 Hz via the **Center** item in the **Demodulator** menu. The center frequency is nominally 800 Hz which is dictated by the quartz filters of professional receivers while other receivers work with 1000 Hz.

Using the **Alphabet** item in the **Options** menu the output can be set to Latin, Cyrillic, Greek, Arabic or Hebrew.

Using the **AGC** item in the **Demodulator** menu the AGC (Automatic Gain Control) may be disabled if receiver AGC has been set to **Manual**. The **Slow/Normal/Fast** settings of the **Options/Filter response** item in the **Options** menu act as a noise suppressor. Defaults are **AGC enabled** and **Normal speed** and these settings are usable in most cases.

The software reports an error condition (ERROR) if the controlled parameters as the dot-dash ratio, the inter-word or inter-character breaks deviate too much from the standard, and error-free decoding cannot be maintained.

DCS SELCAL

Parameter	Value
Frequency range	VHF
System	Digital Selcal
Center frequency	
Shift/Bandwidth	
Speed	133.7,134.4, 137 Baud
Modulation	FSK
Receiver settings	FM, BW=15kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

DCS means **D**igital **C**oded **S**quelch (also known as DCSS, **D**igitally **C**oded **S**quelch **S**ignaling) and is used for selective calls and remote control applications.

The data is transmitted on sub audible tones with a bandwidth from 2 Hz to 300 Hz. In practice, DCS is similar to CTCSS, but uses 104 octal 3 digit code words instead of continuous analogue tones.

The data is sent as a series of 23 bit GOLAY encoded frames without any sync bits. Polarity can be normal or inverse and must be selected by the user.

DCS Code Table

Normal	Inverse	Normal	Inverse	Normal	Inverse	Normal	Inverse
023	047	155	731	325	526	516	432
025	244	156	265	331	465	523	246
026	464	162	503	332	455	526	325
031	627	165	251	343	532	532	343
032	051	172	036	346	612	546	132
036	172	174	074	351	243	565	703
043	445	205	263	356	212	606	631
047	023	212	356	364	131	612	346
051	032	223	134	365	125	624	632
053	452	225	122	371	734	627	031
054	413	226	411	411	226	631	606
065	271	243	351	412	143	632	624
071	306	244	025	413	054	654	743
072	245	245	072	423	315	662	466
073	506	246	523	431	723	664	311
074	174	251	165	432	516	703	565
114	712	252	462	445	043	712	114
115	152	255	446	446	255	723	431
116	754	261	732	452	053	731	155
122	225	263	205	454	266	732	261
125	365	265	156	455	332	734	371
131	364	266	454	462	252	743	654
132	546	271	065	464	026	754	116
134	223	274	145	465	331		
143	412	306	071	466	662		
145	274	311	664	503	162		
152	115	315	423	506	073		

DGPS

Parameter	Value
Frequency range	HF
System	FSK, Broadcast FEC
Center frequency	
Shift/Bandwidth	
Speed	100.0 and 200.0 Baud
Modulation	Minimum-Shift-FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

DGPS (Differential Global Positioning System) data is mainly transmitted in the low frequency band e.g. 285 – 315 kHz. This correction signal for GPS receivers is used to increase the accuracy of the satellite based GPS signal. The DGPS principle is based on the transmission of correction data by a reference station, the position of which has been determined with high accuracy by traditional position finding measurements. With the correction data an absolute accuracy of up to 4 meters can be achieved.

Transmissions use MSK (Minimum Shift Keying) with speeds of 100 or 200 baud.

DGPS data, which is formatted according to RTCM v.2.0 or 2.1, is continuously transmitted in frames consisting of a varying number of data words. The two first words of each frame contain the reference station id, the message type, a sequence number, the frame length and the health of data. A data word has a length of 30 bits: 24 data bits and 6 parity bits. The last two bits of a word are used as an EXOR function for selected bits of the succeeding data word. The value of the last bit indicates whether the next data word is sent with inverse or normal polarity.

If **Normal 3, 7, 16** is chosen in the **Message Type** options field, messages containing ASCII text are decoded. The message types 1, 6 and 9 containing the real DGPS information are not displayed in this mode of operation. Selecting **Raw excl. 1, 6, 9** offers a raw bit display except of the message types 1, 6 and 9 and **Diff. corrections** displays the corrections messages. By selecting the **All frame headers** option, all frame headers are displayed regardless of the message type.

RTCM v.2.0 and 2.1 are not completely compatible, but both systems are used. This may lead to erroneous interpretation of certain frame types.

More detailed information may be found in "RTCM Recommended Standards for Differential NAVSTAR GPS Service 2.0" (RTCM paper 134-89/SC104-68).

DTMF

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW= 12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence.

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	DTMF Tones
0	941/1336
1	697/1209

2	697/1336
3	697/1477
4	770/1209
5	770/1336
6	770/1477
7	852/1209
8	852/1336
9	852/1477
A	697/1633
B	770/1633
C	852/1633
D	941/1633
E	941/1209
F	941/1477
TONE DURATION	70 ms

DZVEI

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

For ZVEI modes having nominal tone durations of 70 ms, the duration of a single tone may vary ± 15 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the Options menu a Time stamp function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	DZVEI
0	2200

1	970
2	1060
3	1160
4	1270
5	1400
6	1530
7	1670
8	1830
9	2000
A	825
B	740
C	2600
D	885
E	2400
F	680
TONE DURATION	70 ms

DUP-ARQ

Parameter	Value
Frequency range	HF
System	FSK, Semi-duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	125 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with block coding

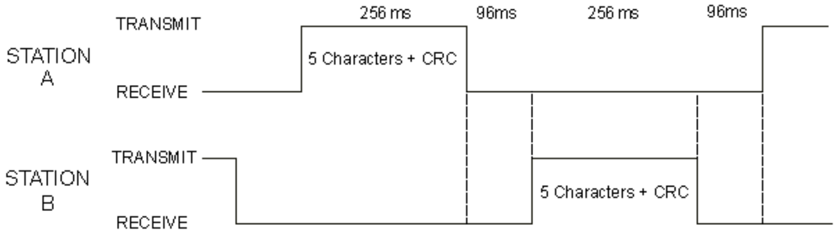
DUP-ARQ operates at a speed of 125 Baud on the radio link.

DUP-ARQ is a semi-duplex system. The radio channel is used by a DUP-ARQ system in the same way as a simplex system, both stations alternating in transmitting blocks of five characters and a Hamming checksum. If a transmission error occurs a repeat request is initiated and the last data block is re-transmitted.

If only one station is sending data, the other station transmits an IDLE pattern and initiates RQ cycles in case of transmission errors.

DUP-ARQ has automatic channel selection facilities. Before transmission starts, the best available short-wave transmission channel is selected and its quality is continuously checked for the duration of the transmission. Within a given frequency range the system may select one of 5 possible channels which are spaced at 400 Hz intervals. Because of this channel selection mechanism, the two linked stations may transmit at different frequencies.

The polarity of the bit stream (upper sideband (USB) or lower sideband (LSB)) cannot automatically be derived from the signal. Polarity may be manually selected by using the **Polarity** menu field. Polarity inversion does not cause a loss of signal synchronization.



DUP-ARQ-2

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	250.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding

DUP-ARQ-2 is a further development of the DUP-ARQ system and the system characteristics are very similar. DUP-ARQ-2 allows transmission of ITA-2 (Baudot) or ITA-5 (ASCII) characters depending on the application.

DUP-ARQ-2 operates at a speed of 250 Baud on the radio link. A complete transmission cycle is 176 bits (704 ms). Both stations alternate in transmitting data blocks of 64 bits each.

The data format is 2 data blocks of 32 bits each. The blocks correspond to the DUP-ARQ (ARTRAC) system. Each of the two blocks contains a 5 bit checksum (inverted Hamming) for error detection and a single bit for the global parity (odd parity). Three 8 bit characters are transmitted in the data block. Two bits remain unused and are set to zero.

Special blocks defining IDLE, INTERRUPT and other special functions are transmitted. For these blocks the two normally unused bits specify the particular special functions with the combinations "10" or "11".

DUP-ARQ-2 has automatic channel selection facilities. Before transmission starts, the best available short-wave transmission channel is selected and its quality is continuously checked for the duration of the transmission. Within a given frequency range the system may select one of 5 possible channels which are spaced at 400 Hz intervals. Because of this channel selection mechanism the linked stations may transmit at different frequencies.

DUP-FEC-2

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Duplex FEC

Center frequency	
Shift/Bandwidth	
Speed	125.0 and 250.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding

DUP-FEC-2 is a further development of the DUP-ARQ-2 system and the system characteristics are very similar. DUP-FEC-2 allows transmission of ITA-2 (Baudot) or ITA-5 (ASCII) characters.

DUP-FEC-2 has a radio channel rate of 125 or 250 Baud. A data frame is 32 bits long. For error protection a five bit CRC-sum (inverted Hamming) and a single bit for global parity (odd parity) is used.

DUP-FEC-2 is often used as a full duplex system. As is the case with other full duplex systems transmission simultaneously takes place on two different frequencies. If an error occurs special sequences are transmitted to signal this condition and a block repetition is requested (RQ).

If errors are received the two last 32 bit blocks are retransmitted when the radio channel rate is 125 Baud and three blocks when working at 250 Baud.

Like DUP-ARQ-2, DUP-FEC-2 has many special blocks for IDLE and RQ.

EEA

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	EEA
0	1981
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
A	1055
B	930
C	2247
D	991
E	2110
F	
TONE DURATION	40 ms

EFR

Parameter	Value
Frequency range	HF
System	FSK, Broadcast asynchronous ASCII
Center frequency	
Shift/Bandwidth	340 Hz
Speed	200.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

A German company operates a radio broadcast load balancing and ripple control system for electrical power distribution networks. Short telegrams are used to control street lights, heaters, tariff switching etc. The subscribers control their equipment by sending messages to the central computer of service provider. The central computer forwards the messages to transmitters in Frankfurt am Main (DCF49, 129.1 kHz) and Burg (DCF39, 139.0 kHz).

Transmissions are 200 Baud ASCII FSK with a shift of 340 Hz.

The transmission format is based on DIN-19244, i.e. start bit, 8 data bits, parity bit and stop bit. The length of the data frame is variable; therefore a length field is required. The frames consist of a start character, followed by the length information, which is sent twice. The fourth byte is the start character again. Bytes five to seven are message number, address field A1 and address field A2. After a maximum of 16 data bytes, a checksum is transmitted and finally the stop character. The checksum is an addition of the message number, address and data fields without considering carry bits. Messages are sent twice to increase transmission security.

Two user data protocols are in use, Semagyr-TOP and Versacom. As messages do not contain a protocol identifier both formats are displayed together with the raw data string in hexadecimal format. Using **Options/Display Mode...** the display may be toggled between **All frames** and **Error free frames**.

If messages are not at hand, EFR periodically transmits time signals which allow the receivers to synchronize their internal clock. From time to time, a test signal is transmitted containing the name of the transmitter, e.g. DCF49.

EIA

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	100.0 and 200.0 Baud
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	EIA
0	600
1	741
2	882
3	1023
4	1164
5	1305
6	1446
7	1587
8	1728
9	1869
A	2151
B	2433

C	2010
D	2292
E	459
F	
TONE DURATION	33 ms

ERMES

Parameter	Value
Frequency range	VHF/UHF
System	Broadcast pager
Center frequency	
Shift/Bandwidth	
Speed	3125 Baud
Modulation	4-PAM/FM
Receiver settings	FM, BW = 15-30 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Bit rate = 6250 bps

Introduction

ERMES is a Europe-wide high speed paging system with a user data rate of 6250 bps in comparison to POCSAG which has a maximum rate of 2400 bps. ERMES radio data may be transmitted using frequency or time multiplex or both. All transfer modes do however utilize the same modulation format on the same frequency. ERMES is operating in several European countries whereas Asian countries tend to standardize on FLEX, which is a technically comparable Motorola system.

Radio Link

ERMES employs a radio link transfer protocol conforming to the ETSI prETS 300 133-4 standard (ETS 300 133-1 to ETS 300 133-7). Transmissions are within the range from 169.4125 MHz to 169.8125 MHz all over Europe. Channel spacing is 25 kHz. The nominal frequencies and the channel numbering are defined as:

fn = 169.425 + n*0.025 MHz

n = Channel number (0...15)

ERMES transmitter allocations follow the CEPT T/R 25-07, annex 1 recommendation.

Modulation

ERMES modulation is 4-PAM/FM. The four frequency pulse-amplitude modulation carries two bits (dibit) per frequency step. In addition to coherent phase keying ERMES also utilizes pre-modulation pulse shaping. To decrease bit error rate, data is encoded using the Gray code.

The nominal frequencies are:

Carrier	Dibit symbol
+ 4687.5 Hz	10
+ 1562.5 Hz	11
- 1562.5 Hz	01
- 4687.5 Hz	00

The ERMES Protocol

A sequence of 60 seconds is partitioned into 60 cycles. The sequences are synchronized to UTC. The cycles have a duration of exactly one minute and synchronize the various ERMES networks (transmitters). In this way the receivers will only receive one or more cycles and thus power consumption is substantially reduced.

Each cycle is subdivided into five subsequences of 12 seconds each. In order to maintain synchronism between networks the subsequence number (command SSN = 0) is transmitted preceding every UTC minute marker.

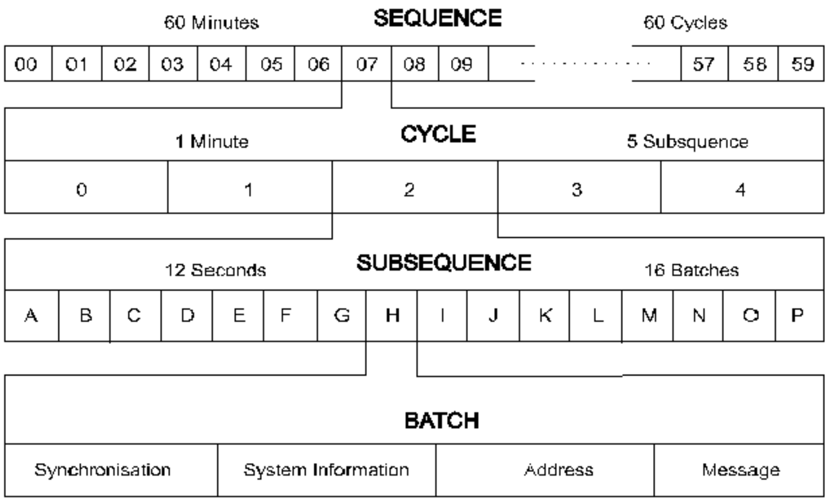
A subsequence may also have a duration of less than 12 seconds. The remaining time is used for transmitter switching.

Each subsequences is further divided into 16 batches designated A to P. Thus the pagers are divided into 16 groups. The transfer mode (tone call only, numerical call, alphanumerical call) is controlled by the position of the batch number.

The receiver addressing only takes place within the appropriate batch. After decoding its address the receiver will wait on the same frequency for data. Data may be transmitted within the same batch, within another subsequence batch or within subsequent subsequences.

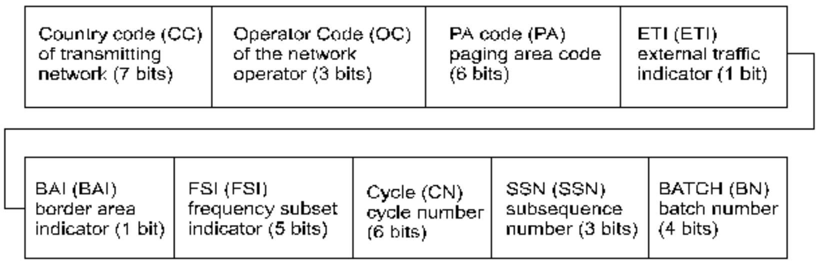
Each batch is subdivided into four parts: Synchronization, system information, address and text.

Protocol Structure



System Information

Network and system information is transmitted within the system subdivision of a batch. The system information is divided into two parts, System Information (SI) and Supplementary System Information (SSI).



Depending on the value of the SSI flag the Supplementary System Information (SSI) carries information on zone, local time and date. Another option displays day of week, month of year and year.

Data

ERMES transmits data in fixed-length frames of 36 bits. A frame may carry an additional data field and the text data.

Message Frame (MHEAD)

Local Address (LADDR) full local address of the receiver (22 bits)	Message Number (MNUM) individual / group calls (5 bits)	External bit (EB) local or external receiver (1 bit)	All (ALL) additional info (1 bit)	VIF variable Info field (7 bits)

The Variable Information Field (VIF) has two main options depending of the status bit ALL = 0 or ALL = 1.

Variable Information Field Without Supplementary Information

RSVD for future definition (1 bit)	Paging Category (PCAT) 00 tone 01 numeric 02 alphanumeric 03 transparent (2 bits)	UMI (UMI) Urgent indicator 0 normal message 1 urgent message (1 bit)	ALERT (ALERT) alert (alarm) signal indicator type 0 - 7 (3 bits)

Variable Information Field With Supplementary Information

The ETS 300 133-4 standard has a very fine grained subdivision of the VIF and this enables ERMES to be used for a wide range of applications.

AIT (AIT) Additional information type long message, remote programming, miscellaneous, additional character set, temporary address pointers and more	AIN (AIN) Additional information number urgent alert 0-7, non-urgent alert 0-7, paging area, identity code, add or replace data in pager, country code and more

ERMES and other pager systems are losing importance in Europe due to the surge in GSM usage, and several networks have been closed down.

EURO

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	100.0 and 200.0 Baud
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	EURO
0	979.8
1	903.1
2	832.5
3	764.4
4	707.4
5	652.0
6	601.0
7	554.0
8	510.7
9	470.8
A	433.9
B	400.0
C	368.7
D	1153.1
E	1062.9
F	339.9
TONE DURATION	100 ms

FEC-A

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	96.0 - 288.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ARQ1A with convolutional coding

The FEC-A mode is started by selecting a standard baud rate from the **Baudrate** item in the **Demodulator** menu. Frequency shift and baud rate are determined using **FSK Analysis**. For automatic tuning **Auto** may be selected.

The synchronization or idle state is easily recognized by its sound. It is an alternating mark-space keying sequence (mark-space ratio approx. 40% - 60%).

FEC-A uses a convolutional error correction scheme based on data bits being read into a shift register, the length of which may be changed. Values of 72 and 128 bits are common. Shift register length is set using the **S-Reg** item in the **Options** menu. Incorrect selection of the S-Reg parameter causes incorrect error correction to be performed and the data output rapidly becomes corrupted. If error correction is disabled (**ECC** off), the length of the shift register will not affect decoding (**S-Reg** not visible). This feature allows any FEC-A signal to be decoded.

FEC-A will detect and correct transmission errors till a certain limit. In the case of extreme interference, error correction may worsen the situation so reception without error correction may improve performance.

FEC-A uses the ARQ-1A alphabet. Every second bit of the bit stream is used for the convolutional error correction and thus each codeword consists of 14 bits.

The OSI-Layer is set using the **OSI-Level** item in the **Options** menu.

FELDHELL

Parameter	Value
Frequency range	HF
System	Graphic mode, Broadcast/Simplex
Center frequency	
Shift/Bandwidth	
Speed	122.5 Baud
Modulation	CARRIER KEYING AM
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Synchronous matrix picture telegraphy

Feld-Hell is a synchronous picture telegraph system invented in the 1930s. It is using a virtual matrix laid down on the character to be transmitted. The pixels of the matrix is then sent, scanning the matrix from the bottom of the first column (left) to the top of the last column (right) covering a matrix of 7 columns x 14 lines. The first and last columns are blank as are the top and bottom lines giving an effective matrix of 5 x 10 pixels. Pixels are always sent in pairs.

The original Hell system was a very simple mechanical one with an indented wheel for each character used to generate the transmit pulse trains via a contact.

In the receiver the pulses activated a printing magnet with a writing edge, which pushed a paper tape towards a helix inked by an ink roller.

No means of synchronization besides of nominal helix speed was used. Speed differences showed up as rising or falling lines of letters, but as the pitch of the helix was designed to print a double row of characters, one complete character would always be displayed on the tape.

Hell utilizes AM in the form of CW or A2. When receiving Feld-Hell the decoder will emulate the original Hell tape printer and print each character twice making exact phasing unnecessary as at least one character will be complete and unbroken.

By selecting **122.5 Baud** or **Variable rate** reception is started. Selecting **Polarity** will determine normal or inverse screen color.

In the **Demodulator** submenu the special function fields **AM-Gain** and **AM-Offset** are placed. Centering of the signal deviations on the bar graph is controlled by adjusting **AM-Offset**. In addition maximum deviation is required on the bar graph. This is done by adjusting **AM-Gain**. It should be noted that these two adjustments are influenced by each other.

Right-click on the image to open the **Zoom** menu from which the image can be zoomed in and out.

FLEX

Parameter	Value
Frequency range	VHF
System	Broadcast pager
Center frequency	
Shift/Bandwidth	
Speed	1600, 3200 Baud
Modulation	DIRECT-FM
Receiver settings	FM, BW=15 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ASCII

FLEX is another mode used for pager transmissions. It is often combined with POCSAG and GOLAY/GSC.

FLEX specifies 4 different transmission modes:

Modulation	Baud rate	Bit rate	Transmitted phases
FFSK	1600 Baud	1600 bits / sec	A
4FFSK	1600 Baud	3200 bits / sec	A, B
FFSK	3200 Baud	3200 bits / sec	A, C
4FFSK	3200 Baud	6400 bits / sec	A, B, C, D

First of all, a preamble is sent, which identifies the modulation type. After that, a Frame Information Word (FIW) is transmitted to identify the cycle and frame number. The preamble and FIW is always transmitted as FFSK 1600 Baud. At the end the message is sent with the modulation according to the preamble.

The message block contains the information and consists of 11 blocks. Each block carries 8 words with 32 bits each. The length of a message block is always constant.

The basic modulation type FFSK, 1600 Baud can transmit one message block. With a higher modulation type, it is possible to transmit four complete and independent message blocks. To distinguish between the different message blocks, they are called phase A to D.

A message block contains a lot of smaller messages. 8 different message types are used with FLEX:

- Alphanumeric / Secure messages for text based messages
- Three types of numeric messages
- Binary messages
- Tone Only messages

- Instruction messages for configuring the pager devices

FM-HELL

Parameter	Value
Frequency range	HF
System	Graphic Mode, Broadcast/simplex
Center frequency	
Shift/Bandwidth	
Speed	122.5 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

FM-HELL is a synchronous picture telegraph system like FELDHELL. It is using a virtual matrix laid down on the character to be transmitted. The pixels of the matrix are then sent, scanning the matrix from the bottom of the first column (left) to the top of the last column (right) covering a matrix of 7 columns x 14 lines. Pixels are always sent in pairs.

By selecting the mode with a baud rate of 122.5 Baud reception is started. Selecting **Polarity** will determine normal or inverse screen color.

FMS-BOS

Parameter	Value
Frequency range	VHF
System	Simplex
Center frequency	
Shift/Bandwidth	
Speed	1200 bps
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	BCD-Code with block coding

FMS-BOS is a radio signaling system for security authorities and organizations. The system allows for a major reduction in message interchange between mobile units and a control center by digital transmission of abbreviated telegrams.

FMS-BOS operates at 1200 bit/s using FSK modulation of 1200 Hz and 1800 Hz tones.

FMS-BOS Transmission Example

```
FZ-->LS : BOS-K 1, LK d, OK 10, FZ 7611, ST d, ZBV 1
█
```

The FMS-BOS data telegrams always have the same structure and a length of 48 bits regardless of the transmission direction or message contents. The actual information is contained in 40 bits. The BCD code is used to transmit the digits in the telegram.

A FMS-BOS message is preceded by 12 bits of carrier and a sync character (0x1a).

The message itself consists of 10 BCD blocks.

Block 1 is the **BOS service identifier** (0...f) identifying the service issuing the message.

Block 2 is the s**tate identifier** (0...f) identifying the German state. Due to the fact that the number of states exceeds the number of available identifier digits, digits E and F are additionally identified by the location identifier to be used by two states each.

Blocks 3 - 4 are the **location identifier** (e.g. OK 10) and can assume one of 99 different possibilities. The actual value is determined by each individual state.

Blocks 5 – 8 are the **vehicle identifier** (e.g. 4213) and can contain one of 9999 combinations. The individual identifiers are assigned by each specific service.

Block 9 is the **status** field contains the actual information. 16 different messages may be transmitted. Depending on the R direction bit status messages attain different meanings. Furthermore the actual meaning of a status message is determined by the service and the individual states.

The last block 10 is mapped to 4 bits in the telegram and serves to communicate the equipment capability (B, bit 1), direction (R, bit 2) and abbreviated tactical information (X, Y, bits 4 – 5).

B

0 – Vehicle – dispatcher communications only

1 – Duplex communications possible

R

0 – Vehicle – Dispatcher

1 – Dispatcher – Vehicle

XY

Locally defined

For data protection, a 7 bit Abramson code redundancy block is appended to the data block. This is followed by a single stop bit which is however not tested.

As FMS data messages does not carry a date-timestamp, this information is generated by the real-time clock of the decoder and output to screen as the first data field.

BOS-Identifier	Character
Police	1
Federal Border Protection	2
Federal Criminal Bureau	3
Catastrophe Protection Service	4
Customs	5
Fire Brigade	6
Technical Support Service	7
"Arbeiter-Samariter" Federation	8
German Red Cross	9
"Johanniter" First Aid Service	a

"Malteser" Support Service	b
Life saving organization	c
Miscellaneous rescue services	d
Civil protection services	e
Remote command	f

State identifier	Character
Sachsen	0
Federal	1
Baden-Wuerttemberg	2
Bayern I	3
Berlin	4
Bremen	5
Hamburg	6
Hessen	7
Niedersachsen	8
Nordrhein-Westfalen	9
Rheinland-Pfalz	a
Schleswig-Holstein	b
Saarland	c
Bayern II	d
Mecklenburg-Vorpommern	e (00 – 49)
Sachsen-Anhalt	e (50 – 99)
Brandenburg	f (00 - 49)
Thueringen	f (50 – 99)

GMDSS/DSC-HF

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex
Center frequency	
Shift/Bandwidth	170 Hz
Speed	100.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5

GMDSS (**G**lobal **M**aritime **D**istress and **S**afety **S**ystem) is a worldwide system for handling maritime emergency and safety transmissions. Part of the system is DSC (Digital Selective Calling). Each user of the GMDSS is assigned a nine-digit number (MMS**I** – Maritime Mobile Service **I**dentity) from the mobile maritime service. 3 digits of this number are used as a country code.

DSC is used on HF and VHF. On HF the system is working with 100 baud and a shift of 170 Hz.

Selecting **Options/Display** offers the option of an **ASCII** or **RAW** bits display.

The complex structures of the DSC are described in detail in the ITU-Rec. M.493-11.

GMDSS/DSC-VHF

Parameter	Value
Frequency range	VHF/UHF
System	Broadcast/Simplex
Center frequency	1700 Hz
Shift/Bandwidth	600 Hz
Speed	1200 bit/s
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	ITA-5

GMDSS (**G**lobal **M**aritime **D**istress and **S**afety **S**ystem) is a worldwide system for handling maritime emergency and safety transmissions. Part of the system is the DSC (Digital Selective Calling). Each user of the GMDSS is assigned a nine-digit number (MMSI – Maritime Mobile Service Identity) from the mobile maritime service. 3 digits of this number are used as a country code.

DSC is used on HF and VHF. On VHF the speed is 1200 baud and the center frequency is 1700 Hz and the shift is 800 Hz.

Selecting **Options/Display** offers the option of an **ASCII** or **RAW** bits display.

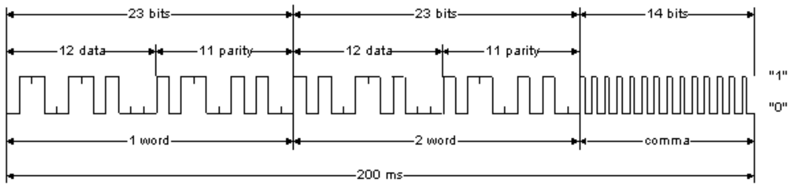
The complex structures of the DSC are described in detail in the ITU-Rec. M.493-11.

GOLAY/GSC

Parameter	Value
Frequency range	VHF
System	Broadcast FEC
Center frequency	
Shift/Bandwidth	
Speed	300/600 bps adaptive
Modulation	DIRECT-FSK
Receiver settings	FM, BW = 15 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

The GOLAY/GSC pager system originates in the USA and is based on the binary code found by Marcel GOLAY/GSC. GOLAY has been in use since 1973. The first standard defined only tone calling and could handle a maximum of 400,000 addresses. After 1982 the system also allows for alphanumeric transmission and up to 4 million addresses may be selected via a coded preamble.

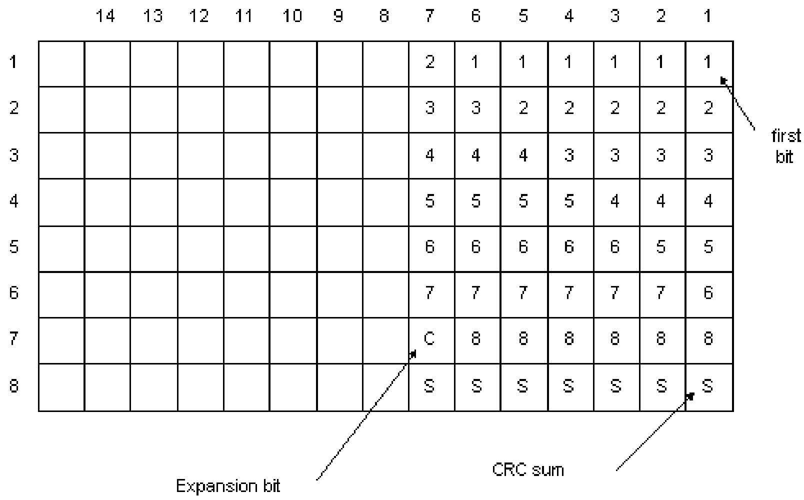
GOLAY Addressing Format



This illustration shows the basic address format of the Golay Sequential Code (GSC). It is constructed from two code words which are derived using the Golay (23,12) algorithm. The bit rate for each code word is 300 bit/s. Each received Golay word can contain up to three errors before integrity is compromised. The GSC is asynchronously decoded. To separate adjacent addresses, a separator word (comma) is transmitted at a rate of 600 bit/s.

The message format is based on eight BCH (15,7) code words that are grouped together to have exactly the same length as an address. Messages and addresses are thus easily interleaved. Each message block may contain up to 12 numeric or 8 alphanumeric characters. Messages which are longer than a single block may be transmitted using any desired sequence of blocks. By implementing block coding, two errors may be corrected in the BCH (15,7) codeword. The bits within a block are interleaved during transmission which allows the correction of burst errors affecting up to 16 bits, which is equivalent to a fading protection of 27 ms.

GOLAY Data Block with Eight Alphanumeric Characters



This illustration shows a block of eight alphanumeric characters of 6 bits each. The high fading protection is achieved by transmitting columns rather than rows (interleaving). In this way a burst error affecting 16 bits does not cause a character error. In addition each block contains a checksum computed by binary addition of the information bits of the other 7 words adding to the error detection capability of the system.

In high capacity systems the GSC makes use of grouping. For this purpose 16 calls are stacked together. Each stack is preceded by one of 10 copy information blocks that consists of 18 repetitions of a single Golay codeword. In this way all receivers in a system are grouped in 10 header block groups and each receiver only has to decode the stack that is preceded by its particular header block.

GOLAY also has a facility for optimizing voice calls. A special audio control code is used to separate voice messages.

GOLAY uses direct frequency modulation. Proper decoding is only possible from the receiver IF output (455 kHz, 10 MHz or 21 MHz).

G-TOR

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100, 200 and 300 Baud adaptive
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding

G-TOR operates at a radio channel rate of 100, 200 or 300 Baud. The quality of the radio channel determines the actual adjusted baud rate.

By clicking the **Auto** button, the demodulator will automatically adjust to the actual shift and center frequency followed by phasing with automatic baud rate and signal polarity detection.

With some skill the actual baud rate of G-TOR may be easily recognized. Baud rates of 100, 200 and 300 Baud may be manually selected. If so phasing will be accelerated.

After synchronism with a G-TOR signal has been achieved, the software will ensure the baud rate adaptation as is the case in **Auto** mode. After the end of transmission the software will re-synchronize.

The cycle duration of G-TOR is always 2.4 s. The data frame has a length of 1.92 s, which leaves 0.16 s for acknowledgement from the remote station. At 300 Baud 69 data bytes are transferred, at 200 Baud 45 bytes and at 100 Baud 21 bytes. After the end of the data block a control byte and a 16 bit CRC sum are appended.

On the receiving side up to 3 incorrect bits may be corrected using a (24, 12) Golay code. In addition the data bits are interleaved (bit interleaving).

The complex G-TOR system is described in detail by the manufacturer KANTRONICS in a booklet ("G-TOR, The New Mode, Articles, Charts, Protocol", edited by Shelley Marcotte).

Two code tables are defined for this mode, **Code Table 0** and **Code Table 1**, which may be selected from **Options/Code Table**.

GW-PSK

Parameter	Value
Frequency range	HF
System	PSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	400 Hz
Speed	200 Baud
Modulation	DQPSK, D8PSK

Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ASCII Requires Professional Version

GW-PSK is used by Globe Wireless on the Maritime Data Network of the company The network works with several digital modes in an adaptive system. GW-FSK is always used for opening a connection. Depending on propagation conditions, it may switch to GW-PSK or other digital modes.

GW-PSK is DQPSK and D8PSK modulated with a bandwidth of 400 Hz. The bit rate is 400 bits/s or 600 bits/s with a fixed symbol rate of 200 Baud.

A GW-PSK frame consists of 288 or 432 bits. Each frame contains 25 characters or data bytes. For error detection a 16 bit CRC-checksum is required. For smaller packets, a filler ‘U’ for traffic or ‘<’ for last packets is used.

A GW-PSK signal is tuned in the same way as a PACTOR-II signal. The precision of the center frequency is very important and influences directly the performance of the decoding.

Most of the traffic is compressed. From time to time uncompressed GPS position data in NMEA format is transmitted on ship frequencies. GW-PSK stations can be found on all maritime bands and also in the fixed service bands. More Information is available on http://www.globewireless.com.

GW-FSK

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	200Hz
Speed	100 or 200 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ASCII Requires Professional Version

GW-FSK is used by Globe Wireless on the Maritime Data Network of the company.

The GW-FSK frame consists of three sections: header, data and control. At 100 baud the size of the data field is 48 bits and at 200 baud the size is increased to 112 bits. Each frame contains 6/14 characters or data bytes. For smaller packets a filler ‘<’ is used. For 100 baud the error detection is unknown while the 200 baud sub mode uses a 16 bit CRC for error detection.

GW-FSK operates adaptively so the baud rate can be either 100 or 200 baud. The baud rate depends on propagation as well as the type of transmission. Station idle and start of communication is done with 100 baud. Traffic and GPS position messages are transmitted at 200 baud.

Station idle and ID signals are transmitted at short intervals whenever the shore station is idle. The format is synchronous ASCII.

Most of the traffic is compressed. From time to time uncompressed GPS position data in NMEA format is transmitted on ship frequencies.

GW-FSK is found on all short wave maritime bands. More information is available on http://www.globewireless.com.

HC-ARQ

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	240.0 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with block coding

HC-ARQ is a simplex system operating at a speed of 240 Baud on the radio link.

HC-ARQ does not use a fixed timing cycle so data blocks of the information sending station (ISS) and the acknowledgement blocks of the information receiving station (IRS) have no fixed timing frame.

Synchronization is achieved by a long bit sequence at the start of each block. The start sequence consists of the bit pattern 1000 1011 10101 0010 and 16 subsequent control bits. After the start sequence sixty ITA-2 characters and 32 check bits for each block follow.

HC-ARQ may be set to one of three data block lengths with 30, 60 or 180 characters (150, 300 or 900 data bits). However, the system is not adaptive and the block length must be set to the same value by both stations before transmissions start.

HC-ARQ was originally intended for use in telephone line based data transmission, but it is also found on short-wave.

HF-ACARS

Parameter	Value
Frequency range	HF
System	PSK, Simplex ARQ TDM
Baud rate	1800.0 Baud
User data rate	300, 600, 1200 or 1800 bps
Modulation	M-ary PSK
Receiver settings	USB
Signal source(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Alphabet	

HF Data Link (HFDL) protocols are defined in the ARINC (Aeronautical Radio, Inc.) Specification 635-3, published on December 29, 2000. The development of HF Data Link service builds on the experiences of ACARS (Aircraft Communications Addressing and Reporting System), therefore HFDL is also known as HF-ACARS.

The protocols are compatible with the OSI model and enable the ground stations and avionics systems on aircraft to communicate with each other in a bit-oriented message format.

HF Data Link employs M-ary Phase Shift Keying (M-PSK) to modulate a carrier centered at RF+1440 Hz, where RF is the nominal HF carrier frequency. The carrier is modulated with 1800 symbols per second (Baud). However, the rate at which user data is transmitted can be selected to be 300, 600, 1200 or 1800 bps.

HFDL air-ground protocols employ a slotted Time Division Multiple Access (TDMA) protocol.

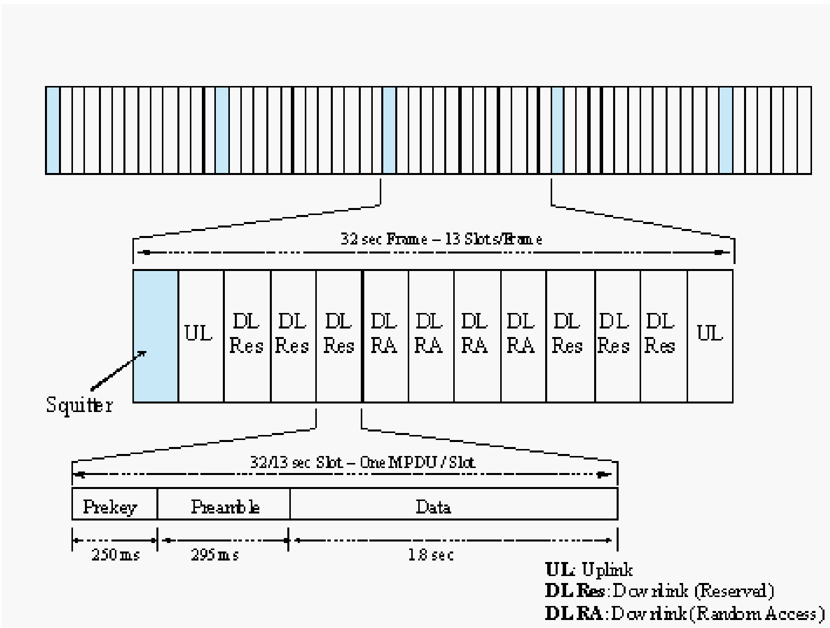
Every frame has a duration of 32 seconds and is divided into 13 slots. The first slot is called a Squitter, which carries various types of information, including slot acknowledgement and assignment codes.

The next 12 slots of a frame are called Medium access Protocol Data Units (MPDU). They are used by aircrafts and ground stations to exchange different kinds of data, e.g. aircraft logon/logoff requests, aircraft position, frequency assignment etc. Each MPDU contains several Link Protocol Data Units (LPDU), which may consist of Basic Data Units (BDU).

Each slot (Squitter or MPDU) has the same structure:

Parameter	Value	Remarks
Pre-key	249 ms	1440 Hz single tone
Preamble	295 ms	Known BPSK symbols for synchronization purposes
Data	1.8 sec (single slot) or 4.2 sec (double slot)	Data section structured in data-probe pairs (45 M-PSK symbols each: 30 user data symbols and 15 known BPSK symbols for synchronization purpose)

The following diagram shows the TDMA slotted frame structure.



The HF-ACARS decoder detects each slot with the characteristic pre-key (1440 Hz single tone), uses the preamble to synchronize the slot, eliminates various distortions in the HF communication channel, configures several components of the decoder, demodulates the user data section and decodes it according to the HFDL protocol interpreter.

Each message is finally output on the screen in Squitter (SPDU) format, Uplink MPDU format (from ground station to aircraft) or Downlink MPDU format (from aircraft to ground station).

Only when a HFDL slot is successfully detected, the decoder enters the **Traffic** state, otherwise it remains in the **Sync** state.

Usually an HFDL station sends the signal with USB setting. However the decoder has the possibility to process signals in both USB and LSB settings. This can be done by setting the polarity in the menu neither to NOR for USB and INV for LSB signals.

The center frequency of the decoder should be set to 1440 Hz when the receiver is set to the nominal frequency of the ground station. A small frequency difference will be automatically compensated by the decoder. However, the center frequency can be tuned by ±400 Hz from its nominal setting.

There are two internal system configuration files for the display of HFDL messages, hfacars.txt and hfacars.dat. These files should not be modified by the user.

HNG-FEC

Parameter	Value
Frequency range	HF
System	FSK, Broadcast /Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	100.05 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 with 10 Bit redundancy

HNG-FEC operates at a speed of 100.05 Baud on the radio link.

HNG-FEC uses a 15 bit code, the first 5 bits corresponding to the ITA-2 alphabet. The first and last bits of this codeword are inverted (Inv, Nor, Nor, Nor, Nor, Inv). The remaining 10 bits are used for error detection and correction. Error correction is done by table look up of the character which closest matches the one that was received in error.

HNG-FEC employs bit spreading (interleaving) with a distance of 64 bits, each new character starting at intervals of 15 bits. The software synchronizes to traffic as well as idle bit patterns. The idle binary bit pattern is given by 110 100 110 010 011.

Transmission reliability for HNG-FEC is good with the code spread offering additional immunity against burst errors.

HNG-FEC is started by clicking the **Auto** button or by selecting a **Baudrate** in the **Demodulator** menu. By toggling the **ECC** item in the **Options** menu error correction may be enabled or disabled.

IAS Bit Stream Output

IAS Bit Stream Output requires the professional version.

The **IAS Bit Stream Output** sends a raw, synchronized bit stream (FSK only) through a **XML interface** to an external application...

When **IAS Bit Stream Output** is selected, the parameters of the decoder software (e.g. demodulator, shift frequency, center frequency etc.) must be set to correct values at first. The synchronized bit stream - after demodulation - will now be available and is sent through the XML interface to a user application.

```
Sending bitstream to external application...
```

ICAO SELCAL

Parameter	Value
Frequency range	HF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	1000 ms
Modulation	USB
Receiver settings	USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

ICAO selective calling was initially defined in 1985 using twelve tones (Tones "A" to "M", but without tone "I"). In 1994 the ICAO calling system, also known as ANNEX10, was extended with the additional tones "P", "Q", "R" and "S" and now operates with 16 tones.

The allocation of selective call addresses is exclusively managed by Aeronautical Radio, Inc. ARINC (ICAO Designator Selcal Registry).

Each address consists of two pairs of tones, e.g. "AB-CD". Both pairs have a duration of 1,000 ms. Between each pair an interval of 200 ms is inserted. ICAO Selcal is used on all frequency bands (HF and VHF/UHF).

ICAO Selcal Tone Allocation

Designation	Frequency (Hz)
RED "A"	312.6
RED "B"	346.7
RED "C"	384.6
RED "D"	426.6
RED "E"	473.2
RED "F"	524.8
RED "G"	582.1
RED "H"	645.7
RED "J"	716.1
RED "K"	794.3
RED "L"	881.0
RED "M"	977.2

RED "P"	1083.9
RED "Q"	1202.3
RED "R"	1333.5
RED "S"	1479.1

MD-674 ASYNC

Parameter	Value
Frequency range	HF
System	FSK
Center frequency	1275 Hz
Shift	85 Hz
Speed	50, 75, 100 or 150 baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Async FSK only

MD-674 is an asynchronous FSK system and is based on ASCII. No error detection or error correction is implemented.

For MD-674 mode standard baud rates from 50 to 150 baud are available. Non-standard baud rates may be selected using the **Baudrate** menu item.

From **Options/Display...** ASCII and BAUDOT are available as output formats.

MD-674 is also known as Wireline FSK.

METEOSAT

Parameter	Value
Frequency range	VHF/UHF
System	Broadcast
Center frequency	
Shift/Bandwidth	
Speed	240 RPM
Modulation	INDIRECT-FM
Receiver settings	FM BW=40 kHz
Input(s)	AF-IN
Additional Info	IOC 288

The METEOSAT software has been specifically tailored to the transmissions of meteorological satellites parked in geo-stationary orbit at 0.2 degrees East and transmitting on 1691.0 MHz. Transmissions are always at 240 rpm using an IOC of 288. In contrast to short-wave stations which use frequency modulation, satellite weather images are transmitted using amplitude modulation. For this purpose the decoder is fitted with a DSP AM demodulator with an integrated software FIR low-pass filter.

The software is started in automatic mode by clicking on the **Auto** button or on **Drum speed** for manual mode. In manual mode the correct display of the image is controlled using the **Phase** function in the **Options** menu.

The special items **AM-Gain** and **AM-Offset** are placed in the **Demodulator** menu. Centering of the signal deviation on the bar graph is controlled by adjusting **AM-Offset.** In addition maximum deviation is required on the bar graph. This is done by adjusting **AM-Gain.** It should be noted that these two adjustments are influenced by each other.

Meteosat reception requires a parabolic reflector and receiver. The AF output of the receiver may be fed directly into the decoder, which converts it into a weather image viewing station providing excellent image quality.

The decoder allows a continuous and smooth alignment of the image as it is being received from **Options/Fine Speed**. By using the **Phase** item in the **Options** menu the image can be shifted into the correct position. **Flip Left-Right** and **Flip Top-Down** will reverse the image or turn it upside down.

MFSK-8 and MFSK-16

Parameter	Value
Frequency range	HF
System	MFSK, FEC
Center frequency	
Shift/Bandwidth	
Speed	7.81 Baud for MFSK-8, 15.625 Baud for MFSK-16
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	MFSK Varicode

MFSK-8 and MFSK-16 are multi-frequency shift keying digital transmission modes. MFSK-8 uses a set of 32 tones with the equal distance of 7.81 Hz, MFSK-16 a set of 16 tones with the equal distance of 15.625 Hz. The baud rate of MFSK-8 is 7.81 Baud and that of MFSK-16 is 15.625 Baud.

Both modes are used to transmit text file (ASCII file). The ASCII character is first converted to Varicode, which encodes frequently used characters to short length bit combinations and less frequently used characters to longer length bit combinations. For example, 'e' is mapped to '1000' and 'Z' is mapped to '110111000'.

The Varicode bit stream is then coded with a FEC (Forward Error Correction) algorithm. To combat frequency fading problems during the transmission, the FEC bit stream is interleaved before it is assigned to tones (source coding).

In both decoders only the center frequency needs to be tuned.

After the center frequency is set, the decoder first synchronizes, most importantly, to the polarity of signal. This takes for MFSK-8 between 5 and 40 seconds, for MFSK-16 between 2 and 7 seconds – this mainly depends on the baud rate of the mode. During the sync phase no text will be output on the screen.

After the decoder is synchronized, it enters the **Traffic** state, and a text file will be output on the screen. The synchronization is maintained as long as the MFSK signal is stable. When the noise is too strong or the signal disappears, the decoder begins to resynchronize – the status changes from **Traffic** to **Sync**.

Tuning a MFSK-8 and MFSK-16 Signal

The only tuning parameter in MFSK-8 and MFSK-16 signal is the center frequency. Set **Peak Hold** to **Max Hold** using the Options menu. After all tones are displayed, determine the minimum and maximum frequency of the tone set using the cursors. With the center cursor the center frequency may be set more accurately. Especially for MFSK-8 the center frequency needs to be set precisely, because the tone distance is only 7.81 Hz.

After the decoder has been synchronized, it enters the **Traffic** phase. The polarity status field on top indicating "N" (for Normal) or "I" (for Inverse) shows whether the MFSK signal is USB (Upper Side Band) or LSB (Lower Side Band). The transmitted text file is output in the window.

MFSK-20

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex
Center frequency	
Shift/Bandwidth	
Speed	100 ms, 50 ms
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

MFSK-20 is a sequential 20 tone mode, which is optimized for the transmission of numeric codes. MFSK-20 is similar to SP-14 and AUM-13.

Most of the tones have been assigned a character:

- 10 tones are assigned to the numerals 0..9
- One tone is used as an idle character
- One tone is used as a space character
- One tone is used as a repetition indicator
- Six tones are assigned to characters

All other tones are undefined.

A transmission is initiated with a start sequence, which identifies this mode and may be used for accurate tuning. This sequence is transmitted at 1 Baud, which makes it readable even during very unfavorable conditions.

The data is transmitted at a rate of 10 or 20 Baud. A block synchronization sequence is initially transmitted followed by the five digit code words. If more than one block is transmitted, a block synchronization sequence is inserted between the different blocks. As the transmission rate is very low this mode is insensitive to fading and multipath propagation.

MIL-188-110A

Parameter	Value
Frequency range	HF
System	PSK, Unprotected/FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	2400.0 Baud
Modulation	8-PSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

MIL-188-110A Serial (single tone) is one of the most popularly used modes in long-haul HF data modems. The mode is specified by the US Department of Defense (DoD) in the "Military Standard Interoperability and Performance Standards for Data Modems" (30. Sept. 1991)

This mode employs 8-ary phase-shift keying (PSK) on a single carrier frequency (1800 Hz) as the modulation technique for data transmission. Serial binary information (raw data) accepted at the line side input is converted into a single 8-ary PSK-modulated output carrier. The modulation of this output carrier is a constant 2400 Baud waveform regardless of the actual user data rate.

MIL-188-110A single tone waveform has the following characteristics:

Baud-rate	User data rate (bps)	FEC coding rate	Interleaver	No. of unknown 8-phase symbols, (User Data)	No. of known 8-phase symbols, (Channel Probe)
2400	4800	No coding	ZERO (No interleaver)	32	16
2400	2400 (Data)	1 / 2	SHORT or LONG	32	16
2400	2400 (Voice)	1 / 2	SHORT	32	16
2400	1200	1 / 2	SHORT or LONG	20	20
2400	600	1 / 2	SHORT or LONG	20	20
2400	300	1 / 4	SHORT or LONG	20	20
2400	150	1 / 8	SHORT or LONG	20	20
2400	75	1 / 2	SHORT or LONG	All	0

Each transmission of a MIL-188-110A message begins with a synchronization phase (preamble) – 0.6 seconds for message with ZERO or SHORT interleaver setting and 4.8 seconds for a message with LONG interleaver setting – followed by the data phase, which is of unlimited length. The data phase is structured in User Data – Channel Probe pairs. The phase value of a User Data symbol is unknown, whereas the Channel Probe has a predefined phase pattern.

Preamble (0.6 s or 4.8 s)	Inter-leaver 1	Inter-leaver 2	Inter-leaver 3	...	Inter-leaver N

The FEC and interleaver are used to combat the effects of fading, frequency drift, multi-path effects and burst noise affecting the HF transmission. The known 8-phase symbols – the Channel Probe – are transmitted to keep the receiver, mainly the equalizer, on track. Thus the receiver can be resynchronized without the preamble being regularly repeated.

The MIL-188-110A decoder processes all the above settings except 2400 bps voice. Generally MIL-188-110A user data is transmitted in binary mode, i.e. in a transparent mode. Thus upper protocols layers are required to further process this data stream. For this reason the decoder displays the user data in **HEX**, **ASCII ASYNC** or **ASCII SYNC** format selected from **Options/Message Type...**.

In the **HEX** display mode, the decoded binary data is just displayed as it is.

In **ASCII ASYNC** mode, the bit stream is searched with an ASCII ASYNC structure, i.e. one start-bit (0), 8 data-bits and at least one stop-bit (1). The 8 data bits are transmitted with the LSB first. The display is stopped when more than 3 NULL characters are received or when the asynchronous data structure is violated more than 8 times.

In **ASCII SYNC** mode, each 8 bits (LSB first) represent one ASCII character.

Tuning the decoder

The decoder processes signal in both SSB settings: USB and LSB. This can be selected with **Polarity** in the menu: NOR means USB and INV means LSB signal.

The center frequency of the decoder should be set to 1800 Hz when the receiver is correctly tuned to the transmitting station. Small frequency variations are automatically compensated in the decoder. The center frequency of the decoder can be adjusted to ±400 Hz from its normal setting. By using the bar-graph, any remaining frequency difference can be compensated by fine tuning of the receiver frequency or by adjusting the center frequency of the decoder.

MIL-188-110-39Tone, 110A or 110B

Parameter	Value
Frequency range	HF
System	PSK, Simplex
Center frequency	1800 Hz
Shift/Bandwidth	
Baud rate	44.44 Baud
Modulation	39 tone Q-DPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Professional Version

Definition

MIL-STD-188-110 39 Tone is a non-mandatory part of the MIL-STD-188-110 military standard for use by all departments and agencies of the Department of Defense.

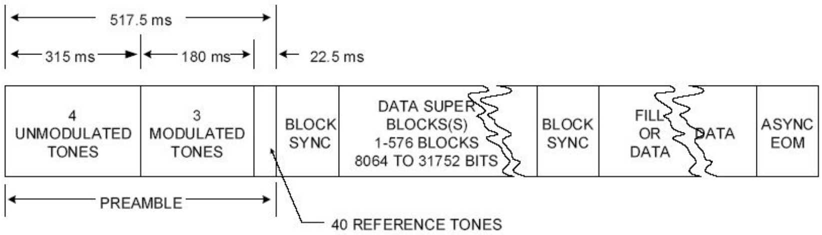
The modulation technique used in this mode consists of differential quadrature phase shift keying (QDPSK) of 39 orthogonal sub carriers in the range from 675Hz to 2812.5 Hz, and an additional unmodulated Doppler reference tone at 393.75Hz.

The modulation speed (symbol rate) is always 44.44 baud. Through the transmission of redundant information on certain tones, different user data rates can be achieved within a range of 75 to 2400 bps.

This mode uses FEC and interleaving to combat the effects of fading, frequency shift, multipath and burst noise.

The user data is transmitted using a continuous frame structure with a variable block length (number of symbols), depending on user data rate and message type.

Each transmission starts with a preamble, consisting of three phases, followed by block synchronization and data segments. The data block immediately follows the next block synchronization segment defining again the start of the next data block. This repeated frame structure enables synchronization of the demodulator at any time of transmission.



The end of transmission is determined by an EOM sequence (at least ten ones "1").

Data Display

There are two different types of data transmissions - synchronous and asynchronous.

In the synchronous data mode, the data is bit synchronously displayed as 7 bit characters, while in the asynchronous mode, different character lengths are possible using start, stop and parity bits. The parity, start and stop bits, as well as the special "null" characters, inserted by the modem and not being part of the data stream, are ignored by the display.

The decoder stops displaying data after the EOM sequence is received and goes to **Sync** state and resynchronizes.

In **Options/Frame Format** the user data rate and interleaver length can be set.

In **Options/Diversity** a value between **Time / Frequency** and **Frequency Only** diversity can be selected. The value must be set correctly for all user data rates except 2400 and 1200 bps.

In **Options/Message Type** all the different character lengths and number of extracted data bits can be set.

Tuning the decoder

The **Polarity** of the decoder should be set according to the signal. When the received signal is in **NOR** polarity (USB), the Doppler frequency should be tuned to 393.75 Hz using the **Translation**, all the 39 tones are at the right side of the Doppler tone; when the signal is in **INV** polarity (LSB), the Doppler frequency should be tuned to 3206.25 Hz using the **Translation**, with all the 39 tones at the left side of it.

The correct decoding process is indicated by a **Confidence** value, with 100 for a 100% correctly decoded message. However, finally getting a useful data output can only be achieved by selecting the proper message type, frame format (user data rate / interleaver), diversity and signal center.

MIL-188-110-16Tone

Parameter	Value
Frequency range	HF
System	Simplex
Center frequency	1760 Hz
Shift/Bandwidth	
Baud rate	
Modulation	16 tone DPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Requires Professional Version Not available for W51

HEX and ASCII output are provided.

Definition

MIL-188-110-16Tone is a non-mandatory part of the MIL-STD-188-110 military standard for use by all departments and agencies of the Department of Defense.

MIL-188-110B (Appendix C), STANAG 4539

Parameter	Value
Frequency range	HF
System	PSK, Broadcast/Simplex FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	2400.0 Baud
Modulation	8-PSK, 16-QAM, 32-QAM and 64-QAM
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Professional Version

The MIL-STD-188-110B "Interoperability and Performance Standards for Data Modems", published on 27th April 2000 by the US Department of Defense (DoD) includes in its appendices different kinds of modem waveforms. The Appendix C defines the HF data modem waveforms and coding specifications for data rates above 2400 bps, i.e. for data rates of 3200, 4800, 6400, 8000 and 9600 bps. Uncoded operation at 12800 bps is a DO (Design Objective). The single-tone waveforms specified use 8-PSK, 16-, 32- and 64-QAM on a single carrier frequency (1800 Hz) as the modulation techniques. The waveform has a unique symbol rate of 2400 baud. Together with a constraint length 7, rate 1/2 convolutional code (FEC), punctured to rate 3/4, the various effective user data rates (except

12800 bps) are realized. A linear interleaver is used to redistribute the FEC coded user data bits of a certain block length ranging from 0.12 sec to 8.64 sec, thus producing a delay in the data transmission.

This mode is equivalent to NATO STANAG 4539.

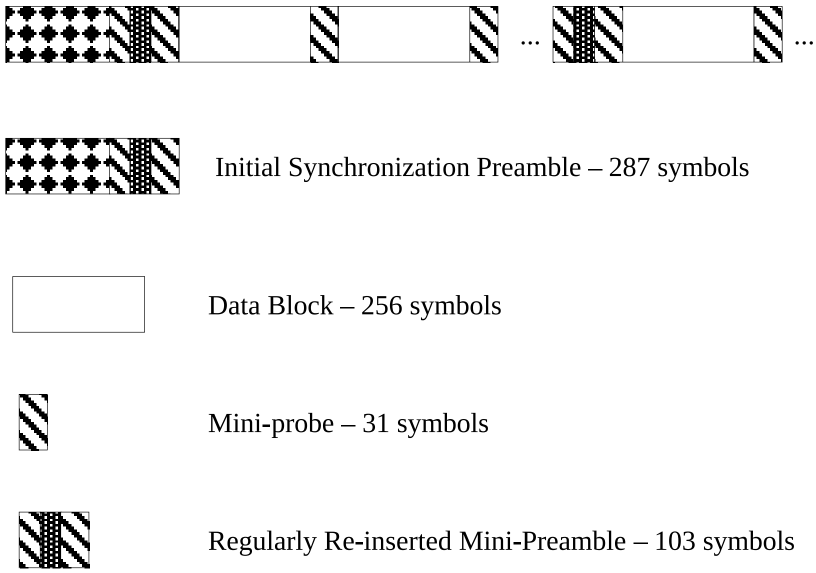
MIL-188-110B Appendix C single-tone waveform has the following characteristics:

Baud rate	User data rate (bps)	Inter leaver	Modulation (bit per symbol)	FEC coding rate	No. of unknown symbols (User Data)	No. of known 8-PSK symbols (Channel Probe)
2400	3200	variable	QPSK (2)	1/2, punctured to 3/4	256	31
2400	4800	variable	8-PSK (3)	1/2, punctured to 3/4	256	31
2400	6400	variable	16-QAM (4)	1/2, punctured to 3/4	256	31
2400	8000	variable	32-QAM (5)	1/2, punctured to 3/4	256	31
2400	9600	variable	64-QAM (6)	1/2, punctured to ¾	256	31
2400	12800	N/A	64-QAM (6)	N/A	256	31

Variable Interleaver

- Ultra short
- Very short
- Short
- Medium
- Long
- Very long

Each transmission of a MIL-188-110B message begins with a synchronization phase (preamble) which includes 287 8-PSK symbols. In the preamble the modem setting, i.e. user data rate and interleaver size, is coded. This auto baud feature should be used to configure the modem to decode the data bits. After the preamble the user data bits are transmitted in blocks of 256 symbols paired with 31-symbol mini-probe blocks. After 72 user data – mini-probe pairs a 103-symbol mini-preamble is inserted. The number of data blocks in a transmission is in principle unlimited. A unique bit pattern (in hexadecimal number, 4B65A5B2, MSB first) is sent to mark the end of message (EOM). The EOM sequence is followed by flush bits, for flushing the FEC coder and for the complete transmission of the remainder of the interleaver data block



The FEC and the interleaver are used to combat the effects of fading, frequency drift, multi-path effects and burst noise etc. in the HF transmission. The mini-probe and regularly re-inserted mini-preamble are transmitted to help keep the receiver synchronized.

The MIL-188-110B decoder processes all the above settings except 12800 bps. This setting is usually not to be used for reliable data transmission, because it has neither FEC nor interleaving. Generally MIL-188-110B transmits the user data in binary mode, i.e. it does not care which type of data is transmitted. This should be defined by the protocol layer using the MIL-188-110B mode. For this reason the decoder just displays the user data in **HEX**, **ASCII ASYNC**, **ASCII ASYNC (7 Data bits and 0 Stop bit)** or **ASCII SYNC** format which may be selected from **Options/Message Type....** The decoder stops displaying data after the EOM bit pattern is received.

In the **HEX** display mode, the decoded binary data is just displayed as is, MSB first. Display is terminated when more than 25 NULL hexadecimal characters have been received.

In **ASCII ASYNC** mode, the bit stream is searched with an ASCII ASYNC structure, i.e. one start bit (0), 8 data bits and at least one stop bit (1). The 8 data bits are transmitted LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received or if the async data structure is violated more than 80 times.

In **ASCII ASYNC (7 Data bits and 0 Stop bit)** mode, the bit stream is searched with another ASYNC structure, i.e. one start bit (0), 7 data bits. The 7 data bits are transmitted LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received.

In **ASCII SYNC** mode, each 8 bits (LSB first) represent one ASCII character. The display will stop if the EOM pattern is received or if more than 20 NULL characters are received.

Tuning the decoder

The decoder processes the signal in both SSB settings: USB and LSB. The sideband can be selected with the **Polarity** option in the menu: **NOR** means USB and **INV** means LSB signal.

The center frequency of the decoder should be set to 1800 Hz when the receiver is correctly tuned to the sending station. Small frequency variations are automatically compensated for in the decoder. The center frequency of the decoder can be adjusted to ± 400 Hz from its normal setting. By using the bar graph, any remaining frequency difference can be compensated for by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

MIL-188-141A

Parameter	Value
Frequency range	HF
System	MFSK, Broadcast/Simplex FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	125.0 Baud
Modulation	MFSK-8
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

MIL-188-141A Standard, also known as Automatic Link Establishment (ALE), specified by the US Department of Defense in September 1988 and with two Change Notices in June 1992 and September 1993, is a procedure whereby radio stations are able to automatically set up their link thus eliminating the need for skilled operators - in fact the growing lack of trained and experienced staff was a driving force behind the idea of ALE.

In March 1999 MIL-188-141A was integrated into the new specification MIL-188-141B, Appendix A. The message protocol was thereby extended slightly.

A station will transmit a link quality burst which may or may not contain the address of another station on a series of pre-assigned frequencies. The listening station(s) will continuously scan through these frequencies. During scanning the receiving station will perform a link quality analysis and measure signal to noise ratio and bit error ratio. These measurements are used to set up a table in memory of link quality assessments for each station and frequency.

Based on the values of the table, the best frequency available is selected when the station wishes to transmit. When the ALE controller of a receiving station hears its own address (or the address of the group to which it belongs) it will stop the scanning and respond to the call. The stations will then either switch to a low speed data exchange mode or to a high speed data (FSK or PSK) modem or to voice mode.

The MIL-188-141A signal is an 8-tone MFSK signal in the range 750 - 2500 Hz spaced 250 Hz apart. Each tone (symbol) is 8 ms long corresponding to 125 Baud and represents three bits giving a bit rate of 375 bps.

The MIL-188-141A bit-stream is structured in 24-bit frame, which includes three bits preamble for the frame type and three 7-bit ASCII characters or just 21 bits unformatted binary data.

To increase robustness the 24-bit frame is Golay (24, 12) encoded, and then interleaved giving a total frame length of 48 bits + 1 stuff bit. Each 49-bit code word is transmitted three times one after another to combat burst interference.

In both specifications, especially according to MIL-188-141B Appendix B, the 21-bit ALE frame data can be encrypted before transmission. This feature is named Link Protection. The data may be encrypted according to different classified application levels: AL-1 to AL-4. Unencrypted data is transmitted with AL-0.

The MIL-188-141A mode decoder processes the signal automatically after the center frequency is set. It synchronizes the signal in both USB and LSB polarities. There are two display modes selected the in **Display Mode** menu: **All Frames** and **Valid Frames Only**. The first option just displays the frames without checking if the ALE protocol is strictly observed; the second option displays the frames according to the ALE protocol defined according to MIL-188-141B (Appendix A), which is backwards compatible to MIL-188-141A. In both options the frame data can be displayed in **ASCII**, **HEX** or both **ASCII and HEX** formats. This can be set by using the **Display** menu.

Only unencrypted data can be displayed correctly with the mode decoder. For protected application data – according to MIL-188-141B Appendix B (Link Protection) – the display may be meaningless, because a user specific key is necessary for data decryption.

MIL-188-141B (Appendix C)

Parameter	Value
Frequency range	HF
System	PSK, Broadcast/Simplex FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	2400 Baud
Modulation	8-PSK
Receiver settings	DATA, CW, USB, LSB??
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Professional Version

MIL-188-141B Appendix C defines the third generation (3G) high frequency (HF) radio technology including advanced automatic link establishment (ALE), automatic link maintenance, and high performance data link protocols. This advanced technology improves on the performance of previous similar techniques (e.g. 2G-ALE). The specification is issued by the US Department of Defense (DoD) in the "Interface Standard Interoperability and Performance Standards for Medium and High Frequency Radio Systems" (1st March 1999).

This mode employs 5 constituent burst waveforms BW0 to BW4 for the various kinds of signaling required in the system, so as to meet their distinctive requirements as to payload, duration, time synchronization, and acquisition and demodulation performance in the presence of noise, fading, and multi-path. All of the burst waveforms use the basic 8-ary PSK serial tone modulation of an 1800 hertz (Hz) carrier at 2400 symbols per second (Baud). The same modulation is used in MIL-188-110A serial mode.

The burst waveforms have the following preamble and data structure.

Waveform	Burst duration	Preamble	Payload
BW0	613.33 ms, 1472 PSK symbols	160.0 ms, 384 PSK symbols	26 bits

BW1	1.30667 s, 3136 PSK symbols	240.0 ms, 576 PSK symbols	48 bits
BW2	640 + (400 * n) ms, 1536 + (960 * n) PSK symbols, n = 3, 6, 12, or 24	26.67 ms, 64 PSK symbols	1881 * n bits
BW3	373.33 + (13.33 * n) ms, 896 + (32 * n) PSK symbols, n = 64, 128, 256, or 512	266.67 ms, 640 PSK symbols	8 * n + 25 bits
BW4	640.0 ms, 1536 PSK symbols	none	2 bits

The data in the different burst waveforms is used for different purposes:

- BW0 is used for 3G-ALE PDUs (Protocol Data Unit),
- BW1 for traffic management PDUs and HDL (High-rate Data Link Protocol) acknowledgement PDUs,
- BW2 for HDL traffic data PDUs,
- BW3 for LDL (Low-rate Data Link Protocol) traffic data PDUs and
- BW4 for LDL acknowledgement PDUs.

The MIL-188-141B decoder processes the waveforms BW0, BW1 and BW4 only, because the configuration (number of data packet, FEC encoding and interleaver) of BW2 and BW3 is negotiated during the peer-to-peer communication, e.g. between two modems.

The decoder displays the payload data of BW0 and BW1 in **HEX**, **ASCII ASYNC**, **ASCII ASYNC (7 data bits, 0 stop bit)** and **ASCII SYNC** formats selected from **Options/Message Type**.

In the **HEX** mode the payload data is displayed as it is, MSB first.

In the **ASCII ASYNC** mode the payload data is displayed as ASCII character, i.e. one start-bit (0), 8 data-bits (one ASCII character) and at least one stop-bit (1). The 8 data-bits are LSB first. The display is stopped when 300 NULL (all zero in 8 data-bits) characters are received or if the async data structure is violated more than 80 times.

In the **ASCII ASYNC (7 data bits, 0 stop bit)** the data is displayed in a similar way – one start bit (0), 7 data bits (LSB first) and no stop bit. Also the display terminates when more than 300 NULL characters occur or the async data structure is violated more than 80 times.

In the **ASCII SYNC** mode the payload data is segmented into 8-bit (LSB first) ASCII characters and displayed.

The waveform BW4 has only 2 bits payload data, they are displayed in HEX format (MSB first).

Tuning the decoder

The decoder processes the signal in both SSB settings: USB and LSB. This can be selected with **Polarity** in the menu: NOR means USB and INV means LSB signal.

MIL-M-55529A NB/WB

Parameter	Value
Frequency range	HF
System	FSK
Center frequency	2000 Hz
Shift/Bandwidth	85 Hz (NB), 850Hz(WB)
Speed	50,75, 100 or 110 baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Async 2 FSK only

MIL-M-55529A is an asynchronous FSK system and is based on ASCII. No error detection or error correction is implemented.

For MIL-M-55529A mode standard baud rates from 50 to 110 baud are available. Non-standard baud rates may be selected using the **Baudrate** menu item.

From **Options/Display...** ASCII and BAUDOT are available as output formats.

MIL-M-55529A is also known as MD-522 / GRC.

The center frequency of the decoder should be set to 1800 Hz when the receiver is correctly tuned to the sending station. Small frequency variations are automatically compensated in the decoder.

The center frequency of the decoder can be adjusted by +/- 400 Hz from its normal setting. By reading the bar graph, any remaining frequency difference can be compensated by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

MPT-1327

Parameter	Value
Frequency range	VHF/UHF
System	Duplex ARQ TDMA
Center frequency	1500 Hz
Shift/Bandwidth	600 Hz
Speed	1200 bps
Modulation	INDIRECT-FM
Receiver settings	FM BW=15 kHz
Input(s)	AF-IN
Additional Info	

Trunked mobile radio makes a limited number of radio channels available for a relatively large number of mobile subscribers by channel sharing and appropriate access and signaling procedures on a control channel. The software monitors control and traffic channels.

A trunked network is controlled by a fixed base station (TSC - Trunked System Controller). Wide areas requiring radio coverage are divided into cells each of which is controlled by a TSC. The TSCs are connected to a hub and are controlled by a Management Controller. The TSCs register roaming of the mobile units and route traffic to the TSC which is nearest to the subscriber. TSCs may be connected to the public telephone network.

Trunked systems may carry voice or data signals. The mobile unit uses two-channel simplex and the base station full duplex.

The British MPT-1327 specifications for trunked private land mobile radio systems have won general and de facto acceptance in Europe. MPT-1327 specifies the general signaling features to be used on the trunked system. The system is used in the UK, France, Germany (Chekker, Lizenz A), Switzerland (Speedcom) and the Scandinavian countries with national adaptations.

MPT-1327 General Specifications

Parameter	Value
Frequency range	Depends on national regulations
Channel spacing	12,5 kHz
Voice modulation	Phase
Data modulation	Sub-carrier FFSK
Access method	Dynamic Frame Length Slotted ALOHA
Bit rate	1200 bps
Modulation rate	1200 Baud
Logical ‘0’	1800 Hz
Logical ‘1’	1200 Hz
Data format	NZRI

The control channel is divided into the Forward Control Channel from base station to units, and the Return Control Channel from units to base.

The forward control channel may be dedicated (fixed), non-dedicated (any free channel) or the same for all TSC's, which then access the channel in TDMA (time division multiple access).

The return control channel is randomly accessed by the mobiles in time-slots of 106.7 ms (128 bits).

The forward control channel is divided into time slots each carrying two 64-bit code words:

- A Control Channel System Codeword (CCSC), which identifies the system to radio units and provides synchronization to the following address codeword
- An address codeword, which is the first codeword of any message and defines the nature of the message

A message consists of a codeword sync sequence, an address codeword and one or more data code words. A codeword contains 48 information bits and 16 check bits. If bit 1 is logical one the codeword is an address codeword, otherwise it is a data codeword.

The more important address code words are:

ALOHA (ALH)

TSC to mobile. Carries information on the number of time slots in the succeeding frame and the channel number of the control channel.

REQUEST(RQS)

Mobile to TSC. Requests for action by the TSC.

AHOY (AHY)

TSC to mobile. General availability check.

ACKNOWLEDGEMENT (ACK)

TSC to mobile, mobile to TSC. Response to RQS or AHY. ACK from TSC also carries ALOHA time slot information.

GO-TO-CHANNEL (GTC)

TSC to mobile. Carries information on traffic channel number allocated for requested call.

The return control channel for the mobile units is accessed randomly using a particular form of the slotted ALOHA protocol. The TSC continuously sends sync messages on the forward control channel to the mobiles inviting random access messages. These TSC messages contain a parameter indicating the number of following timeslots - a frame - available. The mobile unit finds a random slot in the frame for its message. If the messages of two or more units collide, the collision is detected by the TSC which now increases the number of timeslots for the next frame and the mobile units retransmit.

If you select **Fixed stations** AHL messages will be filtered out except for the two following a non-AHL message. This is to prevent the display being flooded by these messages which are the most numerous in the system.

If you select **Mobile stations** all messages in the control channel will be displayed, and the messages which are identical, but have different labels depending on their origin from TSC or mobile, will be labeled with their mobile label.

Error correction may be enabled or disabled by toggling the **ECC** menu item.

A PC generated timestamp may be inserted ahead of the decoded message. Go to the **Options** menu and enable the **Time stamp** function.

Here are a few examples of the most frequent MPT messages monitored on the Forward Control Channel transmitted by the TSC. The most common message is ALH, a general invitation to transmit any single codeword message:

ALH(P:42,I1:5461,CH:3,WT:6,M:0,N:4)

Invitation to all mobile units belonging to group **42-5461 (P:42,I1:5461)** to transmit. The message is sent on control channel **3 (CH:3)**, the TSC responses may be delayed by **6** slots **(WT:6)**, **no** subdivision of the radio population is enabled **(M:0)** and the next frame contains **4** random access timeslots **(N:4)**.

A radio unit calls another unit with the same prefix:

AHY(P:79,I1:760,I2:770,D:0,P:0,CHK:1,E:0,AD:0)

General availability check on the called **(D:0)** unit **760 (I1:760)** sent before allocating a traffic channel. The TSC is checking if the called unit is ready for a data call **(CHK:1).** The calling party **770 (I2:770)** is requesting a non-emergency transaction. No data codeword **(AD:0)** is appended to this AHY message.

GTC(P:79,I1:760,CH:427,I2:770,N:0)

Calling unit **770** and called unit **760** are directed to proceed with traffic on channel **427 (CH:427)**. The next frame contains **no** timeslots **(N:0)**.

A broadcast message:

BCAST(SYSDEF:5,SYS:20265,CH:520,SPARE:0,RSVD:00,ADJ:2)

Option for non-active radio units to determine the signal strength **(SYSDEF:5)** at the following time slice on control channel **520 (CH:520)** of system **20265 (SYS:20265)** having local serial number **2 (ADJ:2)**.

To select monitoring either the base station (**Fixed**) or the **Mobile**s, use **Options/Station.** To change the display format of Data Code Words use **Options/Format.**

MOBITEX-1200

Parameter	Value
Frequency range	VHF
System	Slotted Aloha TDMA system, full duplex
Center frequency	1500 Hz
Shift/Bandwidth	600 Hz
Speed	1200 Baud
Modulation	FM/FFSK
Receiver settings	Narrow FM, BW = 15 kHz
Input	AF-IN

Mobitex 1200 is a multiple access packet radio system for wireless communications. Mobitex 1200 operates in the VHF band 76 – 82 MHz in Sweden and around 160 MHz in Finland, using 1200 bps FFSK indirect FM. In Sweden a nationwide system channel is operating on 76.7375 MHz for base-to-mobile communications and on 81.7375 MHz in the opposite direction.

When traffic is low it is transmitted on the system channel, but if it is heavy the base stations may automatically set up additional traffic channels or local system channels.

The Mobitex 1200 frames consist of a frame header with a unique synchronization word, base station identification, traffic area identification and control flags followed by zero or more blocks of data, max 32 blocks. Each block consists of 6 bytes followed by an error correcting code.

Each system is identified by the unique 4 hexadecimal digit sync word. The sync word is inverted for mobile-base communication.

The first data block – the link header - contains addressing information, frame type id, sequence number, number of blocks in the frame and other control information. Frames can either be data link frames used for the management of traffic or payload data frames called MRM frames. The payload frames contain so called MPAKs, i.e. Mobitex PAcKets which can have a total length of 512 bits. If the message is longer it is split into a number of sequences.

The first payload data block contains MPAK header information: source and destination addresses, subscription flags, packet class and packet type information and a timestamp if they are transmitted in the base-to-mobile direction. The remote terminals do not insert a time stamp, this is done by the network.

The system has four payload packet classes, PSUBCOM for subscriber packet switched communication, PSOSCOM for alert messaging, CSUBCOM for circuit-switched subscriber communication and DTESERV for service messages.

PSUBCOM will accommodate text (7-bit ASCII text), data (transparent data), status messages (transparent data) and higher protocol data identified by a protocol identification byte after the time stamp.

Mobitex 1200 also has voice call ability.

MOBITEX-8000

Parameter	Value
Frequency range	UHF
System	Slotted Aloha TDMA system, full duplex
Center frequency	
Shift	+/- 2 kHz
Speed	8000 Baud
Modulation	GMSK
Receiver settings	Narrow FM, BW = 15 kHz
Input	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Mobitex Network Settings, Message Type

Mobitex 8000 is a multiple access packet radio system for wireless communications developed from the older Mobitex 1200 bps system. Mobitex 8000 operates in the UHF bands and is found around 420 and 900 MHz in a number of countries using direct 8 kbps GMSK modulation.

The Mobitex 8000 frames consist of a frame header with a unique synchronization word, base station identification, traffic area identification and control flags followed by zero or more blocks of data, max 32 blocks. Each block consists of 18 bytes followed by two CRC bytes.

The data block bytes are protected by a 4 bit (12, 8) Hamming code so each data word is 12 bits long. For further protection the data bits are interleaved. However, the frame header is not interleaved and does not have a CRC sum appended.

Each system is identified by the unique 4 hexadecimal digit sync word. The sync word is inverted for mobile-base communication.

This sync word must be chosen for proper decoding in the Mobitex network settings and depends on the Mobitex network provider.

The first data block contains addressing information, frame type id, number of blocks and other control information. Frames can either be data link frames used for the management of traffic or payload data frames called MRM frames. The payload frames contain so called MPAKs, i.e. Mobitex Packets which can have a total length of 512 bits. If the message is longer it is split into a number of sequences.

The first payload data block contains MPAK header information: source and destination addresses, subscription flags, packet class and packet type information and a timestamp if they are transmitted in the base-to-mobile direction. The remote terminals do not insert a time stamp, this is done by the network.

The system has two payload packet classes, PSUBCOM for subscriber packet switched communication and DTESERV for service messages.

PSUBCOM will accommodate text (7-bit ASCII text), data (transparent data), status messages (transparent data) and higher protocol data identified by a protocol identification byte after the time stamp.

MODAT

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

For MODAT mode having nominal tone durations of 40 ms, the duration of a single tone may vary ± 5 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	MODAT
0	637.5
1	787.5
2	937.5
3	1087.5
4	1237.5
5	1387.5
6	1537.5
7	1687.5
8	1837.5
9	1937.5
E (REPETITION)	487.5
TONE DURATION	40 ms

NATEL

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	1800 Hz

Shift/Bandwidth	
Speed	2400.0 Baud
Modulation	INDIRECT-FM
Receiver settings	FM BW=12 kHz
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	NATEL
0	1633
1	631
2	697
3	770
4	852
5	941
6	1040
7	1209
8	1336
9	1477
A	1633
B	600
C	1995
D	2205
E	1805
F	
TONE DURATION	70 ms

NMT-450

Parameter	Value
Frequency range	VHF/UHF (450 MHz)
System	Duplex FEC TDMA
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	1200.0 Baud

Modulation	INDIRECT-FM (FFSK)
Receiver settings	FM BW=12 kHz
Input(s)	AF-IN
Additional Info	

NMT-450 is an analogue mobile telephone system, developed by the Telecommunication Administrations of Denmark, Finland, Norway and Sweden. The idea was to establish a compatible, automatic, public mobile telephone system in the Nordic countries. NMT-450 mobile station signals can be found from 453 MHz to 457.5 MHz, base station signals from 463 MHz to 467.5 MHz. The frequency range is divided into 180 channels of 25 kHz each (channel 1 -180).

In areas with a lot of mobile subscribers, an extended band from 452.5 MHz - 452.975 MHz (mobile) and 462.5 MHz - 462.975 MHz (base) may be used as an option. The offset between mobile and base frequency is always 10 MHz.

Control messages (signals) containing system wide information, assignment, status and dialed number are exchanged between the mobile station and the base station.

All signals are transmitted at 1200 baud FFSK with a center frequency of 1.5 kHz and a shift of 600 Hz.

An encoded NMT-450 frame has a length of 166 bits. Every frame contains 15 bits bit sync sequence followed by an 11 bits frame sync sequence. The last 140 bits contains the encoded message. In order to combat errors on the radio path, due fading and interference, an error-correcting code is used.

Today , NMT-450 is used in Sweden and a modified NMT-450 in Poland and Eastern Europe. More information can be found in the NMT DOC 450-1 / 450-3 specifications.

NOAA-GEOSAT

Parameter	Value
Frequency range	VHF/UHF
System	Broadcast
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	120 RPM, IOC=576
Modulation	INDIRECT-AM
Receiver settings	FM, BW=40 kHz
Input(s)	AF-IN
Additional Info	

The NOAA-GEOSAT software has been specifically tailored to the transmissions of meteorological satellites. Transmissions are always at 120 rpm using an IOC of 576. In contrast to short-wave stations which use frequency modulation, satellite weather images are transmitted using amplitude modulation.

The software is started in free-run mode by enabling the mode. Because this mode has no synchronization sequence the correct display of the image is controlled by using the **Phase** function in the **Options** menu.

The special items **AM-Gain** and **AM-Offset** are placed in the **Demodulator** menu. Centering of the signal deviations on the bar graph is controlled by adjusting **AM-Offset**. In addition maximum deviation is required on the bar graph. This is done by adjusting **AM-Gain**. It should be noted that these two adjustments are influenced by each other.

The orbiting satellites may be received with an active antenna and a high quality VHF-UHF receiver. An optimal receiving station allows reception for approximately 20 minutes before the satellite has moved below the horizon. The AF output of the receiver may be fed directly into the decoder, which converts it into a weather image viewing station providing excellent image quality.

Polarization problems occur with orbiting satellites resulting in reception gaps of up to 2 minutes. A special antenna may alleviate this problem.

Due to the Doppler effect the frequency of the received signal may change as much as 1000 Hz during the reception period. The receiver should therefore have a built-in automatic frequency control (AFC) capability.

NWR-SAME

Parameter	Value
Frequency range	VHF/UHF
System	FSK
Center frequency	1822.9
Shift/Bandwidth	520.83 Hz
Speed	520.83 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

NWR is the abbreviation for NOAA (National Oceanic and Atmospheric Administration [USA]) Weather Radio, which is operated by the NWS (National Weather System).

SAME is the abbreviation for Specific Area Message Encoding.

This feature is incorporated in information regarding severe weather conditions, which is distributed by the NWS. The area to which such a message applies is restricted by the area code, thus avoiding false alarm in areas which are not affected by the weather condition which causes the alarm.

The coded message is transmitted, using Audio Frequency Shift Keying, on the audio channel of the NWR transmitter system. Seven channels between 162.400 and 162.550 MHz are assigned to this task.

The baudrate is 520.83, mark-frequency is 2083.3 Hz and space-frequency 1562.5 Hz, all values fixed.

The user cannot change the audio-frequency by tuning the receiver.

For this reason the center–frequency is preset, as well as the baud-rate.

The display shows the information of the messages split into its meaningful parts.

The area-code is divided into state, county and subpart-code, the dissemination date into day, hour and minute.

EAS Event Codes

Event	Code
Blizzard Warning	BZW
Coastal Flood Watch	CFA
Coastal Flood Warning	CFW
Dust Storm Warning	DSW
Flash Flood Watch	FFA
Flash Flood Warning	FFW
Flash Flood Statement	FFS
Flood Watch	FLA
Flood Warning	FLW
Flood Statement	FLS
High Wind Watch	HWA
High Wind Warning	HWW
Hurricane Watch	HUA
Hurricane Warning	HUW
Hurricane Statement	HLS
Severe Thunderstorm Watch	SVA
Severe Thunderstorm Warning	SVR
Severe Weather Statement	SVS
Special Marine Warning	SMW
Special Weather Statement	SPS
Tornado Watch	TOA
Tornado Warning	TOR
Tropical Storm Watch	TRA
Tropical Storm Warning	TRW
Tsunami Watch	TSA
Tsunami Warning	TSW
Winter Storm Watch	WSA
Winter Storm Warning	WSW
National Information Center	NIC
Avalanche Watch	AVA
Avalanche Warning	AVW
Child Abduction Emergency	CAE
Civil Danger Warning	CDW
Civil Emergency Message	CEM
Earthquake Warning	EQW
Evacuation Immediate	EVI
Fire Warning	FRW
Hazardous Materials Warning	HMW
Law Enforcement Warning	LEW

Local Area Emergency	LAE
911 Telephone Outage Emergency	TOE
Nuclear Power Plant Warning	NUW
Radiological Hazard Warning	RHW
Shelter in Place Warning	SPW
Volcano Warning	VOW
Administrative Message	ADR
Practice/Demo Warning	DMO
Required Monthly Test	RMT
Required Weekly Test	RWT

FIPS Area Codes

Code	Area
01	Alabama
02	Alaska
04	Arizona
05	Arkansas
06	California
08	Colorado
09	Connecticut
10	Delaware
11	District of Columbia
12	Florida
13	Georgia
15	Hawaii
16	Idaho
17	Illinois
18	Indiana
19	Iowa
20	Kansas
21	Kentucky
22	Louisiana
23	Maine
24	Maryland
25	Massachusetts
26	Michigan
27	Minnesota
28	Mississippi
29	Missouri
30	Montana
31	Nebraska
32	Nevada
33	New Hampshire
34	New Jersey
35	New Mexico

36	New York
37	North Carolina
38	North Dakota
39	Ohio
40	Oklahoma
41	Oregon
42	Pennsylvania
44	Rhode Island
45	South Carolina
46	South Dakota
47	Tennessee
48	Texas
49	Utah
50	Vermont
51	Virginia
53	Washington
54	West Virginia
55	Wisconsin
56	Wyoming
57	Eastern North Pacific Ocean, and along U.S. West Coast from Canadian border to Mexican border
58	North Pacific Ocean near Alaska, and along Alaska coastline, including Bering Sea and Gulf of Alaska
59	Central Pacific Ocean, including Hawaiian waters
60	American Samoa
61	South Central Pacific Ocean, including American Samoa waters
64	Federated States of Micronesia
65	Western Pacific Ocean, including Mariana Island waters
66	Guam
67	Johnston Atoll
68	Marshall Islands
69	Northern Mariana Islands
70	Palau
71	Midway Islands
72	Puerto Rico
73	Western North Atlantic Ocean, and along U.S. East Coast, from Canadian border south to Currituck Beach Light, N.C.
74	U.S. Minor Outlying Islands
75	Western North Atlantic Ocean, and along U.S. East Coast, south of Currituck Beach Light, N.C., following the coastline into Gulf of Mexico to Bonita Beach, FL., including the Caribbean
76	Navassa Island
77	Gulf of Mexico, and along the U.S. Gulf Coast from the Mexican border to Bonita Beach, FL.
78	Virgin Islands of the U.S.

79	Wake Island
81	Baker Island
84	Howland Island
86	Jarvis Island
89	Kingman Reef
91	Lake Superior
92	Lake Michigan
93	Lake Huron
94	Lake St. Clair
95	Palmyra Atoll
96	Lake Erie
97	Lake Ontario
98	St. Lawrence River above St. Regis

PACKET-300

Parameter	Value
Frequency range	HF
System	FSK, Duplex FEC TDMA
Center frequency	
Shift/Bandwidth	
Speed	300 and 600 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding, amateur AX.25 System

PACKET-300 is mainly used by radio amateurs. Very seldom 600 Baud test transmissions may be heard. On HF SSB modulation (LSB or USB) is standard.

The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Packet radio is a synchronous system in which data is transmitted in ASCII character packets.

At the start and end of each block a control character or flag (01111110) is sent. The address can consist of up to 80 characters, but 16 or 24 character addressing is common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types: I (Information), S (Supervisory) and U (Unnumbered). Payload data transfer uses I frames or very rarely U frames. S and U frames are used for transmission control.

The data field can contain up to 256 characters. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

The status field contains three fields with connection status information in addition to the call-signs:

Frame types are indicated by I, S or U.

S-frame status messages, e.g. Receiver Ready (RR), Receiver Not Ready (RNR) or Reject (REJ) are displayed.

In the third field the transmit and receive sequence numbers are displayed. This number ranges from r0 to r7 or s0 to s7. The sequence number indicates to the opposite station which packets have been received free of errors.

The large volume of available radio amateur literature is recommended for further study of the packet radio system.

PACKET-1200

Parameter	Value
Frequency range	VHF/UHF
System	Duplex FEC TDMA
Center frequency	1700 Hz
Shift/Bandwidth	1000 Hz
Speed	600 or 1200 Baud
Modulation	INDIRECT-FM
Receiver settings	FM BW=12 kHz
Input(s)	AF-IN
Additional Info	ITA-5 with block coding, amateur AX.25 System

PACKET-1200 can be monitored in the amateur VHF and UHF. This mode uses indirect FM (sub carrier) modulation.

To start PACKET-1200, select **1200 Baud** or **600 Baud**. The correct shift or center may be set in the **Demodulator** menu. Standard values for the center frequency and the shift are 1700 Hz and 1000 Hz.

The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Packet radio is a synchronous system in which data is transmitted in ASCII character packets.

At the start and end of each block a control character or flag (01111110) is sent. The address can consist of up to 80 characters, but 16 or 24 character addressing is common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types: I (Information), S (Supervisory) and U (Unnumbered). Payload data transfer uses I frames or very rarely U frames. S and U frames are used for transmission control.

The data field can contain up to 256 characters. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

The status field contains three fields with connection status information in addition to the call-signs:

Frame types are indicated by I, S or U.

S-frame status messages, e.g. Receiver Ready (RR), Receiver Not Ready (RNR) or Reject (REJ) are displayed.

In the third field the transmit and receive sequence numbers are displayed. This number ranges from r0 to r7 or s0 to s7. The sequence number indicates to the opposite station which packets have been received free of errors.

The large volume of available radio amateur literature is recommended for further study of the packet radio system.

PACKET-9600

Parameter	Value
Frequency range	VHF/UHF
System	Duplex FEC TDMA
Center frequency	
Shift/Bandwidth	4800 Hz
Speed	2400, 4800 or 9600 Baud
Modulation	FSK
Receiver settings	FM BW=15 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding Amateur AX.25 System

PACKET-9600 may be monitored in the amateur UHF and SHF bands. 2400 Baud transmissions are rare. Some digipeaters support two modes, PACKET-1200 and PACKET-9600.

To start PACKET-9600 select a baud rate. The correct shift may be set in the **Demodulator** menu. The default value for the shift is 4800 Hz.

As PACKET-9600 uses direct FSK modulation, the translation frequency pre-selection is equal to the center frequency of the IF input. Some digipeaters offset their transmit frequency up to 1.000 Hz from their normal frequency and this introduces many reception errors. The frequency offset is compensated by changing the translation frequency.

The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Packet radio is a synchronous system in which data is transmitted in ASCII character packets.

At the start and end of each block a control character or flag (01111110) is sent. The address can consist of up to 80 characters, but 16 or 24 character addressing is common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types: I (Information), S (Supervisory) and U (Unnumbered). Payload data transfer uses I frames or very rarely U frames. S and U frames are used for transmission control.

The data field can contain up to 256 characters. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

The status field contains three fields with connection status information in addition to the call-signs:

Frame types are indicated by I, S or U.

S-frame status messages, e.g. Receiver Ready (RR), Receiver Not Ready (RNR) or Reject (REJ) are displayed.

In the third field, the transmit and receive sequence numbers are displayed. This number ranges from r0 to r7 or s0 to s7. The sequence number indicates to the opposite station which packets have been received free of errors.

The large volume of available radio amateur literature is recommended for further study of the packet radio system.

PACTOR

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100.0 or 200.0 Baud adaptive
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding

PACTOR operates as a bit synchronous simplex system in a fixed timing cycle. The entire cycle length is 1.25 seconds and the packet length 0.96 seconds. Consequently the correlation amounts to 250 bits at 200 Baud. The change-over time and signal propagation delay limits the system’s range to approximately 20.000 km.

The PACTOR data block consists of three sections: Header, data and control (status and 16 bit CRC). At 100 Baud the data field is 64 bits and at 200 Baud it increases to 160 bits. Block coding is performed according to the CCITT standard starting with the data section.

PACTOR operates adaptively so the baud rate can be either 100 or 200 Baud. During day time 200 Baud may be successfully used. In the evening, however, strong propagation distortion occurs which necessitates a reduction of the baud rate to 100 Baud.

PACTOR includes HUFFMAN data compression by design. This scheme relies on the fact that frequently occurring characters e.g. space, e, n or i, can be represented with shorter bit combinations than characters which are rarely used. A compression factor of approximately 1.7 is achieved in comparison to uncompressed ASCII.

Looking purely at monitoring, the Huffman code has the disadvantage that compression synchronization may be lost during propagation disturbances and so the remaining text in the data block is also lost.

PACTOR is a frequent visitor in the amateur radio bands. In addition, commercial users also use this system. The data protocol was modified into several variants for this purpose. The WAVECOM software automatically detects and decodes versions 1 to 8.

Detailed descriptions of the PACTOR protocols can be obtained in the radio amateur literature. It must however be pointed out that real-world PACTOR implementations differs considerably from these descriptions.

Options/CRC Recognition. The detected CRC is displayed in the decoder status bar.

To apply or manipulate the various checksum algorithms in use, select **Options/CRC Table...**

A table of CRC's is stored in \Config\CRCTABLE.TXT.

PACTOR-FEC

Parameter	Value
Frequency range	HF
System	FSK
Center frequency	
Shift/Bandwidth	200Hz
Speed	100 or 200 baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding

PACTOR-FEC is a bit synchronous simplex system and is based on PACTOR.

The PACTOR-FEC data block consists of three sections: Header, data and control (status and 16 bit CRC). At 100 baud the data field is 64 bits and at 200 baud it increases to 160 bits. Block coding is performed according to the CCITT standard starting with the data section.

In contrast to PACTOR, all data blocks are in consecutive order with no or little space between them. They are several variants on the market. The baud rate is fixed to 100 or 200 baud. PACTOR-FEC is used for broadcast transmission and is recognized by the FSK Code Check or Classifier Code Check.

PACTOR-II

Parameter	Value
Frequency range	HF
System	PSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100.0 Baud
Modulation	Two channel DBPSK, DQPSK, D8PSK, D16PSK adaptive
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding 7.035 MHz, 14.070 MHz

With PACTOR-II, a modern, narrow-band and reliable two-channel PSK mode is available, which covers the needs of both amateur and professional users for a secure and fast data transmission system. The good performance during disturbances and a small bandwidth of 500Hz are achieved by the use of a two channel DPSK modulation. As propagation conditions change, PACTOR-II is able to select the most suitable modulation (DBPSK, DQPSK, D8PSK, and D16PSK) and the length of the frame (SHORT or LONG). Under very poor conditions PACTOR-II changes to DBPSK short block, which has a frame duration of 1.25 seconds and carries only a small amount of data. For very good conditions, D16PSK with a long frame is used, which transfers a large amount of data and needs 3.75 seconds.

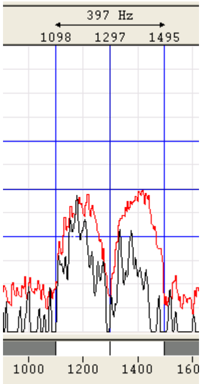
To achieve a data transmission, which is robust against all kind of disturbances, a decision must be made, if a short or a long frame-length should be used. The resulting input bit stream is then terminated with a convolutionally encoded and interleaved CRC-sum. After that, the symbol mapping for the two channels is done, and then this signal is applied to the DPSK demodulator.

To extract the data from a PACTOR-II signal, the signal is received and demodulated with a two channel DPSK-demodulator. The center frequency must be adjusted to the center between the two channels. To achieve the best performance, the AFC (automatic frequency control) should be enabled. After the demodulation and the bit synchronization, the symbols of the two channels are combined to one bit stream. After the modulation type has been determined, the resulting bit stream is deinterleaved, passed through a Viterbi-decoder and the CRC is checked.

PACTOR-II is suited to the transfer of large files rather than hand-typed text. The data may be transmitted as ASCII without compression or can be compressed with HUFFMAN or PSEUDO-MARKOV compression. In addition, run length encoding (RLE) is included.

Tuning a PACTOR-II Signal

After launching the mode, the first step is to look for a valid PACTOR-II signal in the spectrum:



The bandwidth of the spectrum can be switched between 500 Hz, 1000 Hz, 4000 Hz and 24000 Hz. The upper and lower frequency boundaries of the signal are the selected with the right and left cursors. With the center cursor, the center frequency may be set more precisely. **The precision of the center frequency is very important and directly influences the performance of the decoding.**

To ensure, that the system can handle drifting signals or a coarsely adjusted center frequency, **AFC** may be enabled in the **Demodulator** menu. The carrier tracking function is now activated. If the deviation between the tracked and the adjusted center frequency is too large, the center frequency should be corrected. The carrier tracking only works over a range of the center frequency ± 10 Hz.

The deviation of the adjusted center frequency and the tracked frequency is shown in the tuning display. If a PACTOR-II signal was not found, the bar of the tuning display moves randomly. If a valid PACTOR-II signal was detected, the bar is frozen during the entire frame and shows the deviation. Now the center frequency may be manually adjusted to fit the correct frequency if necessary.

If a valid PACTOR-II signal was found the detected modulation type, frame length and the polarity is displayed. If it was an error free frame, the detected compression type, the status and the decoded text is displayed.

An automatic detection of the CRC can be switched on/off with

Options/CRC Recognition. The detected CRC is displayed in the decoder status bar.

To apply or manipulate the various checksum algorithms in use, select **Options/CRC Table...**

A table of CRC's is stored in \Config\CRCTABLE.TXT.

PACTOR-II-AUTO

Requires Professional Version

Fully automatic switching between PACTOR-II (ARQ) and PACTOR-II-FEC may be achieved by selecting **PACTOR-II-AUTO** mode.

PACTOR-II-FEC

Parameter	Value
Frequency range	HF
System	PSK, Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	100.0 Baud
Modulation	Two channel DQPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding Requires Professional Version

With PACTOR-II-FEC, a modern, narrow-band and reliable two-channel PSK mode is available, which covers the needs of professional users for a secure and fast data transmission system. The good performance during disturbances and a small bandwidth of 500Hz are achieved by the use of a two channel DPSK modulation.

In contrast to PACTOR-II, modulation and block length in PACTOR-II-FEC is fixed to "DQPSK LONG BLOCK". Where PACTOR-II uses ARQ, i.e. after each block sent, an acknowledge message from the receiving station is required, PACTOR-II-FEC has no acknowledge return channel. Thus, the receiving station must be able to do all the error correction. This is achieved by using a Viterbi decoder with k = 9 and code rate = ½. Interleaving protects the transmission against fading. Using a DQPSK modulation is a good compromise when looking at the amount of bits transmitted and the necessary signal-to-noise-ratio.

To extract the data from a PACTOR-II-FEC signal, the signal is received and demodulated with a two channel DPSK-demodulator. The center frequency must be adjusted to the midpoint between the two channels. To achieve the best performance, the AFC (automatic frequency control) should be enabled. After the demodulation and the bit synchronization, the symbols of the two channels are combined to one bit stream. After the modulation type has been determined, the resulting bit stream is de-interleaved, passed through a Viterbi decoder and the CRC is checked.

PACTOR-II-FEC uses the same compression algorithms and CRC masks as PACTOR-II.

An automatic detection of the CRC can be switched on/off with **Options/CRC Recognition.** The detected CRC is displayed in the decoder status bar.

To apply or manipulate the various checksum algorithms in use, select **Options/CRC Table...**

A table of CRC's is stored in \Config\CRCTable.xml.

Tuning a PACTOR-II-FEC signal

See "Tuning a PACTOR-II Signal on page 193".

PACTOR-III

Parameter	Value
Frequency range	HF
System	PSK, Half-duplex synchronous ARQ
Center frequency	In the range (−2900, 2900) [Hz]; automatic frequency control (AFC): +/−50 Hz
Shift/Bandwidth	N/A
Speed	100.0 Baud
Modulation	DBPSK, DQPSK; 2, 6, 14, 16, or 18 tones
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding 14.106 MHz, 21.112 MHz Optional Mode

PACTOR-III is an adaptive transmission mode that provides higher throughput and improved robustness compared to PACTOR-I and –II, both designed for operation within a bandwidth of 500 Hz. To achieve the improved features, PACTOR-III uses up to a maximum of 18 tones spaced 120 Hz, thus occupying a maximum bandwidth of 2160 Hz. Six so-called **Speed Levels (SL)** are specified, which are predefined combinations of modulation type (DBPSK or DQPSK), channel coding and number of tones (2, 6, 14, 16, or 18) as well as positions of tones. For all Speed Levels, the modulation rate of each tone is 100 Baud.

TN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
						B							B					
SL=1						B							B					
SL=2				B		B		B			B		B		B			
SL=3			B	B	B	B	B	B	B	B	B	B	B	B	B	B		
SL=4			Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q		
SL=5		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	
SL=6	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q

TF	480	600	720	840	960	1080	1200	1320	1440	1560	1680	1800	1920	2040	2160	2280	2400	2520

Tone numbers (TN) and respective frequencies (TF) in Hz as well as modulation types (B = DBPSK, Q = DQPSK) for the 6 Speed Levels (SL).

As propagation conditions change, PACTOR-III is able to select the most suitable speed level. Under very poor conditions PACTOR-III changes to speed level 1, whereas, under optimum conditions, speed level 6 is used. As in the previous PACTOR standards, the frame durations are still 1.25 seconds (short cycle) and 3.75 seconds (long cycle for data mode). Again, a long path option is available to enable contacts up to 40.000 km. In such a case, the duration of the short and long cycle is extended to 1.4 and 4.2 seconds, respectively.

Initial link establishment is achieved using the frequency shift-keying (FSK) protocol of PACTOR-I, corresponding to the lowest protocol level. If both calling and called stations are capable of PACTOR-III, automatic switching to this protocol is done.

For data transmission, which is robust against all kinds of disturbances, a decision must be made, whether a short or a long frame-length should be used. Each frame consists of the user data, a status byte, and two CRC bytes. This input bit stream is then bit-interleaved and convolutionally encoded. After that, the symbol mapping for the different channels is done, and the resulting signals are applied to the DxPSK modulators.

To extract the data from a PACTOR-III signal, the signal is demodulated with the appropriate number of DxPSK-demodulators, according to the speed level. The center frequency must be adjusted to the center between the lowest and highest tone in use. AFC (automatic frequency control) is always enabled. After demodulation and bit synchronization, the symbols of the channels are combined to one bit stream, which is deinterleaved and passed through a Viterbi-decoder. The CRC is used to check whether transmission errors occurred. After successful synchronization, it may take several tens of seconds before any text is output in the GUI.

In PACTOR-III, the data may be transmitted as ASCII without compression or can be compressed with HUFFMAN or PSEUDO-MARKOV compression (PMC). In addition, run length encoding (RLE) is included.

PCCIR

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	PCCIR
0	1981
1	1124
2	1197
3	1275
4	1358
5	1446
6	1540
7	1640
8	1747
9	1860
A	1050
B	930
C	2400
D	991
E	2110
F	
TONE DURATION	100 ms

PDZVEI

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	PDZVEI
0	2200
1	970
2	1060
3	1160
4	1270
5	1400
6	1530
7	1670
8	1830
9	2000
A	825
B	886
C	2600
D	856
E	2400
F	
TONE DURATION	70 ms

PZVEI

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

For ZVEI modes having nominal tone durations of 70 ms, the duration of a single tone may vary ± 15 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	PZVEI
0	2400
1	1060
2	1160
3	1270
4	1400
5	1530
6	1670
7	1830
8	2000
9	2200
A	970
B	810
C	2800
D	885
E	2600
F	680
TONE DURATION	70 ms

PICCOLO-MK6 and PICCOLO-MK12

Parameter	Value
Frequency range	HF
System	MFSK, Simplex
Center frequency	
Shift/Bandwidth	
Speed	50ms, 25 ms
Modulation	MFSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 for MK6, ITA-5 for MK12

PICCOLO-MK6 and PICCOLO-MK12 are MFSK (multi frequency shift keying) systems. The earlier PICCOLO versions MK1, MK2 and MK3 used 34 or 40 tones, each tone representing one character of the ITA-2 or ITA-5 alphabet respectively. The tone duration was 100 ms and the tone spacing 10 Hz.

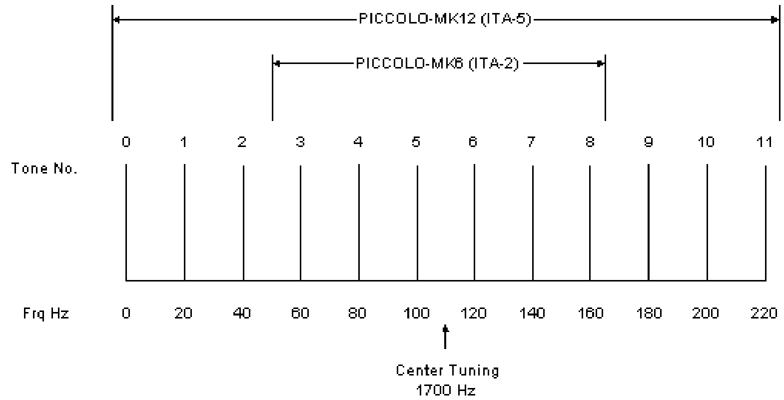
Recent systems operate with two sequential tones. The combination of the two tones defines the transmitted character. An increase in the signal-to-noise ratio is achieved by this method.

PICCOLO-MK6 is based on the ITA-2 Baudot alphabet. 6 tones are used which results in a total of 36 combinations. The tone duration is 2 x 50 ms for one character which corresponds to 75 Baud Baudot with 7.5 bit code words.

PICCOLO-MK12 transmits ITA-5 characters. To transfer 7 bit ASCII characters, twelve tones are required. This produces 144 bit combinations of which 128 are used. The transmission speed is equivalent to an asynchronous data rate of 110 Baud.

The WAVECOM software displays four windows on the screen: **Normal T1/T2**, **Inverse T1/T2**, **Normal T2/T1** and **Inverse T2/T1**. This way of organizing the display is due to the fact that it is not possible for the operator to decide from the monitored tone sequence, whether the first received tone constitutes tone 1 or tone 2 of a character. In addition, reception may occur using either the upper or the lower sideband giving a total of four decoding possibilities. Decoding of data is done simultaneously in all four windows.

Tone Assignment of PICCOLO-MK6 and PICCOLO-MK12



The decoder or receiver must be tuned to obtain the midpoint between tones 5 and 6 as the center frequency. In the case of IDLE (standby) transmissions these two tones are keyed at a rate of 100 ms and tuning becomes quite simple.

Decoding of PICCOLO and COQUELET systems requires receivers with high frequency stability. Thus state-of-the-art receivers using PLL or DDS frequency synthesis are well suited for the reception of these systems.

The software also provides an AFC (Automatic Frequency Control) function. Frequency deviations are continuously monitored by the software and automatic correction is introduced. The control range is ±5 Hz. The AFC function may be enabled/disabled using the **Demodulator** menu.

The MFSK demodulator is intended for use with MFSK systems. This mode may be selected in the **Demodulator** menu via the **Mode** item. The center frequency should be set to approximately 1700 Hz.

One manufacturer has doubled the data transfer rate and shortened the tone duration to 2 x 25 ms. this is equivalent to a transfer rate of approximately 150 Baud Baudot with 7.5 bit codeword. The standby tones were also changed, but otherwise the systems are identical.

Almost all transmissions in PICCOLO-MK6 and PICCOLO-MK12 are encrypted. However, some stations transmit meteorological data and operator communication in clear.

POCSAG

Parameter	Value
Frequency range	VHF/UHF
System	Simplex pager
Center frequency	
Shift/Bandwidth	
Speed	512, 1200 or 2400 bps
Modulation	FSK
Receiver settings	FM BW=15 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-5 with block coding, PAGER

The pager services introduced by a number of PTT administrations use the POCSAG (Post Office Code Standard Advisory Group) standard. Pagers are one-way devices. A base station controls a large number of receivers and a return channel for transmission of reception acknowledgements or text is not available.

POCSAG specifies four different call modes:

Tone only pagers (Mode 0 and 1)

The receiver can receive four different messages. The meaning of the four tones must be determined beforehand. The acoustic signal is supported by the display of the A, B, C or D messages on a small LCD display. All pagers must in principle have tone-only capability as a minimum.

Numeric pagers (Mode 2)

Individual parties receive their messages in the form of transmitted digits and some special characters. In this way for example, the telephone number which the POCSAG subscriber is to call, can be relayed. Messages are displayed on the pager display and may be partially stored.

Alphanumeric pagers (Mode 3)

The pager type which is easiest to use, is the alphanumeric pager where the transmitted message is displayed on the pager display. Such messages may be up to 80 characters long.

A country-wide pager network is, like a mobile telephone service, subdivided into individual cells that are each serviced by a base station.

Cells are fed with information in a time multiplex fashion i.e. messages are transmitted in cycles. This prevents that areas falling in the overlap zone of adjacent cells, receive the same message simultaneously. To prevent the condition that a base station only transmits for one third of the available time, stations are usually equipped to handle four frequencies.

Selecting **Options/Message Type** enables the user to select the various pager modes for display:

1...3: ASCII Mode 1 – 3 in ASCII format

0: BIN Mode 0 in binary format

0...3: ASCII Mode 0 – 3 in ASCII format

0...3: AUTO Mode 0 – 3 automatic format detection

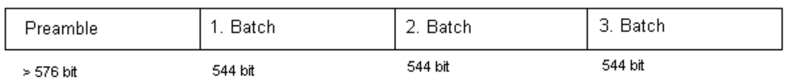
3: ASCII Mode 3 in ASCII format

Data modulation is achieved by direct 2FSK carrier keying with a transmission speed of 512 bit/s. Newer nets operate at 1200 or 2400 bit/s using FFSK modulation.

For reasons of compatibility with older pagers two different bit rates (512 Bit/s and 1200 Bit/s or 1200 Bit/s and 2400 Bit/s) are often used on the same frequency. In some countries POCSAG and GOLAY systems are on the same frequency. By selecting the **Auto speed** function all baud rates are automatically detected and switch-over between 512, 1200 and 2400 bps is performed.

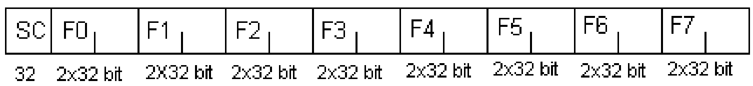
POCSAG Signaling

Generally activation of the HF carrier is followed by the transmission of a preamble or bit synchronization pattern which slaves the receiver to the clock frequency. The preamble contains at least 576 bits and represents a continuously alternating sequence of 010101...0101. Following the preamble, data batches containing the actual information are transmitted, each batch being 17 x 32 bit or 544 bits long.



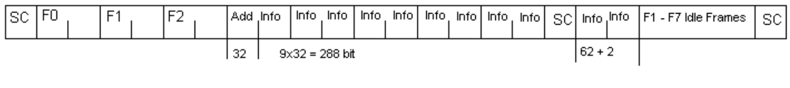
The structure of a batch is fixed: Each batch starts with a 32 bit synchronization codeword with a fixed content.

The synchronization word is followed by eight frames (frame 0 - 7) containing 2 x 32 bits in total. Only the first 32 bits are however used for transmitting a pager address. It would therefore be possible to double the maximum number of subscribers in the group by utilizing the frame contents to its full extent.



The message contents of the code words may include pager addresses or messages destined for specific pager addresses. The frames contained in a batch are numbered from 0 to 7. All pagers are similarly divided into 8 groups with each pager only receiving frames for the group to which it has been assigned. A pager synchronizes itself to the batch synch codeword (SC) and ignores the seven frames which are not applicable.

Following the address at the beginning of a frame, a message of any desired length may be sent. In the case of numeric pagers, digits are sent in BCD code while for alphanumeric pagers the message is transmitted using 7 bit ASCII codes.



The example shows the transfer of a message of 350 bits in frame 3. The first 32 bits of frame 3 are the address codeword (Add). Then follow 4 1/2 frames equivalent to 9 x 32 bits which extend up to the next synch word (SC). The remaining 62 bits fit into frame 0. If the frame containing the end of a message is not required to send a new address, it is filled with IDLE codes until a new address or a new synch word must be sent.

POCSAG mode uses direct frequency modulation. Proper decoding is only possible from the receiver IF output (455 kHz, 10.7 MHz or 21.4 MHz).

POL-ARQ

Parameter	Value
Frequency range	HF
System	FSK, Duplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100, 150 and 200 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

POL-ARQ operates at a speed of 100 and 200 Baud on the radio link.

To synchronize to this mode select a baud rate. By selecting the **Auto** button, the automatic determination of center frequency, shift frequency and baud rate is performed. Signal polarity (LSB or USB sidebands) is automatically detected.

POL-ARQ is a full duplex system with two transmitting frequencies. The system is based on the SITOR-ARQ alphabet. This alphabet having a 4:3 mark-space ratio allows error detection. Like all duplex systems, POL-ARQ initiates a request for repetition cycle (RQ) when transmission errors occur.

To maintain synchronization between the two duplex stations, both transmitters operate continuously. If no data is transmitted an idle bit pattern is sent.

At 100 Baud the last three characters are repeated after the RQ character. At 200 Baud the last four characters are repeated (5 character repetition cycle). Due to mode characteristics the character repetition cycle must be controlled manually.

PRESS-FAX

Parameter	Value
Frequency range	HF
System	Graphic mode, Broadcast
Center frequency	1900 Hz
Shift/Bandwidth	
Speed	60, 90, 120, 180 and 240 RPM, IOC 288, 352 and 576
Modulation	FSK
Receiver settings	FAX, DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

The transmission of press fax images on short-wave is based on gray levels and specific IOC values. A number of IOC assignments were modified for press image transmissions. These special characteristics are taken into account in the PRESS-FAX software.

If the **Auto** function is selected the software waits for the IOC identifier and synchronization sequence. Both parameters are only transmitted at the start of an image and hence capture will only start when the next image occurs. By selecting **PRESS-FAX,** the decoding starts immediately and the drum speed and IOC can be programmed manually via the **Drum speed** and **IOC** items in the **Demodulator** menu. The selected parameters are displayed in the decoder status bar.

The decoder allows a continuous and smooth alignment of the image as it is being received from **Options/Fine Speed**. By using the **Phase** item in the **Options** menu the image can be shifted into the correct position. **Flip Left-Right** and **Flip Top-Down** will reverse the image or turn it upside down.

To enhance the interpretation of gray-scale images, a false **color** option is available. Right-click on the image to open the **Zoom** menu, and select a color scheme from the bottom part. A checkmark is placed to the left of the selection.

PSK-10

Parameter	Value
Frequency range	HF
System	PSK, Simplex
Center frequency	
Shift/Bandwidth	40 Hz
Speed	10 Baud
Modulation	DBPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	10.148 MHz, 14.075 MHz

PSK-10 is a very narrow-band and reliable mode developed by F6CTE. The aim of this experimental slow mode is to allow a chat-type communication between hams.

The baud rate is fixed at 10 Baud and is optimized to transfer the data rate, which an operator can input on a keyboard by hand.

To separate the transferred characters, the sequence "011" is inserted between every character. Thus the characters can be clearly separated, as long as no "011" sequence appears in the character itself. This was taken into consideration when designing the alphabet.

To optimize the data throughput rate of the system, an alphabet with a variable character length is used. For frequently used characters a symbol is used, which has a short word length (as is done with the Huffman compression). This alphabet is called Varicode and differs from the alphabet used in PSK-31.

PSK-AM

Parameter	Value
Frequency range	HF
System	
Center frequency	
Shift/Bandwidth	50 ... 260 Hz
Speed	10, 31.25, 50 Baud
Modulation	DBPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	14.075 MHz

PSK-AM is a very narrow-band and reliable amateur mode developed by F6CTE. The aim of this experimental slow mode is to allow chat communication between hams.

PSK-AM is similar to PSK-31, but uses its own fixed length 8 bit alphabet with a 5:3 ratio. Each character is repeated 5 positions later. This diversity in time allows the correction of an invalid character.

Bitstream:

D(x)	R(x-2)	D(x+1)	R(x-1)	D(x+2)	R(x)	D(x+3)

D(x): character

R(x): repeated character

PSK-31, PSK-62.5, PSK-125

Parameter	Value
Frequency range	HF
System	PSK, Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	31.25, 62.5 or 125 Baud
Modulation	DBPSK, DQPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	3.580 MHz, 7.035 MHz, 14.070 MHz

PSK-31 is a very narrow-band and reliable mode. The good performance against disturbances is achieved by the use of DPSK modulation. Two demodulators are available:

- For normal use, DBPSK can be selected to demodulate a bi-phase modulated signal. The baud rate is fixed at 31.25 Baud and is optimized to transfer the data rate, which an operator can input on a keyboard by hand.
- Alternatively DQPSK can be selected to demodulate a four-phase modulated signal. In this mode additional redundancy is generated by a convolutional encoder with a code rate = 1/2 and a constraint length of K=5, i.e. 2 bits were produced per bit by 2 polynomials. After the demodulation of the signal,

the encoded bits are converted to a normal bit stream by a Viterbi decoder with K=5 and a code rate =1/2.

To separate the transferred characters, two zeros are inserted between every character. Thus the characters can be clearly separated, as long as no two consecutive zeros appear in the character itself. This was taken into consideration when designing the alphabet.

To optimize the data throughput rate of the system, an alphabet with a variable character length is used. For frequently used characters a symbol is used, which has a short word length (as is done with the Huffman compression). This alphabet is called Varicode.

Tuning a PSK-31 Signal

After launching the mode, the first step is to look for a valid PSK-31 signal in the spectrum. It is possible that within a bandwidth of 4 kHz more than on station is working.

The bandwidth of the spectrum can be switched between 500 Hz, 1000 Hz, 4000 Hz and 24000 Hz. After that with the left cursor the lower limit and with the right cursor the upper boundary of the signal may be selected. Using the center cursor, the center frequency may be more precisely set. **The accurate adjustment of the center frequency is very important and directly influences the performance of the decoding.**

To ensure, that the system can handle drifting signals or a coarsely adjusted center frequency, **AFC** may be enabled in the **Demodulator** menu. The carrier tracking function is now activated. If the deviation between the tracked and the adjusted center frequency is too large, the center frequency should be corrected. Carrier tracking only works over a range of:

- DBPSK center frequency ± 8 Hz
- DQPSK center frequency ± 4 Hz

Hence adjustment of the center frequency must be accurate.

The tuning display indicates if a DBPSK or a DQPSK signal is being received. Two bars mean DBPSK, four bars DQPSK. The demodulator must be adjusted accordingly.

Polarity of PSK-31

If a LSB signal is received using the receivers USB position or vice versa, the phase-plane is mirrored on the horizontal axis. For a DBPSK signal this has no effect, because all the phase states are on the horizontal axis itself. For DQPSK however this must be considered by switching the polarity. This can be done in the **Demodulator** menu by toggling **Polarity** or with a double-click on the field on the left side of the status field.

PSK-31-FEC

Parameter	Value
Frequency range	HF
System	PSK, Simplex FEC
Center frequency	
Shift/Bandwidth	160 Hz
Speed	31.25

Modulation	DBPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	3.580 MHz, 7.035 MHz, 14.070 MHz

PSK-31-FEC is a narrow-band amateur mode developed by F6CTE. The aim of this experimental slow mode is to allow “chat ” communication between hams with much less errors than with PSK-31.

The baud rate is fixed at 31.25 Baud. The speed of transmission is about 30 words per minute compared to CW.

Each bit is repeated 13 bits later for forward error correction using the same principle as used in AMTOR FEC or PSK-AM, except that this type of FEC is bit related instead of character related.

To separate the transferred characters, a “011” sequence is inserted between each character guaranteeing separation as long as this sequence does not appear in the character itself.

PSK-31-FEC uses the same varicode alphabet as PSK-10 having a maximum length of seven bits per character.

PSK-63F, PSK-125F, PSK-220F

Parameter	Value
Frequency range	HF
System	Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	62.5, 125 or 220 Baud
Modulation	DBPSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Varicode, 3.580 MHz, 7.035 MHz, 14.070 MHz

PSK-63F and PSK-125F, are very narrow-band and reliable modes. The performance against disturbances is achieved by the use of DPSK modulation.

Compared to PSK-31 an improvement was made, concerning the error rate and ionospheric effects such as doppler, fading and multi-path. The result was a mode, which uses forward error correction (FEC) and also has a higher baud rate.

In contrast to PSK-31, only DBPSK modulation is used. The baud rate is optimized to the data rate, which an operator can input on a keyboard by hand.

To recover bit stream after demodulation, a Viterbi decoder with K = 7 and code rate ½ is used. Because of the use of DBPSK only, the mode is insensitive against a confusion of LSB and USB.

To optimize the data throughput rate of the system, the alphabet uses a variable character length. For frequently used characters a symbol is used, which has a short word length (as is done with the Huffman compression).

Note: In contrast to PSK-31 these modes do not use DQPSK modulation.

Tuning a PSK-63F and PSK-125F Signal

After launching the mode, the first step is to look for a valid PSK-63F or PSK-125F signal in the spectrum. It is possible that within a bandwidth of 4 kHz more than on station is working.

The bandwidth of the spectrum can be switched between 500 Hz, 1000 Hz, 4000 Hz and 24000 Hz. After that with the left cursor the lower limit and with the right cursor the upper boundary of the signal may be selected. Using the center cursor, the center frequency may be more precisely set. **The adjustment precision of the center frequency is very important and directly influences the performance of the decoding.**

To ensure, that the system can handle drifting signals or a coarsely adjusted center frequency, **AFC** may be enabled in the **Demodulator** menu. The carrier tracking function is now activated. If the deviation between the tracked and the adjusted center frequency is too large, the center frequency should be corrected. Carrier tracking only works over a range of DBPSK center frequency ± 8 Hz.

Hence adjustment of the center frequency must be accurate.

In contrast to PSK-31, this mode does not use DQPSK modulation.

RUM-FEC

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	164.5 and 218.3, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	16 Bit redundancy

RUM-FEC operates at speeds of 164.5 and 218.3 Baud on the radio link.

The HNG-FEC and RUM-FEC modes are technically very similar. RUM-FEC alphabet has a codeword length of 16 bits where each of the 32 used bit combinations corresponds to an ITA-2 character.

The RUM-FEC alphabet is designed to obtain a maximum Hamming distance for error detection and has deep interleaving. The actual ITA-2 alphabet is not contained in the code table. As in HNG-FEC error correction is performed by table look-up of the bit pattern (character) closest resembling the character in error.

RUM-FEC has a bit interleaving of 128 bits, each new character starting at intervals of 16 bits. The software synchronizes to traffic as well as idle bit patterns.

Error correction may be enabled or disabled using the **ECC** item in the **Options** menu.

In RUM-FEC mode the signal polarity (sideband) can be manually selected by toggling the **Polarity** item in the **Demodulator** menu. If polarity changes during a transmission, synchronization will not be lost.

SAT-AERO (Beta)

Parameter	Value
Frequency range	L-BAND
System	Forward TDM, packet-mode data
Modulation	600, 1200, 2400 bps ABPSK (SDPSK) 4800, 10500 bps AQPSK (OQPSK)
Receiver settings	
Input	IF-IN-VAR, IF-IN-10.7, IF-IN-21.4

The SAT-AERO system carries digital voice, fax and low speed data. The forward direction channels from Aeronautical (Ground) Earth Stations (GES) to Aircraft Earth Stations (AES) are ABPSK or AQPSK modulated with 600, 1200, 2400, 4800 or 10500 bps.

There exist 4 different channel types: P, R, T and C. The interesting ones are the P (Control) and C (Traffic) channels. At the moment only the P channel can be decoded. 2 possibilities of output formats can be chosen: “All Signaling Units” or “Messages Only”.

With “All Signaling Units” all signaling units are shown except the signaling units containing no data.

With “Messages Only” the embedded packet-mode data is converted to a readable text and is displayed.

As an example the satellite „Atlantic-East“ could be tried with the frequency

1'546.0705MHz, modulation OQPSK and 5’250 baud.

SAT-A-TELEX

Parameter	Value
Frequency range	L-Band/C-Band
System	Signaling/Telex: Duplex FEC/ARQ TDM/TDMA Voice: SCPC
Center frequency	
Shift/Bandwidth	
Speed	Forward NCS, TDM: 1200 Baud MES TDMA: 4800 Baud
Modulation	Forward: BPSK, FM Return: DBPSK, FM
Receiver settings	BW = 5-10 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode

The SAT-A-TELEX system carries telex and analogue voice, fax and modem traffic. The forward direction channels from land earth stations (LES or CES) to mobile earth stations (SES or MES) are 1200 bps TDM differentially encoded BPSK channels. In idle mode all mobile stations listen to the NCS (Network Control Station) common TDM channel, which carries signaling information. When a mobile station identifies its id in a signaling frame it will act on the commands received from the NCS and in case of a channel assignment message being received tune to the assigned transmit-receive frequency pair. The forward telex traffic channel (from the LES) is also a TDM with the same frame structure as the NCS TDM containing 22 timeslots of 50 Baud telex channels. The telex return channel is a TDMA (Time Division Multiple Access) channel. Voice traffic is FM SCPC (Single Channel Per Carrier). Telex channels are assigned by the each CES and voice channels only by the NCS. The system has 323 channels available.

The status lines will display the information carried in the signaling channel as well as the state of the 22 telex channels.

For a NCS the CES ID field will indicate the CES being assigned a channel or time slot when the TDM is transmitting traffic, but will indicate the NCS ID when idle.

WAVECOM software decodes SAT-A signaling and telex traffic.

Use the **ECC** item available from the **Options** menu to enable or disable the error detection and correction. The decoder has the ability to detect two errors and correct one error.

Using the **Options** menu various display formats may be selected:

	Information
Signaling Info	Displays signaling information
Sel. Time Slot	Enables the selection of a particular time slot. The actual selection is done using the menu item Options/Time Slot. When a time slot is selected its number is displayed in the decoder status bar
Raw Bits	Displays a signaling frame in binary format
All Time Slots	Displays the content of all time slots in the format ii m xx n yy, where ii = time slot no., m = status flag for 1st character, xx = hex value of 1st character, n = status flag for 2nd character, and yy = hex value of 2nd character

See "The SAT System (Optional) on page 254".

SAT-B

Parameter	Value
Frequency range	L-Band/C-Band
System	Forward: 6 kbps DPSK, NCS TDM, LES TDM 24 kbps OQPSK, CES Voice, CES Low Speed Data 132 kbps OQPSK, CES High Speed Data Return: 24 kbps OQPSK, Aloha, TDMA, SCPC
Center frequency	
Shift/Bandwidth	

Speed	
Modulation	
Receiver settings	
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode Not available for W51

The SAT-B system carries digital voice, low and high speed data and telex. The forward direction channels from land earth stations (LES or CES) to mobile earth stations (SES or MES) are 6 kBaud, 12 kBaud and 65.1 kBaud TDM or SCPC depending on service.

In idle mode all mobile stations listen to the NCS (Network Control Station) common TDM channel, which carries signaling information. When a mobile station identifies its id in a signaling frame it will act on the commands received from the NCS and in case of a channel assignment message being received tune to the assigned transmit-receive frequency pair. The forward telex traffic channel (from the LES) is also a TDM with the same frame structure as the NCS TDM.

The return channels are all 12 kBaud Aloha for SES requests, call acknowledgements and registration traffic, TDMA for SES response and telex traffic, and SCPC for SES voice, low and high speed data.

WAVECOM software decodes SAT-B fax traffic up to 9.6 kbps and low speed 2.4 kbps asynchronous data. The decoder will automatically adjust to the modulation type in use (BPSK or OQPSK).

All SAT Modes (except SAT-A) store the monitor information in a result file. The list of all result files is displayed in the lower part of the User Interface. The file names are constructed with the Date/Time and possibly additional information.

Options

For the SAT Modes additional parameters can be set in the **Options/SAT Settings** menu. These settings are:

- **Service**: Select the service to monitor. Choose between:

  FAX/DATA/TEL/ISDN/TELX_SM//TELX_MM/All. There are two different possibilities for monitoring telex:

  TELX_SM: Single Message monitoring: only the Telex of the MES found in the Control Channel will be recorded

  TELX_MM: Multi Message monitoring, the Mode stays on the TDM channel until there are no more Telex transmissions on this channel

- **Path server**: Set the Windows directory where the monitor files should be stored
- **Path client**: Currently not used
- **Watchlist**: Click the **All MES IDs** box, if all MESs must be monitored; leave this box empty if only specific MESs should be monitored. Enter these MES IDs into the combo box. If ranges of MES IDs should be monitored, enable each range, and enter it

See "The SAT System (Optional) on page 254".

SAT-C-TDM, SAT-C-TDMA, SAT-C-EGC

Parameter	Value
Frequency range	L-Band (TDM) C-Band (TDMA)
System	Broadcast/Duplex FEC/ARQ TDM/TDMA
Center frequency	
Shift/Bandwidth	
Speed	1200 Baud
Modulation	BPSK
Receiver settings	BW = 5-10 kHz
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode

SAT-C is a satellite based store-and-forward low speed message transmission system operating in the L-band to (forward direction) and from (return direction) the mobile earth stations (MES) and in the C-band to and from the land earth stations (LES) and network control stations (NCS).

Mobile stations may be maritime, land based or aeronautical.

Transmission speed in both directions is 1200 symbols/sec BPSK giving a bit rate of 600 bps. Error protection is done by convolutional encoding with R = 1/2 and k = 7.

A block or frame of data in the forward (TDM) direction comprises 10368 symbols (8.64 s). Data is highly interleaved to combat slow fades. It is also scrambled to ensure an even distribution of logical 1s and 0s for proper bit synchronization. Frame synch is achieved by using an unscrambled unique word at the beginning of the frame.

The coding will correct some errors otherwise ARQ is used.

The forward channels from the LES and NCS are continuous time division multiplex (TDM) channels and are used for message transmission and signaling.

In the return direction messages are transmitted by the MES on time division multiple access (TDMA) channels assigned by the NCS. The frame length varies between 2176 symbols and 10368 symbols in steps of 2048 symbols.

The frequencies for SAT-C must be entered by the user into the 'Translation' field, taking the converter front end specified in the 'Setup/Receiver and Satellite Settings' into account.

Each TDM channel is operated by a LES, while the NCS operates the NCS channel. To find out the frequencies of the TDM channels in each Ocean Region, follow the procedure below.

- Use the NCSC Frequency of your Ocean Region according to the table, and watch the frequencies of the TDM channels given in the Announcements ('Anno') for a period of time

Ocean Region	NCSC Frequency
AOR-W	1537.70 MHz
AOR-E	1541.45 MHz
IOR	1537.10 MHz

POR	1541.45 MHz

- Set any of the frequencies in the 'Translation' field (with correct conversion)

The output window is split as in other SAT Modes. The top window ('Session Window') displays all message packages, in the order they are transmitted. The bottom Window ('Session List Window') shows the generated files of all successfully transmitted messages.

The **Transmitter ID** field is always empty.

Besides TDM channel assignments, the NCSC also transmits so called Group Call Messages (Enhanced Group Calls, EGC), which are not sent to a specific MES, but to groups of MES or to all MES. The name of the result file of such a transmission contains an additional '_e'. For SAT-C-TDMA the file contains an additional '_r' (for return).

SAT-C TDM

In SAT-C TDM the MES ID can have the value 0. This value has 2 different meanings, depending on the channel being decoded:

- On a LES TDM channel, MES ID = 0 means, the MES ID is not known because the message was not correctly terminated
- On a NCS TDM channel, MES ID is **always** = 0, since these messages are all EGC messages

SAT-C TDMA

The MES Id is **always** = 0, because this ID is not transmitted together with the message.

SAT-C-EGC

Introduction

The Inmarsat C maritime mobile satellite system has an inherent capability, known as Enhanced Group Call (EGC), which allows broadcast messages to be made to selected groups of ship stations located anywhere within a satellite's coverage. Four geostationary satellites provide worldwide coverage for these types of broadcasts. Two types of EGC services are available: SafetyNET and FleetNET. FleetNET is a commercial messaging services offered by Inmarsat, and is not recognized by the Global Maritime Distress & Safety System, or GMDSS. SafetyNET, along with NAVTEX, is recognized by the GMDSS as the primary means for disseminating maritime safety information. Ships regulated by the Safety of Life at Sea Convention travelling outside areas covered by NAVTEX must carry an Inmarsat C SafetyNET receiver by 1 February 1999.

SafetyNET Services

Virtually all navigatable waters of the world are covered by Inmarsat satellites. Each satellite transmits EGC traffic on a designated channel at 1.5 GHz. Any ship sailing within the coverage area of an Inmarsat satellite will be able to receive all SafetyNET messages broadcast over this channel by that satellite. All Inmarsat C maritime ship stations can monitor the EGC channel. The EGC channel can also be monitored by dedicated receive-only equipment installed separately or as part of an Inmarsat A station.

The International Maritime Organization has announced that by June 1998, broadcasts of navigational and meteorological information will be made for every NAV/MET Area of the globe. Search and Rescue information is also broadcast in most areas.

Inmarsat C SafetyNET services currently include:

- Urgency messages and navigational warnings to rectangular or circular areas
- Coastal warnings (in place of NAVTEX; used only in Australia)
- Shore-to-ship distress alerts to circular areas
- Search-and-rescue coordination messages to rectangular or circular areas
- Meteorological and navigational warnings and meteorological forecasts to a NAVAREA
- United States SafetyNET broadcasts include:
- NAVAREA IV and XII navigational warning broadcasts from the U.S. National Imagery and Mapping Agency
- NAVAREA IV, XII and XVI meteorological forecasts and warnings from the U.S. National Weather Service
- Distress alerts and search and rescue warnings from the U.S. Coast Guard
- Atlantic ice reports from the International Ice Patrol, U.S. Coast Guard

Ships located outside a circular or rectangular area will not receive a message addressed to these areas, provided the Inmarsat C satellite terminal is connected to a GPS or similar navigational receiver, or the ship's position has been recently updated manually. If the terminal is not connected to a navigational receiver, then it will receive all such messages. Ships will receive all messages addressed to a NAVAREA if the user has entered the NAVAREA number into the terminal.

The printing of messages already received correctly is automatically suppressed.

SafetyNET messages include a special header consisting of five "C" codes:

- C1 - priority code - 1 digit - distress, urgency, safety, routine
- C2 - service code - 2 digits - type of message broadcast
- C3 - address code - 12 characters - area broadcast instructions
- C4 - repetition rate - 2 digits - number and frequency of broadcasts
- C5 - presentation code - 2 digits - type of alphabet used

The National Geospatial-Intelligence Agency (NGA) maintains the SafetyNET Users Handbook on the Inmarsat Homepage, and is available at no charge. The address is http://safety.inmarsat.com/snet.pdf

Receiving Broadcasts

Most Inmarsat C terminals will not receive a safety broadcast if it is transmitting a message, or if it is tuned to an Inmarsat ocean region not used for safety broadcasts in the area travelled. Most SafetyNET messages are rebroadcast after 6 minutes, to give a transmitting terminal time to receive missed messages. Lists of SafetyNET broadcast schedules and areas have been published by the **JOINT WMO/IOC COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY** to assist ship operators tune Inmarsat C terminals to the proper Inmarsat ocean region.

Although reception of SafetyNET traffic is automatic, the shipboard operator must set up the receiver properly at the start of the voyage:

1. Select the appropriate broadcast channel. This can often be accomplished by logging on to a land earth station in the ocean region for which needed broadcasts are made.
2. Select the NAVAREA identification code.
3. If travelling near Australia, select the proper coastal area codes.
4. Ensure the Inmarsat C station is connected to a working navigational receiver. If a connection cannot be made, the ship's position must be manually updated every four hours during the ship's voyage. Without these updates, reams of unnecessary broadcast messages will be received.

Broadcast Channel Information

The modulation rate of the broadcast channel is 1200 bits per second. Forward error correction is applied to this, creating an effective information transfer of 600 bits per second (rate 1/2 convolutional coding with interleaving is used to disperse error bursts which arise when deep fades are present). This ensures that there is a high probability of receiving a message correctly at the first transmission, irrespective of the atmospheric conditions or the ship's position within the satellite coverage.

Inmarsat Utilities

A copy of the latest International SafetyNET Users Manual Issue is available from the Inmarsat Support Page. Click on Tools. The Handbook is located near the bottom of the left hand column.

STATUS OF MARITIME SAFETY INFORMATION BROADCASTS

NAVAREA/	**NAV**	**MET**	**SAR**	**OCEAN REGION**
METAREA	WARNINGS	FORECASTS & WARNINGS	ALERTS	FOR SCHEDULED BROADCASTS
I (UK)	X	X	X	AOR-E
II (France)	X	X	X	AOR-E
III (Spain/Greece)	X	X	X	AOR-E
IV (USA)	X	X	X	AOR-W
V (Brazil)	X	X	X	AOR-E
VI (Argentina)	X	X	X	AOR-W
VII (South Africa)	X	X	X	AOR-E + IOR
VIII (India/Mauritius/La Reunion)	X	X (Note 3)	X	IOR
IX (Pakistan)	X	X	X	IOR
X (Australia)	X	X	X	IOR + POR
XI (Japan/China)	X	X	X	IOR + POR
XII (USA)	X	X	X	POR + AOR-W

XIII (Russian Federation)	X	X (Note 4)		POR
XIV (New Zealand)	X	X	X	POR
XV (Chile)	X	X	X	AOR-W
XVI (Peru/USA)	X	X	X	AOR-W

1. X = Full Service now available.

2. IMO has decided that routine broadcasts of navigational warnings and meteorological forecasts will be made at scheduled times over a single nominated satellite for each

NAVAREA/METAREA. Unscheduled

Options

For the SAT Modes additional parameters can be set in the **Options/SAT Settings** Menu. These Settings are:

- **Path server**: Set the Windows directory where the monitor files should be stored
- **Path client**: Currently not used
- **Watchlist**: Click the **All MES IDs** box, if all MESs must be monitored; leave this box empty if only specific MESs should be monitored. Enter these MES IDs into the combo box. If ranges of MES IDs should be monitored, enable each range, and enter it

See "The SAT System (Optional) on page 254".

SAT-M

Parameter	Value
Frequency range	L-Band/C-Band
System	Forward: 6 kbps DPSK, NCS TDM (LES TDM optional) 8 kbps OQPSK, LES Voice , LES Low Speed Data Return: 3 kbps DPSK, Slotted Aloha, TDMA, 8 kbps OQPSK SCPC
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	
Receiver settings	
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode

The SAT-M system carries digital voice and low speed data. The forward direction channels from land earth stations (LES or CES) to mobile earth stations (SES or MES) are 6 kBaud for NCS and LES TDM and 4 kBaud for LES voice and low speed data.

In idle mode all mobile stations listen to the NCS (Network Control Station) common TDM channel, which carries signaling information. When a mobile station identifies its id in a signaling frame it will act on the commands received from the NCS and in case of a channel assignment message being received tune to the assigned transmit-receive frequency pair. The forward telex traffic channel (from the LES) is also a TDM with the same frame structure as the NCS TDM.

The return channels are 3 kBaud Slotted Aloha for MES requests, call acknowledgements and registration traffic, TDMA for MES response and 4 kBaud OQPSK for MES voice and low speed data.

WAVECOM decodes SAT-M 2.4 kbps fax and data. The decoder will automatically adjust to the modulation type in use (BPSK or OQPSK).

Options

For the SAT Modes additional parameters can be set in the **Options/SAT Settings** Menu. These Settings are:

- **Service**: Select the service to monitor. Choose between:

  FAX/DATA/TEL/All
- **Path server**: set the Windows directory where the monitor files should be stored
- **Path client**: Currently not used
- **Watchlist**': Click the **All MES IDs** box, if all MESs must be monitored; leave this box empty if only specific MESs should be monitored. Enter these MES IDs into the Combo box. If ranges of MES IDs should be monitored, enable each range, and enter it

See "The SAT System (Optional) on page 254".

SAT-MINI-M

Parameter	**Value**
Frequency range	L-Band/C-Band
System	Forward: 6 kbps DPSK, NCS TDM 8 kbps OQPSK, LES Voice SCPC, LES Low Speed Data Return: 3 kbps DPSK, Slotted Aloha, TDMA, 8 kbps OQPSK SCPC
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	
Receiver settings	
Input(s)	IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Optional Mode

The SAT-miniM system carries digital voice and low speed data and fax. The forward direction channels from land earth stations (LES or CES) to mobile earth stations (SES or MES) are 6 kBaud for NCS TDM, 2.8 kBaud for LES voice, low speed data and fax...

In idle mode all mobile stations listen to the NCS (Network Control Station) common TDM channel, which carries signaling information. When a mobile station identifies its id in a signaling frame it will act on the commands received from the NCS and in case of a channel assignment message being received tune to the assigned transmit-receive frequency pair.

The return channel is a 2.8 kBaud TDMA 3 kBaud for all service types.

WAVECOM decodes SAT-M 2.4 kbps fax and data. The decoder will automatically adjust to the modulation type in use (BPSK or OQPSK).

Options

For the SAT Modes additional parameters can be set in the **Options/SAT Settings** Menu. These Settings are:

- **Service**: select the service to monitor. Choose between:

  FAX/DATA/TEL/All

- **Path server**: set the Windows directory where the monitor files should be stored
- **Path client**: Currently not used.
- Watchlist: Click the **All MES IDs** box, if all MESs must be monitored; leave this box empty if only specific MESs should be monitored. Enter these MES IDs into the Combo box. If ranges of MES IDs should be monitored, enable each range, and enter it

See "The SAT System (Optional) on page 254".

SI-ARQ

Parameter	Value
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	96.0, 192.0 and 200.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-3

SI-ARQ operates at speeds of 96, 192 or 200 Baud on the radio link.

SI-ARQ is a simplex system similar to for example SITOR. SI-ARQ therefore also sounds similar to the well-known SITOR system. Because data and pause blocks are longer in duration, the perception of a lower baud rate is created.

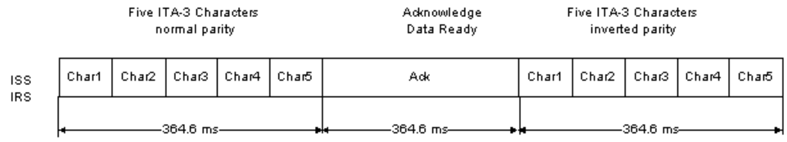
SI-ARQ uses the ITA-3 alphabet for data transmission and error detection. Data blocks usually consist of 5 or 6 characters.

One transmission cycle is made up of twice the length of a character block. If the information sending station (ISS) receives an acknowledgement character, the next data block is sent with inverted phase or polarity. However, if the receiving station (IRS) requests a retransmission, the repeated block is sent with unchanged polarity.

If the ISS does not receive the acknowledgement packet, it transmits a RQ block as is the case with SITOR.

The software automatically detects SI-ARQ block lengths of four, five or six characters and displays this information after phasing has been achieved. The polarity of the signal is automatically detected.

Transmission Sequence of SI-ARQ at 96 Baud with Five Characters



SI-FEC

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	96.0 and 192.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-3

SI-FEC operates at speeds of 96 and 192 Baud on the radio link.

SI-ARQ stations can switch to FEC broadcasting operation in similarity to SITOR-ARQ (Mode A) and SITOR-FEC (Mode B).

The SI-FEC sound is similar to the sound of SITOR-FEC. However, SI-FEC is used very seldom and stations mostly switch to this mode only under extremely poor propagation conditions.

The SI-FEC mode uses the ITA-3 alphabet for data protection. Each character is sent twice, but with a time delay. The repeated character is transmitted with inverted polarity.

For a pair of characters which have been decoded and recognized as error-free one character is displayed. If both characters are received in error the underscore (_) character is displayed.

SI-AUTO

Fully automatic tuning to signal center, shift and transmission modes SI-ARQ (Mode A) and SI-FEC (Mode B) may be achieved by selecting **SI-AUTO** mode.

SITOR-ARQ

Parameter	Value
Frequency range	HF

System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	170 Hz
Speed	100.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

SITOR systems almost exclusively operate at a speed of 100 Baud and with a shift of 170 Hz.

After the receiver has been correctly tuned, the SITOR mode may be started by selecting a baud rate.

Fully automatic tuning to the signal center and shift may be achieved by selecting the **Auto** button.

SITOR-ARQ is a simplex system where both stations transmit alternately on the same frequency.

The CCIR recommendation 476-3 defines a cycle of 450 ms and the two stations are designated as follows:

ISS - information sending station and IRS - information receiving station.

The WAVECOM software always decodes the information of the ISS station.

The SITOR 7 bit alphabet employs a 3:4 mark-space ratio. The ISS transmits blocks of 210 ms duration each containing 21 bits. In turn the IRS transmits acknowledgement bursts with a duration of 70 ms.

If the ISS does not receive an acknowledgement, a block containing the RQ character is sent. In the case of blocks being received in error by the IRS, the last data block sent is repeated.

SITOR-FEC

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	100.0 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

The SITOR-FEC mode is used in broadcast applications where a return channel is not required or unavailable. Two sub-modes are in use: General broadcasting to a number of stations and selective addressing of only one station.

SITOR-FEC transmissions are used in maritime radio communication to distribute traffic lists, news, safety and weather information. Amateurs also use the FEC mode for calls to all (CQ calls).

The selective FEC is used when the receiving station must operate under "radio silence" conditions and hence cannot transmit.

In most cases SITOR-FEC transmissions uses a rate of 100 Baud using the standard shift of 170 Hz.

Each character is transmitted twice with an interval of 35 bits. In the case of error-free reception of both characters, the character is displayed on the screen. The underscore (_) character is displayed if both characters are received in error.

SITOR-AUTO

Fully automatic tuning to signal center, shift and transmission modes SITOR-ARQ (Mode A) and SITOR-FEC (Mode B) may be achieved by selecting **SITOR-AUTO** mode.

SP-14

Parameter	Value
Frequency range	HF
System	Broadcast/Simplex
Center frequency	
Shift/Bandwidth	
Speed	133.3 ms
Modulation	14 tone AM
Receiver settings	AM
Input(s)	AF-IN
Additional Info	14.891 MHz, 14.888 MHz, 15.791 MHz, 16.291 MHz. Requires Professional Version

SP-14 is an AM modulated sequential 14 tone mode, which is optimized for the transmission of numeric codes. The tone separation is 16 Hz. The center frequency is 409 Hz and the bandwidth is approximately 210 Hz. Each tone has been assigned a character:

10 tones are assigned to the numerals 0...9

- One tone is used as a start character
- One tone is used as a stop character
- One tone is used as a space character
- One tone is used as a repetition indicator

A transmission is initiated with a start sequence, which identifies this mode and may be used for accurate tuning. This sequence is transmitted at 1 Baud, which makes it readable even during very unfavorable conditions.

The data proper is transmitted at a rate of 7.5 Baud. A sequence of 19 'P' characters is initially transmitted followed by the five digit code words. The transmission is terminated by transmitting 20 'K' characters. As the transmission rate is very low this mode is insensitive to fading and multipath propagation.

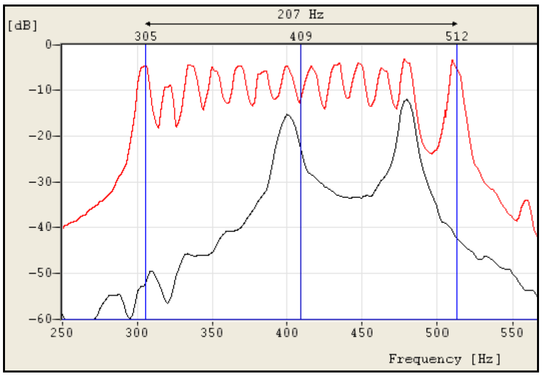
To decode a SP-14 signal it must first be demodulated using an AM demodulator in order to retrieve the MFSK signal. The simplest way is to use the AF output of the receiver and select receiver AM demodulation. If a receiver IF output is used, AM demodulation is not available and decoding becomes difficult. However, using the MFSK demodulator the transmitted symbols may be retrieved. A MFSK IAS using 16 bit over sampling will retrieve symbol clock. In order to process both baud rates used by SP-14, the IAS has to be configured to a baud rate of 15 Baud. Thus at a rate of 1 baud 15 symbols per transmitted symbol, and at 7.5 Baud two symbols per transmitted symbol must be received with a certain tolerance. Even if for instance the same character is received 15 times in succession, error correction is impossible due to the fact that in case of repetition of numerals the numeral itself is followed by the repetition indicator 'R'.

Tuning a SP-14 Signal

Using the WAVECOM decoder as an example the following shows how decoding SP-14 is performed:

After tuning the receiver to the selected frequency and turning AM demodulation on, the receiver AF output (Line Out) is connected to the AF input.

If the receiver has been correctly tuned the following FFT display is shown:



For the FFT, bandwidths of 500 Hz, 1000 Hz, and 4000 Hz may be selected. A bandwidth of 500 Hz will ensure a good quality of signal display, and will also enable a fine tuning of the signal. Then using the display cursors the center frequency of the signal may be determined. All 14 tones, except tone 2 and tone 13 are clearly displayed. The missing tones are the start and stop indicators which are of course only transmitted at the start and the stop of the transmission. It is important to tune to the signal center frequency as accurately as possible, because accuracy of this tuning directly influences the quality of demodulation and the synchronization. In case the receiver AF output is used, the center frequency should be as close to 409 Hz as possible. The value of the center frequency is directly transferred to the decoding software module.

The screen shot below shows a decoded SP-14 signal.

```
648 648 648 1 648 648 648 1 648 648 648 1 648 648 648 1 648 648 648 1 648 648 64
8 1 648 648 648 1 648 648 648 1 648 648 648 1 44PPPPPPPPPPPPPPPPPPP         047
86 00257 63655 15036 24409 46922 29195 44536 23756 88189 19734 13815 05559 15248
 03935 48092 22844 39614 37412 85835 65608 04564 40088 55422 26178 70730 52333 1
6231 51008 48925 72744 421566 05865 47410 47631 36932 83107 77635 05071 68333 10
397 74041 97767 70457 04590 05554 14024 49859 06664 27877 49094 37750 86984 0123
8 81688 92279 08231 09517 67628 69921 70891 01138 12040 61286 08078 51489 06823
98251 40456 04672 81354 84511 06900 89257 94580 62857 78635 99173 42002 87669 15
302 97115 17707 46330 41140 15536 44764 93508 93881 18273 49302 14834 98787 8900
0 22523 06297 11356 67247 17772 60186 26178 10242 14560 40096 57694 80894 64722
36845 88997 12536 92933 71541 88034 68312 18204 50227 94411 12950 60637 73908 32
183 08242 94365 47715 49531 10214 97453 66511 50792 21633 87670 66427 70967 8496
7 54120 56534 18562 82186 54955 21287 62427 08256 38131 59174 59664 53885 68060
42712 83564 96617 02533 87734 72544 74843 96193 67417 07798 32650 20306 18077 05
029 53414 80773 71243 42385 71838 95833 06771 83235 74802 82129 55074 24771 4239
9 55780 00282 88496 01384 38622 03790 55638 82128 41994 23934 13000 99630 60315
79139 94185 42986 67164 49911 88313 90872 66312 30121 86797 97915 54694 00994 13
867 65350 02023 20403 35974 49563 24559 49003 16913 84037 02018 90793 39625 7725
7 29947 18098 80461 97815 32446 97978 99707 14838 20277 28941 45243 95468 25732
62256 38446 75465 05588 73029 97780 97342 40652 78990 64547 59103 45368 77833 02
537 41390 65606 69572 54246 12590 16550 46181 15588 25287 71034 03921 50920 1235
3 64490 03921 50920 12353 64490 KKKKKKKKKKKKKKKKKK P942 47P2 5941648     P  648
 648 1 648 648 648 1 648 648 648 1 648 648
```

SPREAD-11, SPREAD-21 and SPREAD-51

Parameter	Value
Frequency range	HF
System	FSK, Simplex FEC
Center frequency	
Shift/Bandwidth	
Speed	68.5-137 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	10 Bit Bauer Code

The operating menus for the SPREAD-11 and SPREAD-12 are identical to the SPREAD-51 menu and are therefore not treated separately.

SPREAD-51 systems mostly use 102.6 Baud on the radio link - 218 Baud is used more seldom.

Like AUTOSPEC the SPREAD-11, SPREAD-21 and SPREAD-51 modes use the 10 bit Bauer code. For improved reliability in terms of burst errors each character is spread in time (interleaving). After each bit of the 10 bit Bauer code, 50 data bits (alternately 10 or 20) from other characters are sent. New characters start at intervals of 10 bits.

The spreading used in the transmission with 11, 21 or 51 bits significantly improves the data transfer reliability. The probability that two or more bits of the same character will be in error is reduced considerably using such bit spreading.

The software synchronizes with traffic or idle characters and the polarity is automatically recognized. Since the SPREAD modes are designed in such a way that they use the same IDLE character as AUTOSPEC, no clear distinction between SPREAD and AUTOSPEC is possible during idle transmissions. Classification is only possible during actual data transmission.

SSTV

Parameter	Value
Frequency range	HF
System	Graphic Mode, FSK, Broadcast/Simplex
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

SSTV is used to transmit still images over a voice channel. Using a SSB transceiver images may be transmitted world-wide. SSTV is a television standard as the images are scanned row by row and then transmitted at a very low rate hence the designation Slow Scan TeleVision. SSTV is normally used by radio amateurs.

SSTV transmissions come in a variety of modes. The picture resolution varies from 120 x 120 and a transmission time of 8 seconds to 640 x 480 with a transmission time of over seven minutes. Some transmissions are black-and-white only, and others are in color using either R-G-B or Y-U-V color coding.

On the air, the most common modes are the Scottie and Martin modes.

The WAVECOM SSTV decoder can decode a variety of modes: Martin 1-4, Scottie 1-4, SC-1 modes, SC-2 modes and B/W Robot modes. These modes can be detected automatically. Modes that use Y-U-V color coding are not supported.

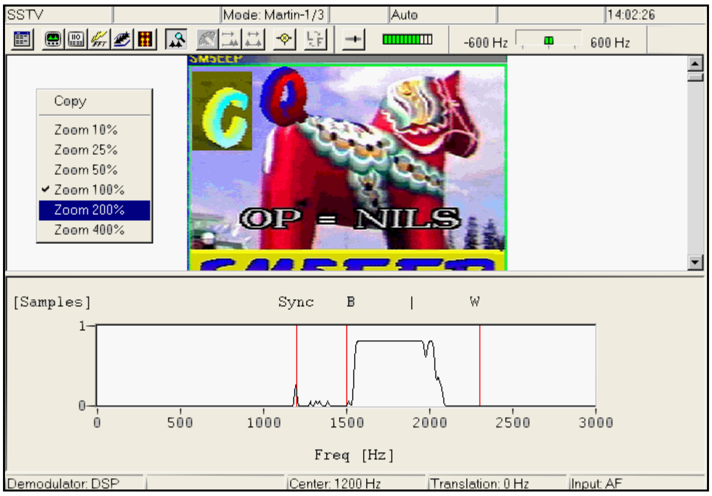
Use the **Auto** button to select automatic mode or alternatively select a specific **SSTV Mode** in the **Options** menu. If a specific mode is selected, the system will not change mode if a SSTV signal of a different mode is detected.

If **Free Run** in the **Options** menu is selected, an image line will be displayed even if no valid Horizontal Sync (i.e. start of a new line) is detected. When **Free Run** is selected, the decoder does not adjust the picture timings to match the received signal. To manually correct the horizontal timing one uses the **Alignment** option. When the alignment is correct, the picture will be received vertically. One would normally only use **Free Run** mode if the signal is very noisy and the system cannot detect the sync pulses itself or if the picture is very wavy.

Click and drag on the image with the left mouse button to select a portion of the image. The selected portion is displayed in reverse colors. Right-clicking on the picture will bring up a popup menu. To copy the highlighted portion of the image, use the **Copy** item in the popup menu. This copy can be pasted into any graphics application (e.g. WINDOWS Paint), and then stored as an image file using the application.

The popup menu also includes **zoom** options. Different zoom settings from 10% to 400% are available.

For the proper functioning of SSTV, the receiver must be correctly tuned. To assist in tuning, the SSTV display includes a frequency spectrum in the lower window. When correctly tuned, one should see a frequency spike around the sync frequency, and a wide band of frequencies between the black and white frequencies. To visually aid tuning, markers are displayed at the **Sync**, **B**lack and **W**hite frequencies.



SSTV Standards for Synchronization

Parameter	Value
Synch Tone	1200 Hz
Black Tone	1500 Hz
White Tone	2300 Hz
Picture Synch	30 ms
Line Synch	5 ms

SSTV Modes

Mode		Type	Time [s]	Resolution [Pixel x Line]	Notes
Martin	M1	RGB	114	320 x 256	a
	M2	RGB	58	160 x 256	a
	M3	RGB	57	320 x 128	b
	M4	RGB	29	160 x 128	b
Scottie	S1	RGB	110	320 x 256	
	S2	RGB	71	320 x 128	
	S3	RGB	55	320 x 128	
	S4	RGB	36	160 x 128	
	DX	RGB	269	320 x 256	*
Robot	8	B/W	8	160 x 120	c
	12	B/W	12	320 x 120	
	24	B/W	24	320 x 240	
	36	B/W	36	320 x 240	
	12	YUV	12	160 x 120	*
	24	YUV	24	320 x 120	*
	36	YUV	36	320 x 240	*
	72	YUV	72	320 x 240	*

B/W Mode	SC-1 8	B/W	8	128 x 128	
	SC-1 16	B/W	16	256 x 128	
	SC-1 32	B/W	32	256 x 256	
Wraase	SC-1 24	RGB	24	128 x 128	b
	SC-1 48	RGB	48	256 x 128	a
	SC-1 96	RGB	96	256 x 256	a
	SC-2 30	RGB	30	256 x 128	
	SC-2 60	RGB	60	256 x 256	
	SC-2 120	RGB	120	512 x 256	
	SC-2 180	RGB	180	512 x 256	
Scanmate	1	RGB	391	310 x 512	*
	2	RGB	261	310 x 512	*
	DX	RGB	269	256 x 256	*
AVT	24	RGB	24	128 x 128	*, d
	90	RGB	90	320 x 240	*, d
	94	RGB	94	320 x 200	*, d
	188	RGB	188	400 x 320	*, d

Notes:

* Not implemented

a Top 16 lines gray scale

b Top 8 lines gray scale

c Similar to original SSTV

d No horizontal sync (start of a new line)

STANAG 4285

Parameter	**Value**
Frequency range	HF
System	PSK, Broadcast/Simplex FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	2400 Baud
Modulation	8-PSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

STANAG 4285 is specified by the NATO (North Atlantic Treaty Organization) Military Agency for Standardization in "Characteristics of 1200 / 2400 / 3600 Bits per Second Single Tone Modulators / Demodulators for HF Radio Links" (16. February 1989).

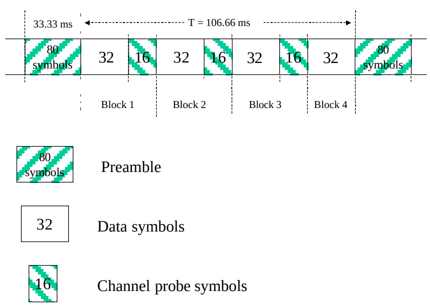
The modulation technique used in this mode consists of phase shift keying (8-PSK) of a single tone sub-carrier of 1800 Hz. The modulation speed (symbol rate) is always 2400 baud.

Using different M-PSK modulations and FEC (Forward Error Correction) coding rates, serial binary user information (raw data) accepted at the line side input can be transmitted at different user data rates.

STANAG 4285 single tone waveform has the following characteristics which may be selected from **Options/Frame Format...**:

Baud Rate	**User data rate (bps)**	**User data rate (bps)**	**FEC coding rate**	**Interleaver**	**No. of unknown 8-phase symbols (User Data)**	**No. of known 8-phase symbols (Channel Probe)**
2400	2400	3 (8-PSK)	2 / 3	SHORT or LONG	32	16
2400	1200	2 (QPSK)	1 / 2	SHORT or LONG	32	16
2400	600	1 (BPSK)	1 / 2	SHORT or LONG	32	16
2400	300	1 (BPSK)	1 / 4	SHORT or LONG	32	16
2400	150	1 (BPSK)	1 / 8	SHORT or LONG	32	16
2400	75	1 (BPSK)	1 / 16	SHORT or LONG	32	16
2400	3600	3 (8-PSK)	No coding	ZERO	32	16
2400	2400	2 (QPSK)	No coding	ZERO	32	16
2400	1200	1 (BPSK)	No coding	ZERO	32	16

The user data is transmitted using a continuous frame structure. Each frame begins with a 33.33 ms preamble containing 80 symbols, the next 176 symbols are divided into four 32-symbol data segments and three 16-symbol channel probe segments.



At the end of transmission, a certain bit-pattern (in hexadecimal numbers, 4B65A5B2, MSB first) is sent to mark the end of message (EOM). The EOM sequence is followed by flush bits, which are for FEC coder flushing and for the complete transmission of the remainder of the interleaver data block.

In most cases FEC and interleaver are used to combat the effects of fading, frequency shift, multipath effects and burst noise. User data is in this case first FEC encoded, interleaved, then mapped into PSK symbol and transmitted in 32-symbol data segment. The 16-symbol channel segment transmitted between every data segment has a known PSK pattern. Its purpose is to keep the demodulator, mainly the equalizer, on track in spite of adverse propagation conditions during the HF transmission.

After the 176-symbol data-probe segment another frame beginning with the same 80-symbol preamble follows immediately. This frame structure makes the synchronization of the demodulator in the mid of the transmission very easy.

The STANAG-4285 decoder processes all the above configurations. This should be set manually in the **Frame Format** menu.

Generally STANAG-4285 transmits the user data in binary mode, i.e. it does not care what type of binary data is transmitted. This should be defined by the higher layer using the STANAG 4285 mode. For this reason the decoder displays the user data in **HEX**, **ASCII ASYNC**, **ASCII ASYNC** (7 Data bits and No Stop bit) or **ASCII SYNC** format selected from **Options/Message Type...**. The decoder stops displaying data after the EOM bit pattern is received.

In the HEX display mode, the decoded binary data is just display as it is, MSB first.

In ASCII ASYNC mode, the bit stream is searched with ASCII ASYNC structure, i.e. one start-bit (0), 8 data-bits and at least one stop-bit (1). The 8 data-bits are LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received or if the asynchronous data structure is violated more than 80 times.

In ASCII ASYNC (7 Data bits and No Stop bit) mode, the bit stream is searched with another ASYNC structure, i.e. one start-bit (0), 7 data-bits. The 7 data-bits are LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received.

In ASCII SYNC mode, each 8 bits (LSB first) represent one ASCII character. The display will stop if the EOM pattern is received or if more than 20 NULL characters are received.

Tuning the decoder

The mode decoder can process signal in both SSB settings: USB and LSB. This can be set by toggling the **Polarity** field: NOR means USB and INV means LSB signal.

The center frequency of the decoder should be set to 1800 Hz when the receiver is correctly tuned to the sending station. Small frequency deviations are automatically tracked and compensated during the decoding. The center frequency of the decoder can be adjusted to ± 400 Hz from its normal setting. By using the bar-graph, any remaining frequency difference can be compensated for by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

Using the Frame Format field the decoder can be set to one of the signal configurations. When the Confidence value is greater than 95 (i.e. 95% correct) in a stable state, the Frame Format is correct.

STANAG 4415

Parameter	Value
Frequency range	HF
System	PSK, Broadcast/Simplex FEC

Center frequency	1800 Hz
Shift/Bandwidth	
Speed	2400.0 Baud
Modulation	8-PSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	16 Bit redundancy Requires Professional Version

The NATO robust, non-hopping, serial (single-tone) mode with tone excision – also known as STANAG 4415 – transmits user data at the 75 bits per second (bps) over severely degraded HF channel with severe Doppler spreads and large multipath spread.

The on-air waveform specified in this mode is identical to the 75 bps waveform of the MIL-188-110A serial mode. The modulation uses 8-ary phase-shift-keying (PSK) on a single carrier frequency (1800 Hz). Serial binary information (raw data), accepted at the line-side input, is converted into a single 8-ary PSK-modulated output carrier at a symbol rate of 2400 baud.

Each data transmission consists of four distinct phases: the synchronization preamble phase, the data phase, the End of Message (EOM) phase and the coder-interleaver flush phase.

The preamble phase lasts for 0.6 second for Zero or Short interleaver setting and 4.8 second when the interleaver size is Long. This is followed by the data phase, which consists of an unlimited number of interleaver blocks. The raw user data, accepted at 75 bps, is first FEC (Forward Error Correction) encoded. Then the bit-stream is put through an interleaver of 10*9 = 90-bit size for Short interleaver or 20*36 = 720-bit size for Long interleaver. Zero interleaver setting will not be selected usually, because through interleaving the effect of short term fading and burst noise can be mitigated.

The coding rate of FEC is 1/2, i.e. after encoding the data rate is 150 bps. Each two bits are then mapped to a 32-bit Walsh sequence, thus giving the 75*32 = 2400 baud symbol rate.

At the end of transmission, a certain bit pattern (in hexadecimal number, 4B65A5B2, MSB first) is sent to mark the end of message (EOM). The EOM sequence is followed by the flush bits, which are for FEC coder flushing and for the complete transmission of the remainder of the interleaver matrix data block. Therefore both the EOM sequence and the flush bit are treated as normal user data bit and put through the last interleaver block.

- Preamble (0.6 s or 4.8 s)
- Interleaver 1
- Interleaver 2
- ... ...
- Interleaver N (including EOM & flush bits)

Besides the FEC and interleaver used in the mode, a special component – the Tone Excision module – is used to pre-process the waveform, so that the more stringent decoding performance can be reached than in the MIL-188-110A mode, even through a severely degraded HF radio link. The Tone Excision module mainly eliminates interfering tones adaptively, which may occur during the transmission.

As in the MIL-199-110A mode, the raw user data transmitted by the NATO Robust mode is just binary. Therefore the NATO Robust decoder displays the user data in HEX, ASCII SYNC and two ASCII ASYNC formats selected from Options/Message Type.... The decoder stops the display after the EOM bit pattern is received and goes to the SYNC status for preamble hunting.

In the HEX display mode, the decoded binary data is just displayed as it is (MSB first).

In the ASCII SYNC mode, each 8 bits (LSB first) represent one ASCII character. The display will stop if the EOM pattern is received or if more than 20 NULL characters are received.

There are two ASCII ASYNC display modes. In the first format (named just as ASCII ASYNC) the 8 data-bits are led by one start-bit (0) and closed by at least one stop-bit (1). The 8 data bits (LSB first) form an ASCII character. The second format (ASCII ASYNC, 7 Data bit, 0 Stop Bit) displays a 7-bit ASCII character (LSB first) which is lead by one start bit (0). There is no stop bit in this format. In both modes the decoder will stop displaying, in addition to upon receiving the EOM pattern, when more than 300 NULL characters are received or when the async data structure is violated more than 80 times.

Tuning the decoder

The decoder processes signal in both SSB settings: USB and LSB. This can be selected with the Polarity in the menu: NOR means USB and INV means LSB signal.

The center frequency of the decoder should be set to 1800 Hz when the receiver is correctly tuned to the sending station. Small frequency variations are automatically tracked and compensated for in the decoder. The center frequency of the decoder can be adjusted to ± 400 Hz from its normal setting. By using the bar-graph, any remaining frequency difference can be compensated for by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

Related mode

MIL-188-110A

STANAG 4481 FSK

Parameter	Value
Frequency range	HF
System	FSK, Broadcast/Simplex FEC
Baud rate	75, 100, 150, 300, 600 Baud
Modulation	FSK
Receiver settings	CW, USB, LSB
Signal source(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

STANAG 4481 is a synchronous FSK mode, which uses KG-84 encryption for communication. It is commonly found in the HF band. A number of communication parameter settings are possible, but 75 Baud and a shift of 850 Hz are widely used.

The KG-84 bit stream contains a 64 bits long header followed by two 256 bits message blocks followed by encrypted data terminated by End-Of-Message. Hence synchronization can be only achieved at the start of transmission using the KG-84 header.

The length of a message is variable. Messages are usually sent consecutively with a short idle sequence between each message.

STANAG 4481 PSK

Parameter	Value
Frequency range	HF
System	PSK, Broadcast/Simplex FEC
Baud rate	2400 Baud
Modulation	BPSK
Receiver settings	USB, LSB
Signal source(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4

This STANAG mode is specified by the NATO (North Atlantic Treaty Organization) Military Agency for Standardization as a "Minimum technical equipment standards for naval HF shore-to-ship broadcast system".

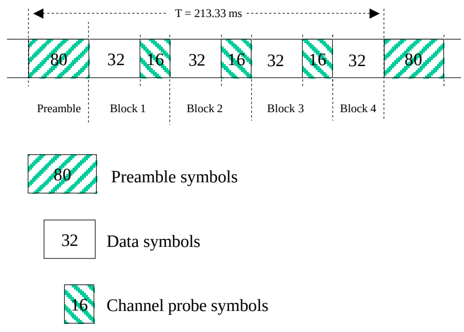
The modulation technique used in this mode is based on the operating conditions encountered by naval broadcasts.

The technology utilizes binary phase shift keying (BPSK) of a single tone 1800 Hz sub-carrier with a constant modulation speed of 2400 baud. Through the use of BPSK modulation and a FEC coding rate of 1/4, the effective user data rate is 300 bps.

Baud Rate	User data rate (bps)	Bits per symbol (M-PSK)	FEC coding rate	Interleaver
2400	300	1 (BPSK)	1 / 4	long

The user data is transmitted using a continuous frame structure with 213.33 ms per frame. Each frame starts with a preamble containing 80 symbols. The following 176 symbols are divided into four 32-symbol data segments and three 16-symbol channel probe segments.

The 176-symbol data-probe segment immediately follows the next frame, beginning with the same 80-symbol preamble. This repeated frame structure enables synchronization of the demodulator at any time of transmission.



At the end of transmission, an EOM bit-pattern (0x4B65A5B2, MSB first) is sent to mark the end of message. The EOM sequence is followed by flush bits, to flush the FEC coder and to complete the transmission of the remainder of the interleaver data block.

FEC and interleaving is used to combat the effects of fading, Doppler spread, multipath and burst noise. User data is first FEC encoded, interleaved, then mapped into BPSK symbols and transmitted in 32-symbol data segments. The 16-symbol channel probe segment transmitted between each succeeding data segment has a known PSK pattern. Its purpose is to keep the demodulator, mainly the equalizer, on track in spite of adverse propagation conditions during the HF transmission.

This STANAG mode is either used to transmit data in binary mode, where it does not care what type of binary data is transmitted, or as ASCII text. For this reason the decoder displays the user data in **HEX**, **ASCII ASYNC**, **ASCII ASYNC (7 Data bits and No Stop bit)** or **ASCII SYNC** format selected from **Options/Message Type...**. The decoder stops traffic after the EOM bit pattern is received.

In the HEX display mode, the decoded binary data is displayed as hex values, MSB first.

In ASCII ASYNC mode, the bit stream is correlated with an ASCII ASYNC structure, i.e. one start-bit (0), 8 data-bits and at least one stop-bit (1). The 8 data bits are displayed LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received or if the asynchronous data structure is violated more than 80 times.

In ASCII ASYNC (7 data bits and no stop bit) mode, the bit stream is correlated with another ASYNC structure, i.e. one start bit (0) and 7 data bits. The 7 data bits are displayed LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received.

In ASCII SYNC mode, each 8 bits (LSB first) represent one ASCII character. The display will stop when either the EOM pattern was recognized or more than 20 NULL characters have been received.

Tuning the decoder

The decoder can process signals in both SSB settings: USB and LSB. The sideband is selected by toggling the **Polarity** field of the display: NOR means USB and INV means LSB.

The center frequency of the decoder is set to the default value of 1800 Hz, but can be adjusted within a range from 800Hz to 2400Hz. Small frequency deviations are automatically tracked and compensated during the decoding. By using the bar graph, any remaining frequency difference can be compensated by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

In the Confidence field, the quality of decoding can be observed. A well recognized stream is determined by a confidence value being stable and greater than 95 (i.e. 95% of the message is correct).

STANAG 4529

Parameter	Value
Frequency range	HF
System	PSK, Broadcast/Simplex FEC
Center frequency	1800 Hz
Shift/Bandwidth	
Speed	1200.0 Baud
Modulation	8-PSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	16 Bit redundancy

STANAG 4529 is specified by the NATO (North Atlantic Treaty Organization) Military Agency for Standardization in "Characteristics of Single Tone Modulators / Demodulators for Maritime HF Radio Links with 1240Hz Bandwidth" (14. December 1995).

The modulation technique used in this mode consists of phase shift keying (8-PSK) of a single tone sub-carrier that is selectable in 100Hz steps from 800Hz to 2400 Hz, with a default value of 1700 Hz.

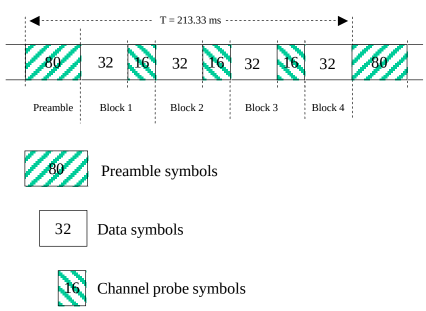
The modulation speed (symbol rate) is always 1200 baud. Through the use of different M-PSK modulation formats and FEC (Forward Error Correction) coding rates, serial binary user information (raw data) accepted at the line side input can be transmitted at different user data rates.

STANAG 4529 single tone waveform has the following format characteristics which may be selected from Options/Frame Format...:

Baud Rate	User data rate (bps)	Bits per symbol (M-PSK)	FEC coding rate	Interleaver
1200	1200	3 (8-PSK)	2 / 3	SHORT or LONG
1200	600	2 (QPSK)	1 / 2	SHORT or LONG
1200	300	1 (BPSK)	1 / 2	SHORT or LONG
1200	150	1 (BPSK)	1 / 4	SHORT or LONG
1200	75	1 (BPSK)	1 / 8	SHORT or LONG
1200	1800	3 (8-PSK)	uncoded	ZERO
1200	1200	2 (QPSK)	uncoded	ZERO
1200	600	1 (BPSK)	uncoded	ZERO

The user data is transmitted using a continuous frame structure with 213.33 ms per frame. Each frame starts with a preamble containing 80 symbols. The following 176 symbols are divided into four 32-symbol data segments and three 16-symbol channel probe segments.

The 176-symbol data-probe segment immediately follows a next frame beginning with the same 80-symbol preamble. This repeated frame structure allows synchronization of the demodulator at any time of transmission.



At the end of transmission, an EOM bit-pattern (4B65A5B2, in hexadecimal number, MSB first) is sent to mark the end of message. The EOM sequence is followed by flush bits, to flush the FEC coder and to complete the transmission of the remainder of the interleaver data block.

In most cases FEC and interleaving is used to combat the effects of fading, frequency shift, multipath and burst noise. User data is in this case first FEC encoded, interleaved, then mapped into PSK symbols and transmitted in 32-symbol data segments. The 16-symbol channel probe segment transmitted between each succeeding data segments has a known PSK pattern. Its purpose is to keep the demodulator, mainly the equalizer, on track in spite of adverse propagation conditions during the HF transmission.

Generally STANAG 4529 transmits the user data in binary mode, i.e. it does not care what type of binary data is transmitted. This should be defined by the higher layer using the STANAG 4529 mode. For this reason the decoder displays the user data in HEX, ASCII ASYNC, ASCII ASYNC (7 Data bits and No Stop bit) or ASCII SYNC format selected from Options/Message Type.... The decoder stops displaying data after the EOM bit pattern is received.

In the HEX display mode, the decoded binary data is just displayed as it is, MSB first.

In ASCII ASYNC mode, the bit stream is correlated with an ASCII ASYNC structure, i.e. one start-bit (0), 8 data-bits and at least one stop-bit (1). The 8 data bits are displayed LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received or if the asynchronous data structure is violated more than 80 times.

In ASCII ASYNC (7 data bits and no stop bit) mode, the bit stream is correlated with another ASYNC structure, i.e. one start bit (0) and 7 data bits. The 7 data bits are displayed LSB first. In addition to the EOM pattern, the display will stop if more than 300 NULL characters are received.

In ASCII SYNC mode, each 8 bits (LSB first) represent one ASCII character. The display will stop if the EOM pattern is received or if more than 20 NULL characters are received.

Tuning the decoder

The decoder can process signals in both SSB settings: USB and LSB. The sideband is selected by toggling the polarity field of the display: NOR means USB and INV means LSB.

The center frequency of the decoder is set to the default value of 1700 Hz, but can be adjusted within a range from 800Hz to 2400Hz. Small frequency deviations are automatically tracked and compensated during the decoding. By using the bar graph, any remaining frequency difference can be compensated by fine-tuning of the receiver frequency or by adjusting the center frequency of the decoder.

Using the **Frame Format** field, the decoder can be set to one of the above listed user data configurations. A correct coded frame format is determined by a confidence value being stable and greater than 95 (i.e. 95% correct), while for uncoded formats the value has no further meaning and remains stable at 75.

STANAG 4539

See “MIL-188-110B (Appendix C), STANAG 4539 on page 170”.

Requires Professional Version.

STANAG 5065 FSK

Parameter	Value
Frequency range	VLF

System	FSK
Center frequency	975 Hz
Shift	85, 850 Hz
Speed	50, 75, 100 or 150 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	Async FSK only

STANAG 5065 is a asynchronous FSK system and was developed to provide NATO countries with interoperable shore-to-ship broadcast communications using the low frequency (LF) band (specifically 60 kHz-160 kHz).

For STANAG 5065 FSK mode standard baud rates from 50 to 150 Baud are available. Non-standard baud rates may be selected using the **Baudrate** menu item.

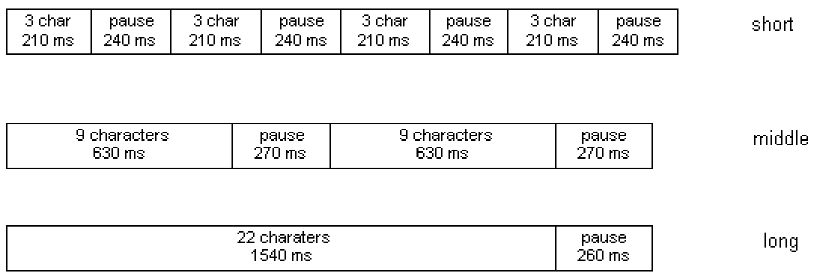
From **Options/Display…** ASCII and BAUDOT are as output format available.

SWED-ARQ

Parameter	**Value**
Frequency range	HF
System	FSK, Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100 Baud, variable 30-650 Baud
Modulation	FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	SITOR Alphabet

SWED-ARQ is an adaptive telegraphy system which operates at a rate of 100 Baud.

Three different block lengths are used in SWED-ARQ. The short block containing three characters is essentially the same as the SITOR-ARQ mode. If favorable propagation conditions prevail the system will switch to medium block length (9 characters) or to long blocks (22 characters). In case of interference the block length is automatically reduced. The block length is displayed on the status line as either short, middle or long. Longer block lengths effectively increase the data transfer rate. The equivalent Baudot rates are 75 and 100 Baud for medium and long block lengths respectively.



The illustration depicts the protocol of data transmission for the SHORT, MEDIUM and LONG block types.

Given this timing scheme, the two stations can maintain the data link even after losing block length synchronization by re-transmitting the change-over commands. These consist of the IDLE A, IDLE B and other characters but are always three characters long.

In some RQ-cycles, SWED-ARQ makes use of bit center keying and maintains a request counter of cycles deviating from the 3:4 mark-space ratio.

The SWED-ARQ mode may be started by selecting a baud rate. If the transmission channel is subject to very strong interference, the block length change-over might be lost. By reselecting the baud rate, re-synchronization may be reestablished.

When phasing the software automatically recognizes block length and polarity.

TWINPLEX

Parameter	Value
Frequency range	HF
System	Simplex ARQ
Center frequency	
Shift/Bandwidth	
Speed	100 Baud, variable 30-650 Baud
Modulation	4FSK
Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	SITOR Alphabet

TWINPLEX (F7B) is a FSK modulation technique with four modulation frequencies. Two transmission channels V1 and V2 are obtained through a combination of the modulation frequencies.

SITOR-TWINPLEX systems employ the second channel to double the data transmission rate from the equivalent of 50 Baud to 100 Baud. The V1 and V2 channels each contain 3 telegraph characters from the SITOR alphabet.

Twinplex transmissions can have widely varying shifts. Seven standard combinations are available from the Shift item of the Demodulator menu:

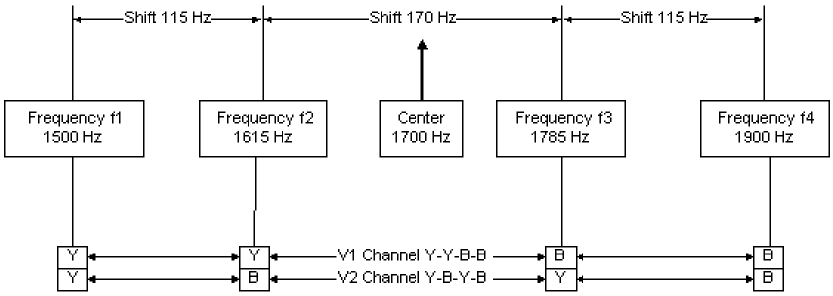
- 100-100-100 Hz
- 200-400-200 Hz
- 170-170-170 Hz
- 115-170-115 Hz
- 200-200-200 Hz
- 115-170-515 Hz
- 65-170-65 Hz

In addition, any desired combination may be programmed.

In addition to shift variations, Twinplex systems may utilize very different keying assignments. On the V1 and V2 channel the software allows the selection of Y-Y-B-B, Y-B-Y-B, B-Y-Y-B, B-Y-B-Y, Y-B-B-Y settings via the Y-B V1 Channel item in the Options menu. In the Y-B V2 Channel menu one of four combinations is selectable.

Most Twinplex stations work with the V1 combination of Y-Y-B-B and Y-B-Y-B (or B-Y-B-Y) in the V2 channel. Transmissions with a B-Y-B-Y combination in V1 and Y-B-B-Y in V2 are however also possible.

TWINPLEX (F7B) Principle of Operation



Measurement and Determination of TWINPLEX Frequency Shifts

Proper tuning is done using the **FSK Analysis**. The frequency shifts may be measured using the cursors.

The effective center frequency is the mid-frequency between the two inner tones f2 and f3. This is also valid in case of asymmetrical shifts, e.g. 115-170-515 Hz.

After the measurements and the determination of the V1 and V2 frequencies, the values found must be set up via the Shift item in the Options menu.

If no standard combination is used, the shift dialog box will allow the entry of any combination.

After the previously described set-up has been completed, the TWINPLEX mode can now be started by selecting 100.0 Baud or a variable baud rate.

The preferred demodulator type is the MFSK mode: Otherwise the DSP mode may be enabled in the Demodulator menu using the Mode item.

The proper assignment of the V1 and V2 keying combinations must now be set-up using the Y-B V1 Channel and Y-B V2 Channel items in the Options menu.

Most stations use the Y-Y-B-B setting for the V1 channel. The second channel frequently uses either the Y-B-Y-B or B-Y-B-Y combination.

If synchronization is not achieved after configuration has been completed, change the V1 and V2 settings until the right combination has been found. For example, transmissions are possible with V1 set to B-Y-B-Y and V2 set to Y-B-B-Y. This combination results in the first three telegraph characters to be transmitted on the V2 channel.

TWINPLEX stations only key the two inner frequencies f2 and f3 during the IDLE state (no traffic) or during the RQ state (incorrect acknowledgement from the remote station). In these states SITOR and TWINPLEX systems cannot be distinguished from each other.

VDEW

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	VDEW
0	2280
1	370
2	450
3	550
4	675
5	825
6	1010
7	1240
8	1520
9	1860
A	2000
B	2100
C	2200
D	2300
E	2400
F	
TONE DURATION	100 ms

WEATHER-FAX

Parameter	Value
Frequency range	HF
System	Graphic Mode, Broadcast
Center frequency	1900 Hz
Shift/Bandwidth	
Speed	60, 90, 120, 180 and 240 RPM, IOC 288 or 576
Modulation	FSK
Receiver settings	FAX, DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	

A number of stations world-wide transmit weather charts on a regular schedule. During the transmission of an image a characteristic and easily recognizable audio signal is heard. A specific frequency deviation may also be seen on a tuning indicator. Most transmitters work with a wide shift (± 400 Hz) and a few with narrow shift (± 150 Hz).

By selecting the **Auto** function, the software waits for the IOC identifier and synchronization sequence. These signals are only transmitted once at the beginning of an image implying that capturing of the signal will only take place at the start of the next image.

By selecting WEATHER-FAX the application starts immediately. The drum speed and the IOC may be entered manually using the **Drum speed** and **IOC** items available from the **Demodulator** menu. The selected values are displayed in the decoder status bar. In the short-wave band, weather charts are transmitted almost exclusively with speeds of 60, 90 or 120 rpm. In the case of 60 rpm the drum rotates once per second, for 90 rpm at one and a half time and for 120 rpm at a speed of twice a second. The index of co-operation (IOC) is readily recognizable from the screen display when images are spread out too wide. An IOC of 576 is mostly used on short-wave.

The decoder allows a continuous and smooth alignment of the image as it is being received from Options/Fine Speed. By using the Phase item in the Options menu the image can be shifted into the correct position. Flip Left-Right and Flip Top-Down will reverse the image or turn it upside down.

To enhance the interpretation of gray-scale images, a false color option is available. Right-click on the image to open the zoom menu and from the bottom part selects a color scheme. A checkmark is placed to the left of the selection.

VISEL

Parameter	Value
Frequency range	HF
System	FSK, Simplex
Center frequency	
Shift/Bandwidth	300 Hz
Speed	81.3, 120.9, 123.5, 125Baud
Modulation	FSK

Receiver settings	DATA, CW, LSB or USB
Input(s)	AF-IN, IF-IN-VAR, IF-IN-10.7 or IF-IN-21.4
Additional Info	ITA-2 Implemented as a Beta Version.

VISEL, also known as FEC-12 or YUG-MIL, is a synchronous system. This mode is used by the military in eastern Europe.

The unusual baudrate of 120.9 baud is very typical for this mode. Synchronization is done at the beginning of every burst transmission. The unencrypted calling setup with tactical call signs has a autocorrelation of 12 bits and all bits are interleaved. All traffic is encrypted. Occasionally op chat in plain text is transmitted.

ZVEI-1

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

For ZVEI modes having nominal tone durations of 70 ms, the duration of a single tone may vary ± 15 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	ZVEI-1
0	2400
1	1060
2	1160
3	1270
4	1400
5	1530
6	1670

7	1830
8	2000
9	2200
A	2800
B	810
C	970
D	886
E	2600
F	
TONE DURATION	70 ms

ZVEI-2

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

For ZVEI modes having nominal tone durations of 70 ms, the duration of a single tone may vary ± 15 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	ZVEI-2
0	2200
1	970
2	1060
3	1160
4	1270
5	1400
6	1530

7	1670
8	1830
9	2000
A	2600
B	2800
C	810
D	886
E	2400
F	
TONE DURATION	70 ms

ZVEI-3

Parameter	Value
Frequency range	VHF/UHF
System	Analog Selcal
Center frequency	
Shift/Bandwidth	
Speed	
Modulation	INDIRECT-FM
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

For ZVEI modes having nominal tone durations of 70 ms, the duration of a single tone may vary ± 15 ms.

Decoding the selective calls is started by clicking on a system. If transmission and system selection conform, the call sign is displayed on the monitor. In the **Options** menu a **Time stamp** function can be enabled to add date and time to each call.

Tone Allocation

DIGIT	ZVEI-3
0	2200
1	970
2	1060
3	1160
4	1270
5	1400

6	1530
7	1670
8	1830
9	2000
A	886
B	810
C	740
D	680
E	2400
F	
TONE DURATION	70 ms

ZVEI-VDEW

Parameter	Value
Frequency range	VHF/UHF
System	Digital Selcal
Center frequency	1500 Hz
Shift/Bandwidth	600 Hz
Speed	1200 Bit/s
Modulation	FFSK
Receiver settings	FM, BW=12 kHz
Input(s)	AF-IN
Additional Info	BCD-Code

The digital selective calling systems ZVEI and VDEW were defined for selective call and data transmission in the non-public mobile land radio service. The ZVEI system adheres to the recommendation AK SRDS 87-3D, while the VDEW system was known as DIN45013 until 1992. The systems are technically identical.

The transmission speed is 1200 bps and the FFSK nominal frequencies are 1200 Hz for logical '1' and 1800 Hz for logical '0'. Indirect modulation (sub carrier) modulation is used. A data packet consists of 64 bits. After a carrier pre-keying, an 8 bit telegram preamble and a 15 Bit Barker sequence follows. Data is protected by using 8 bit redundancy.

Mode labeling (BAK:)

Can assume 16 values for the various call types:

Parameter	Value
0	User defined
1	Call to mobile
2	Call to base station
3	Identification
4	Acknowledgement
5	Sequence telegram
6	Separation call

7	Spare
8	Priority call
9	Status request
10 - 14	Spare
15	Emergency call

Status (STAT:)

4 bits are available. Their use is not determined.

Rhombic labeling (RHOMBUS:)

4 bits used as additional distinction for a producer designation. The use is not determined.

Manufacturer identification (PROD:)

Two digits. The classification is determined by ZVEI.

Call number (Call#:)

Three digits. The hundreds digit is transmitted first, the last transmitted is the ones' digit. Group calls are transmitted as pseudo-tetrads of '1111' (16). For a group call in the 10s range the digit representing 1s is filled with logical '1'. For a group call in the 100s range, the 1s and 10s digit are filled with logical '1' and for a 100s group call all 12 bits are filled with ones.

Additional Functions

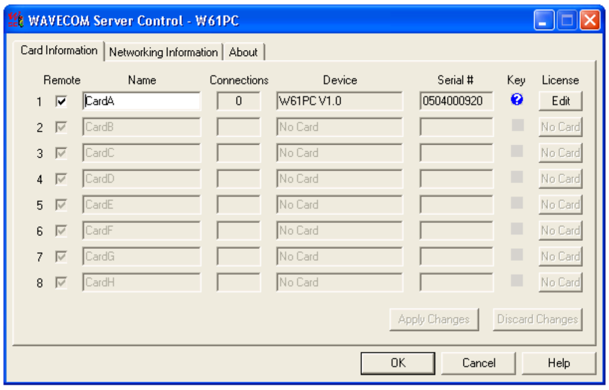
WAVECOM Server

Introduction

The WAVECOM Server and the WAVECOM Server Control applications are used to setup and monitor the connections between decoder cards (clients) and the server. The server is responsible for managing the decoders connected to the computer as well as all the connections made to that decoder. The WAVECOM Server is started by the GUI for a local connection (GUI and card on the same machine) or by the Server Control for a remote connection. The WAVECOM Server is started as a **Service**.

WAVECOM Server Control

The WAVECOM Server and the WAVECOM Server Control applications are used to setup and monitor the connections between decoder cards (clients) and the server. The server is responsible for managing the decoders connected to the computer as well as all the connections made to that decoder. The WAVECOM Server is started by the GUI for a local connection (GUI and card on the same machine) or by the Server Control for a remote connection. The WAVECOM Server is started as a **Service**.



Card Information

Card information is available from the **Card Information** tab:

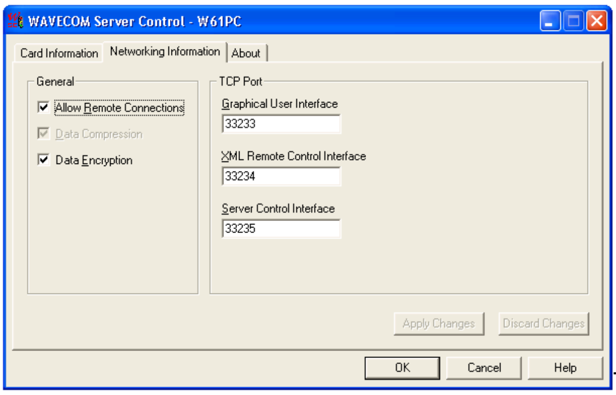
- Card names
- Number of connections to the card, including local and remote connections
- Device name
- Card serial number

Setting Up the Card Names

A maximum of eight cards may be connected to a single computer. Each of these cards has a name associated with it. The card names can be used to establish a connection to a specific card. The default names are "CardA" through "CardH". It is possible to change the card names by:

- Clicking into the name edit field
- Change the name of the card
- Click on the **Apply Changes** button. **Discard Changes** will discard any changes

Networking Information



The following network setup parameters for remote control are available from the **Networking Information** tab:

- **Allow Remote Connections**. Disable this box if you do not allow connections to the decoder cards from another computer
- **Data Compression**. Enable or disable data compression for the data transfer to the remote computer. Data compression

is required if you use a slow remote connection. If your modem is already compressing the data, disable this option

- **Data Encryption**. Enable optional data encryption if a secure connection is required. If the connection is already safe (crypto devices, VPN etc), disable this option
- **TCP Port**. Enter a free TCP port. If the port is already used by another application, change the port number. If you use routers, firewalls etc. check that traffic from the selected port is transferred to the client's location. The default value for the WAVECOM server is 33233. Your client can only connect to the server if it is working on the same port.

In addition to the port number of the GUI, port numbers for the XML Remote Interface and the Server Control Interface may be entered here.

Data Encryption

The WAVECOM user interface is able to communicate with the WAVECOM server application over an encrypted connection. The server has built in cryptographic capability; use the WAVECOM ServerControl application to switch this option on or off.

WAVECOM uses the Crypto++ Library 5.2.1 to encrypt and decrypt the data transfer between client and server. The code of this library is open source and can be found on the following address: http://sourceforge.net/projects/cryptopp/

Crypto++ offers several block and stream ciphers, hash functions and other cryptographic functions. More information about this library is found on http://cryptopp.com/

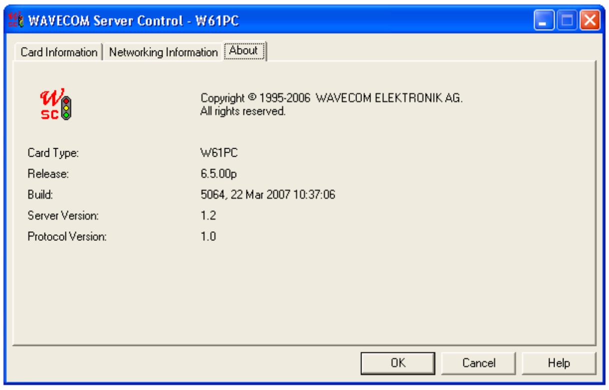
The WAVECOM server application makes use of a block cipher in CBC mode. All data is encrypted and decrypted using the DES-EDE2 algorithm with a key length of 128 bit. During initialization of the encrypted connection, a key is generated using the SHA hash function. The input for the SHA hash function is defined within the WAVECOM software and cannot be changed by the user.

General information about cryptography and other software that is using Crypto++ is listed on this website:

http://www.mobiuslinks.com/links.asp?sid=1

Important: Export of this software from the United States may require a specific license from the United States government. It is the responsibility of any person or organization contemplating export to obtain such a license before exporting. Certain parts of this software may be protected by patents. It is the users' responsibility to obtain the appropriate licenses before using these parts.

About



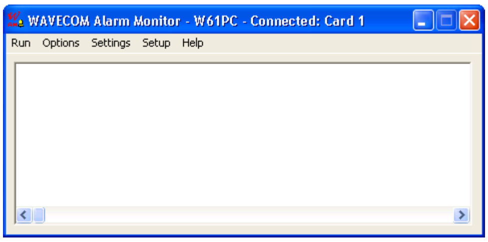
Displays information on software version, build number, and release date for the installed application.

Alarm Monitor

Introduction

The Alarm Monitor is a component of the decoder software. Although it is a separate application, it is only useful when used in conjunction with the WAVECOM software. The Alarm Monitor can monitor all data output from text modes of the WAVECOM decoder, and produce alarms for user configured messages. An alarm produces an alert (with optional audio alert), and logs the message to a file.

The Alarm Monitor can be started directly from the decoder using the **View/WAVECOM Alarm Monitor** menu item.



The Alarm Monitor performs three basic functions:

1. Save text data

   All received text data will be saved in a text file (***.txt**) located anywhere on the network.

2. Save alarm data

   It is possible to set so-called **Alarm strings**. The received text data will be scanned for those strings line by line. When a match is found, the text lines that include at least one alarm string will immediately be saved in a separate text file (***.alm**) located anywhere on the network.

The detected text line will also be presented on the Alarm Monitor display.

If selected an audible alert will be generated.

3. Forwarding of the alarm text

   If enabled each message raising an alarm will be saved in another text file (***.sms**) anywhere on the network. This function allows the message to be forwarded via SMS (Short Message Service). A third party product is required for this option.

The **Setup** menu is used to configure the hardware, and to customize the Alarm Monitor display to your favorite font size and color.

Connect to any decoder on your network.

All settings are automatically saved. The Alarm Monitor will automatically use these settings the next time it is started.

Exception:

The computer name and the card number will be overwritten if you run the Alarm Monitor directly from the WAVECOM decoder GUI. Alarm Monitor also inherits its settings from the decoder.

Setup – W61PC Card

If you plan to connect to a card installed in a PC other than the one on which you have installed Alarm Monitor, Server Control or the WAVECOM software must be running on that PC.

Connect the Alarm Monitor to any WAVECOM card located in any computer on your local network. If you do not connect to a card located in your local PC, enter the name of the remote computer that contains at least one WAVECOM card. Select the card number.

Note:
Connecting to a decoder card on the network may take up to two minutes! The wait cursor will appear while the connection is being made.

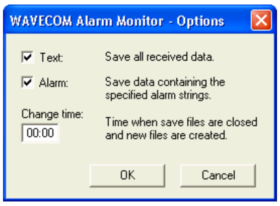
Setup – Font size

The Alarm Monitor will display the text lines with the WAVECOM Unicode font in the selected size.

Use **Color:** to display the background with the selected color.

Options

The **Save** menu is used to configure the file saving options.



Text

If checked, all text data will be saved to a file.

Alarm

If checked, text that contains the specified alarm strings will be saved to a file.

Change time

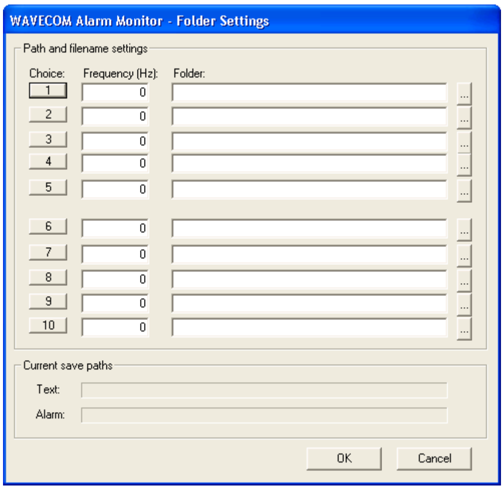
This specifies the time when Alarm Monitor will create new data files for the information being written to files. When new files are created, data will not be lost during the changeover. The old files are closed and stored for later use.

Settings

The **Settings** menu is used to configure the file and folder names, alarm strings and SMS settings.

Settings – Folder

The settings in this dialog box help you archiving the different files. The file name will consist of the date, computer name, card number and frequency of the transmission.



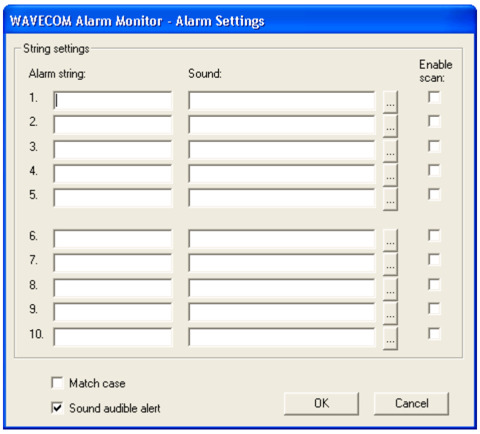
Proceed as follows:

- Enter the frequency to which you have tuned your receiver
- Select a folder using the browse button on the right
- Press the numbered button on the left to see the current save paths at the bottom for that choice

You may set up to ten different path and filename settings. These are used so the user can quickly change the save filenames when changing frequencies. When you change your receiver to another frequency, simply select the correct choice button on the left to use the new filename settings.

Settings – Alarm

Alarm Monitor allows you to scan for up to ten different alarm strings at the same time. You may assign a different audible alert to each alarm string. When Alarm Monitor has detected an alarm string you will hear it immediately.



Proceed as follows:

- Enter an alarm string (max. 50 characters)
- Select a WAV file using the browse button on the right
- Check the **Enable scan** box to enable that alarm string
- Select the **Match case** box if you wish the alarm strings to be case sensitive
- Deselect the **Sound audible alert** box to disable all audible alerts

Note:
Without sound hardware, you can only hear the default beep regardless of the WAV file settings. If you leave the filename blank, or give an incorrect filename, you will hear the default WINDOWS sound.

Remember:

You may record your own WAV files. In this way the computer can play "World Cup" for an alarm.

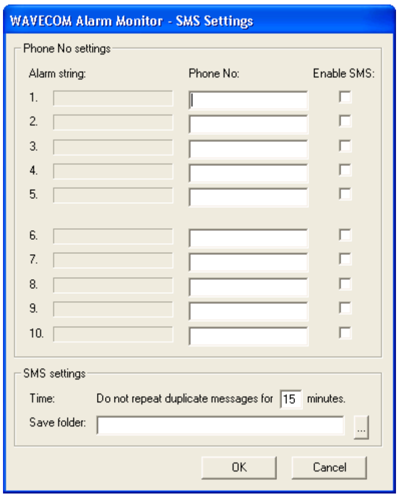
Settings-SMS

The settings in this dialog box are needed to create different files for each message. The filename will consist of the date, time, computer name, card number and phone number.

Example: C:\Temp\19980626_215847_webradio_2_09418727060.sms

The file itself will contain just one text line which includes the detected alarm string.

Pager modes such as POCSAG often transmit duplicate text data lines. To prevent sending duplicate SMS messages, a time delay can be specified. This time delay prevents the identical message from creating a new SMS message file for the duration of the specified delay. The time delay is specified for the contents of the whole message, not the alarm string contained in the message.



Proceed as follows:

- Enter a phone number for the message to be forwarded to
- Check the **Enable SMS** box to enable the forwarding
- Set the SMS time delay (1..59 minutes)
- Select a folder where to store the SMS files using the browse button on the right

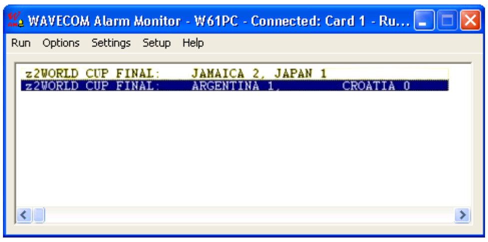
Note: To forward the SMS message files created using these settings requires a third party product.

Run

This menu allows you to start and stop the monitoring of the Alarm Monitor. After connecting to a card, you must press the **Start** menu item to begin monitoring. Before you can select a new card, you must stop Alarm Monitor using the **Stop** menu item.

When Alarm Monitor is active this will be indicated in the title bar as "Running..."

Use the scrollbar to see the whole text line.



Note: The display will only allow the user to go back the latest 1,000 lines of text.

Serial Link

Introduction

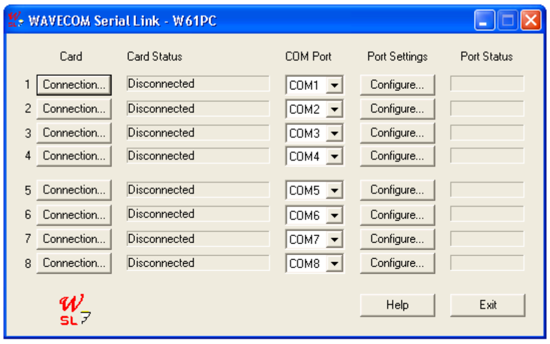
Serial Link is a component of the decoder software. Although it is a separate application, it is only useful when used in conjunction with the WAVECOM decoder software. Serial Link can send all data from text modes of eight decoder cards to eight different COM ports. Each COM port can be configured.

Getting Started

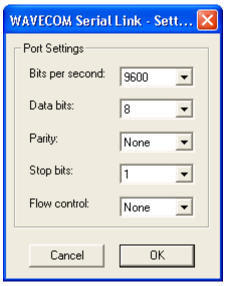
The Serial Link can be started directly from the decoder using the **View/WAVECOM Serial Link** menu item.

If you plan to connect to a card installed in a PC, which is different from the one on which Serial Link is installed, Server Control or the WAVECOM decoder software must be running on that PC.

Select a COM port for each WAVECOM decoder card.



Configure each COM port using the corresponding **Configure** button.



Select the computer on your network that contains the WAVECOM decoder cards.

To connect to a card on your network using Serial Link, click **Connection...** The **W61PC Card** screen appears and you may select **This Computer** or **Remote Computer** entering also the remote computer name.

Connect each card to the selected port using the **Connect** button. The selection will now appear in the Serial Link main screen.

All settings are automatically saved. Serial Link will automatically use these settings the next time it is started.

Status Information

Serial Link displays status information for each card. Status messages could be one of the following:

Comp. Status	Explanation
Connecting...	The Serial Link application (client) is being connected to the selected computer (server)
Connected	The Serial Link application (client) is connected to the selected computer (server)
Disconnecting...	The Serial Link application is being disconnected
Disconnected	The Serial Link application is disconnected

Card Status	Explanation
Initialize...	The card is being initialized. Each card needs to be initialized when a connection is made to that card for the first time
Running	The card is ready and active
Error	A general error occurred and the card is in an error state
Error loader	The software could not be downloaded to the card
Card in use	Another application is accessing the card
No card	A card is not connected at that address
Timeout	A time out error occurred
Err dev driver	A device driver error occurred
Err drv conflict	The device driver is not correctly set up

Port Status	Explanation
Initialize...	The COM port is being initialized
Idle	The COM port is ready, but data is not currently being transmitted
Traffic	Data is being sent to the COM port
Error	A general error occurred and the COM port is in an error state
Timeout	A time out error occurred
No port	The selected COM port is not available or is in use
Overflow	The COM port is congested. Check port settings and increase the baud rate

Remote Control

XML

See separate documentation.

DCOM

See separate documentation.

The SAT System (Optional)

Terms and Abbreviations

Abbreviation	Definition
AMBE	Advanced Multi-Band Excitation speech coding
AOR	Atlantic Ocean Region
APC	Adaptive Predictive Coding
EOD	End-Of-Data
FFT	Fast Fourier Transform
IF	Intermediate Frequency
IMBE	Improved Multi-Band Excitation speech coding
IOR	Indian Ocean Region
LAN	Local Area Network
LES	Land Earth Station
LNA	Low Noise Amplifier
MES	Mobile Earth Station
MPDS	Mobile Packet Data System
NCSC	Network Control Station Channel
PC	Personal Computer
POR	Pacific Ocean Region
PSTN	Public Switched Telephone Network
RHCP	Right Hand Circular Polarization
SNAC	Single Network Access Code
SNR	Signal-to-Noise
SW	Software

Overview

INMARSAT Ltd. is a private company based in London, UK (http://www.inmarsat.com). It evolved from an inter-governmental organization to its current private status in the late 1990s. It operates a number of geostationary satellites covering the entire world (except the polar regions) by global beams, and by spot beams for the more traffic intensive regions.

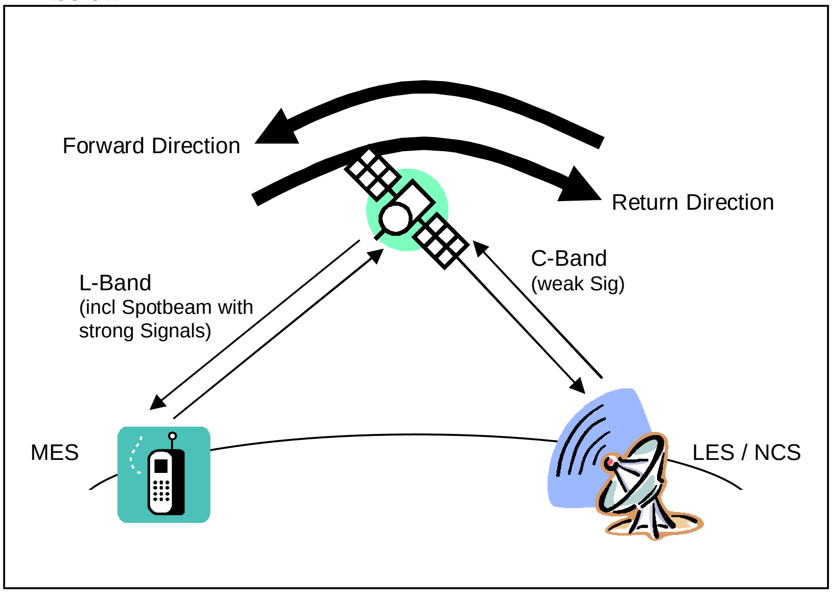
The satellite positions (INMARSAT orbital slots) are listed in the table below.

Region		Orbital Position	Country Code
Atlantic Ocean Region West	AOR-W	54 ° W	+874

Atlantic Ocean Region East	AOR-E	15 ° W	+871
Indian Ocean Region	IOR	64 ° E	+873
Pacific Ocean Region	POR	178 ° E	+872

Remarks:

- INMARSAT also offers the country code 870 as a single country code for all regions (SNAC)
- Each region has a system architecture as depicted in fig. 1 below



- A region is controlled by a Network Control Station, NCS. Its functions are:
    - Operation of the control channels
    - Traffic channel and channel resource allocation
- Each region can have a number of Land Earth Stations, LES. Their functions are
    - Interface to land based networks (PSTN, data networks);
    - Session control
- The user terminal is called a Mobile Earth Station, MES

Systems

New generation of satellites were launched into orbit, while new services were added over time.

Currently the third generation of satellites is in operation (3F), while the next generation (4F) is being deployed.

Operations started 1982 with leased satellite capacity for the INMARSAT A system. The table below shows the evolution of the various Inmarsat systems.

System	Services Offered	Intro-duction	Max User Data Rate (fax, data)
A	Analog voice, G3 fax, telex, data.	1982	3 kHz, 9.6 kbps,

	End of life time.		50 Baud, 56 kbps
Aero-H	Digital voice, fax , data	1990	9.6 kbps
B	Digital voice, G3 Fax, data, telex	1994	9.6 kbps
C	Store-and-forward messaging	1992	600 bps
M	Digital voice, G3/4 fax, data	1993	2.4 kbps
mini-M	Digital voice, G3 fax, data	1996	2.4 kbps
D	Forward paging	1996	20 bps
D+	Paging with return channel	1997	20 bps
E	Emergency position indicating radio beacon (EPIRB). End of life time.	1997	600 bps
mini-M	Digital voice, G3/4 fax, data	1997	2.4 kbps
Aero-I	Digital voice, fax , data	1998	2.4 kbps
M4 (GAN)	Digital voice, G3/4 fax, data, packet data	2000	64 kbps
R-BGAN	Digital voice, G3/4 fax, data, packet data	2003	144 kbps
BGAN	Digital voice, G3/4 fax, data, packet data	2006	492 kbps
Aero-C	For the aeronautical mobile servic-es , adapted from C		
Swift64	For the aeronautical mobile servic-es, adapted from M4		
mini-M Aero	For the aeronautical mobile servic-es, based on mini-M		
F77	For the maritime mobile service, based on M4, approved for GMDSS, operates in global beams (-4 dB/k antenna), options: 2.4 kbps G3 fax, 9.6 kbps G3 fax, 9.6 kbps async data		
F55	For the maritime mobile service, same as F77, but not approved for GMDSS, operates in spot beams (-7 dB/k antenna), except global 4.8 kbps AMBE voice, ISDN bearer services are optional and has no optional 2.4 kbps G3 fax		
F33	For the maritime mobile service, (-12.5 db/k antenna), global 4.8 kbps AMBE voice, optional spot beam 9.6 kbps G3 fax, async data, MPDS		
mini-C	For the land mobile service, as C, not approved for GMDSS, compact all-in-one unit housed in the anten-na		

RF Channels

L-Band Frequency Range

Receive (Satellite – MES)	1525.0 – 1559.0 MHz
Transmit (MES – Satellite)	1626.5 – 1660.5 MHz.

C-Band Frequency Range

Receive (Satellite – NCS/LES)	3600.0 – 3629.0 MHz
Transmit (NCS/LES – Satellite)	6425.0 – 6454.0 MHz

Logical Channels

The logical channels are described in the table below.

Name	Type	Function	Direction
NCS Common	Control	Network Bulletin Board status information	Forward (to MES)
NCS Assignment	Control	Channel assignment	Forward (to MES)
NCS Spot-beam Identification	Control	Spot beam identification for MES	Forward (to MES)
NCS Inter-station	Control	NCS-LES signaling and assignment	Forward (to LES)
NCS Registration Acknowledgement	Control	Registration acknowledgement	Forward (to MES
LES Assignment	Control	Stand-alone or NCS backup assignment	Forward (to MES)
LES Inter-station	Control	LES-NCS signaling	Return (to NCS)
MES Request	Control	Access request channel	Return (to LES, NCS)
MES Response	Control	Signaling response channel	Return (to NCS)
MES Registration	Control	Initial registration	Return (to LES, NCS)
MES Call Acknowledgement	Control	Call acknowledgement	Return (to LES)
SCPC channel	User traffic	Circuit switched	Forward and return
Shared channels	User traffic	Packet switched	Return

The only frequencies the MES initially knows are the frequencies of the NCSC in all regions, all other frequency information is dynamically extracted from the NCS Bulletin Board or in session oriented signaling messages. After being switched on, the MES must be told (or remembers) in which region it is currently located, and will automatically tune to the corresponding frequency of the NCS. The terminal will then search through the NCSS spot beam ID frequencies to identify the best spot beam.

MES Identification

A MES is called from the terrestrial network by its Inmarsat Number (IMN) which is identical to its public telephone number with a country code prefix according to Table 2. Internally the system uses two different (24 bits) IDs:

The Forward MESID, used on the forward path, i.e. in the direction from the Land Earth Station (LES) to the Mobile Earth Station (MES).

The Return MESID, used on the return path, i.e. from the MES to the LES.

These IDs are unrelated to the publicly published IMN and are only known to the Inmarsat system, which maintains a database describing the relationship between the IMN and the MESID pairs. These IDs are hard coded into the satellite terminals at manufacturing time.

Session Signaling

In its idle state, the MES continuously listens to the NCSC, updating its internal network status database (control channels, frequencies, etc) through the Bulletin Board messages.

There are two possibilities for starting a session:

- Fixed station initiates the session;
- MES initiates the session;

Fixed Station Initiated Session

Through the terrestrial network, the fixed station connects to a LES. The LES sends a signaling message to the NCS, which in turn pages the MES via the NCSC. The MES receives the session oriented signaling message with its Forward MESID, and sends a response back to the NCS with its Return MESID. The NCS in turn sends a channel assignment signaling message to both the MES and LES, and both stations will tune to the assigned traffic channel, where the session will take place. The traffic channel carries all user data (voice, fax, data) plus signaling messages as required. At the end of the session, the traffic channel is released and the LES informs the NCS, that the channel is free again. The NCS returns the assigned channel and channel equipment to its pool of available resources.

MES Initiated Session

On a MES Request Channel, the MES sends a request signaling message to the NCS containing its Return MESID. The NCS then sends the traffic channel assignment using the Forward MESID to both the LES and the MES. The remaining part of the protocol is as in the case above.

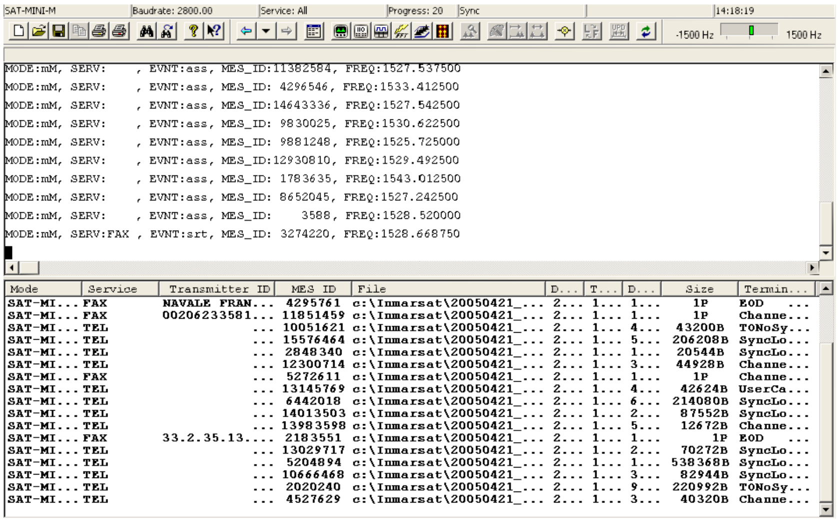
Operation

W61PC displays the session output in two windows, a **Session Window** and a **Session List Window.**

The **Session Window** continuously displays control channel information:

Field	
MODE:	B, M, mM
SERVice	DATA (data), FAX (fax), TEL (voice),TELX (telex)
EVeNT	srt Traffic channel start ass Assignment ccs Control channel start end End

The result (a file) of a monitoring session is listed in the **Session List Window**. Bold font indicates that a file has is unread by the user, while normal font indicates the file has been read (Display Status). In order to display a file, double click on the corresponding **File** field. This enables the correct viewer. It is also possible to directly view a file through Windows Explorer; however, this does not change the Display Status.



The fields of the **Session List Window** are listed below:

- **Mode:** The mode of the recorded session
- **Service:** The service of the recorded session
- **MES ID:** The Forward MES ID of the user terminal of the recorded session
- **Transmitter ID:** Fax ID (usually a name or fax number)
- **File:** Path and file name of the monitored data. The file name contains the date and time of the session
- **Date, Time:** Start date and time of the recorded session
- **Duration:** Duration of recorded session
- **Size:** For **Fax** service - The number of pages of the fax. For **Data** service - The number of user bytes transmitted

Termination:

- **EOD -** End-of-data
- **ChannelRelease** – Normal channel release
- **StopMode** - Bit stream interrupted
- **SyncLost** – Excessive number of resync attempts
- **TONoSync** – Sync or resync time-out
- **TONoScrVect** – Bad scrambling vector
- **TooManyBadCRCs** – Excessive number of failed checksum calculations
- **UserCanc** – User cancellation

A file in the **Session List Window** can be deleted by right-clicking on it and following the delete dialog.

Trouble Shooting

Receiver Frequency Error Compensation

The receiver must tune exactly to the frequency setting received from the W61PC. Any offset must be corrected and entered into the system via the Freq **Offset** field in the **Setup/Receiver and Satellite Settings...** dialog.

The following procedure can be used to find out and correct this offset:

- After start of the SAT Mode on the W61PC, wait until the receiver displays the frequency of the control channel (see the NCSC table below and take into account down converter use)
- Select spectrum analysis (**VHF/UHF Modes/Analysis DIRECT/Real-time FFT**) on the user interface of the W61PC. Make sure all the settings are still correct (**Input, Translation**). Select a bandwidth of 24 kHz,, set **Averaging** to about 4 or 5
- The spectrum of the control channel is about 8 kHz wide, and it should be in the centre of the 24 kHz FFT display. If this is not the case, determine the frequency offset - if the spectrum is too far to the right, the sign of the offset is negative, otherwise it is positive
- Now, close the FFT window, select **Setup/Receiver and Satellite Settings....**Enter the amount and sign of the frequency offset into the **Freq Offset** field
- Start the SAT Mode again, after the receiver has been retuned taking the frequency offset into consideration. Select the FFT again and check if the control channel is now exactly in the middle of the FFT display. Repeat the adjustment if necessary. It is very important that the control channel spectrum should not be offset more than 100 Hz, i.e. it should be symmetrically centered

Ocean Region	NCSC Inmarsat B/M	NCSC Inmarsat miniM
AOR-W	1538.120000 MHz	1537.3100000 MHz
AOR-E	1538.220000	1537.3200000
IOR	1538.180000	1537.3400000
POR	1538.230000	1537.3300000

Signal Strength

The SNR for the control and traffic channels should be at least 18 dB as measured with the FFT of the W61PC. Depending on the location of the monitoring system, a dish size of 2 – 3 m will be needed.

Spot Beam Reception

Traffic channels may be allocated for power saving and frequency reuse in spot beams. These spot beams cover only a part of the ocean region for the satellite being monitored. Therefore it is possible that the monitoring systems tunes to a frequency without signal. Nothing can be done in this case (except moving your antenna at least 500 km!). By observing the Bulletin Board form the NCS the user may deduce which spot beams are visible in his location.

Session Success (Fax)

Patience is required when monitoring satellite transmissions as the monitoring of sessions may fail, in particular fax sessions. The reasons for the failure may be:

- The W61PC monitoring system cannot synchronize to the traffic channel because the traffic channel is not in a spot beam seen by the antenna, or it is too weak. Check the FFT display
- The W61PC monitoring system cannot synchronize, or it may synchronize, but after some time it loses synch, because the traffic channel is in a spot beam which is disturbed by a neighbor channel. This neighbor channel can be inactive at the beginning of the session, but gets active after a while. Check the FFT display.
- The session is terminated after less than 100 seconds and no fax is received. Many fax sessions never start transmitting fax data, because the handshaking process at the beginning of the session fails. The handshake may take as long as 120 seconds.
- The fax transmission is successful, but the fax Viewer does not display anything or displays only a partial fax. This could be due to bit errors preventing the fax decoding process or because the fax devices during the handshake agreed on a coding version not yet implemented in the WAVECOM fax viewer
- The fax transmission is successful, but output is not the normal .TIF file, but a .JBG file, because fax encoding is according to recommendation T.82/85. Call WAVECOM for support on this issue.

SAT-A-TELEX

SAT-A is the original mobile satellite system, and its architecture is therefore less complex. Essentially the NCS and LES continuously transmit TDM carriers carrying forward signaling and telex traffic in frames according to the table below. Return telex traffic is TDMA. Voice and analog modem traffic is carried in SCPCs assigned by the regional NCS.

SAT-A-TELEX frame structure

Use	Length
Spare bit	1 (always = 0)
Unique Word	20
Signaling (63 bits):	
Terminal ID	21
Message Type	6
Channel Type	4
Channel Number:	
Time Slot	6
Frequency Pair No.	9
TDM Number	3
Shore Station (8 bits):	
Spare	1

Priority	2
Call Origination	1
CES ID	4
Error Detection	6
Data (22 time slots of each 2 chars of each 6 bits (1 flag + 5 ITA2)):	264
Total frame length	348

Every 6th unique word is inverted.

Error calculation is done using a BCH (63, 57, 1) code which detects two errors and corrects one bit in error.

Channel Types

00	Duplex telegraphy
01	Duplex telephony
02	Duplex telephony without compandors
05	Ship-to-shore high speed data
10	Shore-to-ship simplex telegraphy
11	Shore-to-ship telephony without compandors
12	Shore-to-ship simplex telephony

Message Types

Messages originating from a CES and repeated by the NCS

02	Request not acceptable (NCS)
08	Assignment command (NCS) (telegraphy)
09	Acknowledgement message (request in queue) (NCS)
10	Channel release command (NCS)
11	Congestion (full queue or network congestion) (NCS)
16	Request for assignment from the NCS (telephony)
17	Notification of ship clearing
24	Revalidation of ship busy
54	Unconditional channel release (NCS)
63	Idle message (NCS)

Messages from NCS to CES

10	Channel release command
18	Message garbled
19	Error (message from CES rejected)
21	Circuit congestion
22	Ship busy
24	Revalidation of ship busy
56	NCS going down
57	New NCS

Messages from NCS to CES

08	Assignment command
10	Channel release command
11	Congestion
54	Unconditional channel release
63	Idle

Time slot no.

- 01 - 22

Channel no.

- 001 - 323

SAT-C-TDM, SAT-C-TDMA

The SAT-C system is a simple store-and-forward messaging system.

SAT-C has four operational channels:

NCS Common Channel (SAT-C-TDM)

- Continuous TDM
- 8.64 s frame
- 1200 symbols/s
- Scrambled, encoded, interleaved
- One bulletin board per frame
- Signaling, Enhanced Group Calls (EGC), polls (see below)

LES TDM (SAT-C-TDM)

- Continuous TDM or demand assigned by NCS
- 8.64 s frame
- 1200 symbols/s
- Scrambled, encoded, interleaved
- One bulletin board per frame
- Signaling and LES-mobile messages

MES Signaling Channel

- Slotted Aloha random access, 28 slots/frame, 120 bits/slot
- 1200 symbols/s
- Scrambled, encoded
- Distress and normal calls, data reporting, NCS log-in, log-out (registration)

MES Message Channel (SAT-C-TDMA)

- TDMA
- 1200 symbols/s
- Scrambled, encoded, interleaved
- Mobile-LES messages

Services

SAT-C supports several services:

Store-and-forward messaging

Allows messages to be exchanged between a mobile station and a user connected to the fixed network (telex, modem connection, X.25 or Internet email). Only messages that are received completely error-free are forwarded to the destination.

Distress calls

Distress calls are sent from a mobile (only maritime) to a LES. Distress priority messages may be sent in both directions. Maritime SAT-C forms part of the Global Maritime Distress and Safety System (GMDSS).

Enhanced Group Calls (EGC)

A broadcast service which may be addressed to individual units as well as groups, either geographical or logical. Two EGC services are available:

FleetNET for commercial traffic and SafetyNET for maritime safety traffic, e.g. navigational warnings, weather forecasts or distress call relays.

EGC traffic is transmitted on the NCS Common Channel.

Data reporting

Lets MES send short data reports such as position information, sensor data etc. which are transmitted via the MES Signaling Channel. Two types of data reporting are supported: Reserved and unreserved.

Reserved access is controlled from the LES by poll messages which contain instructions on starting time and duration of the reporting and also the type of data report required. A poll message may be interpreted as a programming macro by the MES.

Unreserved access is initiated by the MES itself.

Polling

Used by base stations to initiate transmissions from a MES of text messages or data reports. Polls may be directed to individual stations, to groups or to geographical areas.

Operation

A NCS controls each active satellite and the network within the satellite coverage area. Whenever a mobile enters or leaves an ocean region it has to register with the NCS using the MES Signaling Channel. The NCS updates its tables accordingly and informs the other NCSs and LESs within its region. These stations also keep updated tables of MES status.

A NCS Common Channel TDM is transmitted by each NCS - when idle, a MES is always tuned to this channel. A Common Channel frame always has a bulletin board as the first information. This board contains network information for all LES capabilities, channel information and other system information.

Each LES has at least one TDM assigned to it. The assignment may be permanent or on a demand basis.

A LES having a message for a mobile unit advises the NCS, which transmits a call announcement packet on the Common Channel containing the ids of the MES and LES, which LES TDM will be used, call direction and priority. The MES retunes to the assigned LES TDM. The LES TDM also carries a bulletin board with information on which MES Signaling Channel slots are free. The MES finds a free slot and transmits a call announcement response on a MES Signaling Channel. It then returns to the LES TDM. The LES then transmits a channel assignment packet containing message length information, time slot number (Logical Channel

Number, LCN) and local routing information. The succeeding message packets are all labeled with the LCN and have also a sequence number and a check sum. The MES must send an assignment acknowledgement packet before message transfer is initiated. The last LES packet is a request for acknowledgement. The MES acknowledge packet will contain a list of packets received in error and the LES will retransmit these packets until all packets have been received by the MES. Then the LES releases the LCN and the MES reverts to idle state.

Message transfer from a mobile station to a LES is initiated by the MES finding the LES TDM frequency information in the NCS bulletin board. It then retunes to this TDM and synchronizes to the TDM frame. The MES finds a free signaling channel slot by reading the LES TDM bulletin board information and transmits an assignment request to the LES. The LES informs the NCS that the MES is busy. It then sends an assignment packet to the MES containing, message channel frequency, slot number and LCN. The MES retunes and starts transmitting its message.

SAT-C is mainly used in maritime communications, but is also widely used for long distance truck fleet management where the trucks are polled and then will return position information from a GPS receiver. The system also finds its use in the remote control of pumping stations or remote data acquisition.

Technical Data

Interfaces W51

Input	AF-IN	IF-IN-VAR	IF-IN-10.7	IF-IN-21.4
Connector	BNC female	BNC female	BNC female	BNC female
Frequency range	0.5 kHz to 20 kHz for HF-signals 0.5 kHz to 24 kHz for VHF/UHF-signals	14 kHz to 1.5 MHz	10.685 MHz to 10.715 MHz	21.385 MHz to 21.415 MHz
Bandwidth	4 kHz for HF-signals 24 kHz for VHF/UHF-signals	4 kHz for HF-signals 24 kHz for VHF/UHF-signals	4 kHz for HF-signals 24 kHz for VHF/UHF-signals	4 kHz for HF-signals 24 kHz for VHF/UHF-signals
Frequency raster DDS	1.0 Hz	1.0 Hz	1.0 Hz	1.0 Hz
Signal level	1 mVrms to 2.5 Vrms	1 mVrms to 2 Vrms	1 mVrms to 2 Vrms	1 mVrms to 2 Vrms
Input impedance	> 10.0 kOhm	> 5 kOhm	> 10 kOhm	> 10 kOhm

Input	EXT-DEM
Connector	Mini-DIN

Signal level	TTL up to RS-232C [0 V, +5 V] to [-12 V, +12 V]
Input impedance	>100 kOhm
Remarks	Max. 12 kBit/s V1 Data Internal Synchronization

System Components W51

Digital Signal Processor (DSP) MASTER

- DSP56301-100 MHz
- Program memory 1.5 Mbytes SRAM 12 ns
- Data memory 24 Mbytes DRAM 50 ns
- PCI-Interface

Digital Signal Processor (DSP) SLAVE

- DSP56302-100 MHz
- Program memory 1.5 Mbytes SRAM 12 ns

Peripheral

- 16-bit A/D converter AD7721
- 12-bit D/A converter DAC7800
- Direct digital frequency synthesizer AD9831
- High-level mixer MPY634
- Digital controlled amplifier CS3310

Alphabets Details

Unicode

WAVECOM uses a Unicode font to display data, which may be replaced by a user installed font within the ranges indicated below.

Alphabet	Range Hex	Range Dec
Basic Latin	U+0000 - U+007F	0 –127
Latin-1 Supplement	U+0080 - U+00FF	128 –255
Latin Extended-A	U+0100 - U+017F	256 –383
Basic Greek	U+0370 - U+03FF	880 –1023
Cyrillic	U+0400 - U+04FF	1024 –1279
Basic Hebrew	U+0590 - U+05FF	1424 –1535
Basic Arabic	U+0600 - U+06FF	1536 –1791
Letter-like Symbols	U+2100 - U+214F	8448 – 8527
Control Pictures	U+2400 - U+243F	9216 – 9279

Dingbats	U+2700 - U+27BF	9984 –10175
Arabic Presentation Form B	U+FE70 - U+FEFF	65136 –65279

Font-Art

A true type, fixed system font produces a better display of table information.

Teleprinter Alphabets

Alphabet	Type
ITA-1 Latin	5 Bit Alphabet
ITA-2 Latin	5 Bit Baudot Alphabet
ITA-2 Latin Transparent	5 Bit Alphabet
ITA-2 Cyrillic	5 Bit Alphabet
ITA-2 Hebrew	5 Bit Alphabet
ITA-2 Swedish	5 Bit Alphabet
ITA-2 Danish-Norwegian	5 Bit Alphabet
Baghdad70 Arabic	5 Bit Alphabet
Baghdad80 Arabic	5 Bit Alphabet
TASS Cyrillic	5 Bit Alphabet
Third Shift Cyrillic	5 Bit Alphabet
Third Shift Greek	5 Bit Alphabet
Chinese	7 Bit ASCII Alphabet
ITA-5 US	7 Bit ASCII Alphabet
ITA-5 German	7 Bit ASCII Alphabet
ITA-5 Swedish	7 Bit ASCII Alphabet
ITA-5 Danish-Norwegian	7 Bit ASCII Alphabet
ITA-5 Bulgarian	7 Bit ASCII Alphabet
SITOR (ITU-476-5)	7 Bit Alphabet
ARQ1A	7 Bit Alphabet
Bauer	10 Bit Alphabet
HNG-FEC	15 Bit Alphabet
RUM-FEC	16 Bit Alphabet
Latin Morse	Standard Latin
Cyrillic Morse	Standard Cyrillic
Greek Morse	Standard Greek
Arabic Morse	Standard Arabic
Hebrew Morse	Standard Hebrew

Transparent

NO.	Transparent	LETTER	FIGURE
1	1 1 0 0 0	A	-
2	1 0 0 1 1	B	?
3	0 1 1 1 0	C	:
4	1 0 0 1 0	D	Hex 05
5	1 0 0 0 0	E	3

6	1 0 1 1 0	F	Hex 5D
7	0 1 0 1 1	G	Hex 5B
8	0 0 1 0 1	H	Hex 5C
9	0 1 1 0 0	I	8
10	1 1 0 1 0	J	Hex 07
11	1 1 1 1 0	K	(
12	0 1 0 0 1	L	)
13	0 0 1 1 1	M	.
14	0 0 1 1 0	N	,
15	0 0 0 1 1	O	9
16	0 1 1 0 1	P	0
17	1 1 1 0 1	Q	1
18	0 1 0 1 0	R	4
19	1 0 1 0 0	S	‘
20	0 0 0 0 1	T	5
21	1 1 1 0 0	U	7
22	0 1 1 1 1	V	=
23	1 1 0 0 1	W	2
24	1 0 1 1 1	X	/
25	1 0 1 0 1	Y	6
26	1 0 0 0 1	Z	+
27	0 0 0 1 0	Carriage Return	
28	0 1 0 0 0	Line Feed	
29	1 1 1 1 1	Hex 25 (%)	
30	1 1 0 1 1	Hex 24 ($)	
31	0 0 1 0 0	Space	
32	0 0 0 0 0	Hex 08	

ITA-2 Alphabet

NO.	ITA-2 Alphabet	LETTER	FIGURE
1	1 1 0 0 0	A	-
2	1 0 0 1 1	B	?
3	0 1 1 1 0	C	:
4	1 0 0 1 0	D	
5	1 0 0 0 0	E	3
6	1 0 1 1 0	F	
7	0 1 0 1 1	G	
8	0 0 1 0 1	H	
9	0 1 1 0 0	I	8
10	1 1 0 1 0	J	Bell
11	1 1 1 1 0	K	(
12	0 1 0 0 1	L	)
13	0 0 1 1 1	M	.

14	0 0 1 1 0	N	,
15	0 0 0 1 1	O	9
16	0 1 1 0 1	P	0
17	1 1 1 0 1	Q	1
18	0 1 0 1 0	R	4
19	1 0 1 0 0	S	‘
20	0 0 0 0 1	T	5
21	1 1 1 0 0	U	7
22	0 1 1 1 1	V	=
23	1 1 0 0 1	W	2
24	1 0 1 1 1	X	/
25	1 0 1 0 1	Y	6
26	1 0 0 0 1	Z	+
27	0 0 0 1 0	Carriage Return	
28	0 1 0 0 0	Line Feed	
29	1 1 1 1 1	Letter Shift	
30	1 1 0 1 1	Figure Shift	
31	0 0 1 0 0	Space	
32	0 0 0 0 0	Unperfo-rated tape	

ITA-3 Alphabet

NO.	ITA-3 Al-phabet	LETTER	FIGURE
1	0 0 1 1 0 1 0	A	-
2	0 0 1 1 0 0 1	B	?
3	1 0 0 1 1 0 0	C	:
4	0 0 1 1 1 0 0	D	
5	0 1 1 1 0 0 0	E	3
6	0 0 1 0 0 1 1	F	
7	1 1 0 0 0 0 1	G	
8	1 0 1 0 0 1 0	H	
9	1 1 1 0 0 0 0	I	8
10	0 1 0 0 0 1 1	J	Bell
11	0 0 0 1 0 1 1	K	(
12	1 1 0 0 0 1 0	L	)
13	1 1 0 0 0 0 1	M	.
14	1 0 1 0 1 0 0	N	,
15	1 0 0 0 1 1 0	O	9
16	1 0 0 1 0 1 0	P	0
17	0 0 0 1 1 0 1	Q	1
18	1 1 0 0 1 0 0	R	4
19	0 1 0 1 0 1 0	S	‘
20	1 0 0 0 1 0 1	T	5
21	0 1 1 0 0 1 0	U	7

22	1 0 0 1 0 0 1	V	=
23	0 1 0 0 1 0 1	W	2
24	0 0 1 0 1 1 0	X	/
25	0 0 1 0 1 0 1	Y	6
26	0 1 1 0 0 0 1	Z	+
27	1 0 0 0 0 1 1	Carriage Return	
28	1 0 1 1 0 0 0	Line Feed	
29	0 0 0 1 1 1 0	Letter Shift	
30	0 1 0 0 1 1 0	Figure Shift	
31	1 1 0 1 0 0 0	Space	
32	0 0 0 0 1 1 1	Unperfo-rated tape	
	0 1 1 0 1 0 0	Request	
	0 1 0 1 0 0 1	Idle a	
	0 1 0 1 1 0 0	Idle b	

ITA-4 Alphabet

NO.	ITA-4 Al-phabet	LETTER	FIGURE
1	0 1 1 0 0 0	A	-
2	0 1 0 0 1 1	B	?
3	0 0 1 1 1 0	C	:
4	0 1 0 0 1 0	D	
5	0 1 0 0 0 0	E	3
6	0 1 0 1 1 0	F	
7	0 0 1 0 1 1	G	
8	0 0 0 1 0 1	H	
9	0 0 1 1 0 0	I	8
10	0 1 1 0 1 0	J	Bell
11	0 1 1 1 1 0	K	(
12	0 0 1 0 0 1	L	)
13	0 0 0 1 1 1	M	.
14	0 0 0 1 1 0	N	,
15	0 0 0 0 1 1	O	9
16	0 0 1 1 0 1	P	0
17	0 1 1 1 0 1	Q	1
18	0 0 1 0 1 0	R	4
19	0 1 0 1 0 0	S	‘
20	0 0 0 0 0 1	T	5
21	0 1 1 1 0 0	U	7
22	0 0 1 1 1 1	V	=
23	0 1 1 0 0 1	W	2
24	0 1 0 1 1 1	X	/
25	0 1 0 1 0 1	Y	6
26	0 1 0 0 0 1	Z	+

27	0 0 0 0 1 0	Carriage Return	
28	0 0 1 0 0 0	Line Feed	
29	0 1 1 1 1 1	Letter Shift	
30	0 1 1 0 1 1	Figure Shift	
31	0 0 0 1 0 0	Space	
32	1 0 0 0 0 0	Unperfo-rated tape	
	0 0 0 0 0 0	Idle a	
	1 1 1 1 1 1	Idle b	
	1 1 0 0 1 1	Phasing signal	

SITOR Alphabet

NO.	SITOR Al-phabet	LETTER	FIGURE
1	1 1 1 0 0 0 1	A	-
2	0 1 0 0 1 1 1	B	?
3	1 0 1 1 1 0 0	C	:
4	1 1 0 0 1 0 1	D	
5	0 1 1 0 1 0 1	E	3
6	1 1 0 1 1 0 0	F	
7	1 0 1 0 1 1 0	G	
8	1 0 0 1 0 1 1	H	
9	1 0 1 1 0 0 1	I	8
10	1 1 1 0 1 0 0	J	Bell
11	0 1 1 1 1 0 0	K	(
12	1 0 1 0 0 1 1	L	)
13	1 0 0 1 1 1 0	M	.
14	1 0 0 1 1 0 1	N	,
15	1 0 0 0 1 1 1	O	9
16	1 0 1 1 0 1 0	P	0
17	0 1 1 1 0 1 0	Q	1
18	1 0 1 0 1 0 1	R	4
19	1 1 0 1 0 0 1	S	‘
20	0 0 1 0 1 1 1	T	5
21	0 1 1 1 0 0 1	U	7
22	0 0 1 1 1 1 0	V	=
23	1 1 1 0 0 1 0	W	2
24	0 1 0 1 1 1 0	X	/
25	1 1 0 1 0 1 0	Y	6
26	1 1 0 0 0 1 1	Z	+
27	0 0 0 1 1 1 1	Carriage Return	
28	0 0 1 1 0 1 1	Line Feed	
29	0 1 0 1 1 0 1	Letter Shift	
30	0 1 1 0 1 1 0	Figure Shift	

31	0 0 1 1 1 0 1	Space	
32	0 1 0 1 0 1 1	Unperfo-rated tape	
	0 1 1 0 0 1 1	Request	
	1 1 1 1 0 0 0	Idle a	
	1 1 0 0 1 1 0	Idle b	

ITA-1 Alphabet

NO.	ITA-1 Al-phabet	LETTER	FIGURE
1	1 1 0 0 0	R	_
2	1 0 0 1 1	I	
3	0 1 1 1 0	Line feed	
4	1 0 0 1 0	W	?
5	1 0 0 0 0	N	
6	1 0 1 1 0	X	,
7	0 1 0 1 1	U	4
8	0 0 1 0 1	H	-
9	0 1 1 0 0	K	(
10	1 1 0 1 0	S	.
11	1 1 1 1 0	Letter shift	
12	0 1 0 0 1	C	9
13	0 0 1 1 1	Carraige return	
14	0 0 1 1 0	Z	:
15	0 0 0 1 1	O	5
16	0 1 1 0 1	J	6
17	1 1 1 0 1	Figure shift	
18	0 1 0 1 0	T	
19	1 0 1 0 0	M	)
20	0 0 0 0 1	D	0
21	1 1 1 0 0	Space	
22	0 1 1 1 1	A	1
23	1 1 0 0 1	B	8
24	1 0 1 1 1	E	2
25	1 0 1 0 1	G	7
26	1 0 0 0 1	F	
27	0 0 0 1 0	V	‘
28	0 1 0 0 0	Q	/
29	1 1 1 1 1	Unperfo-rated tape	
30	1 1 0 1 1	Y	3
31	0 0 1 0 0	L	=
32	0 0 0 0 0	P	%

WAVECOM Data File Format

In this chapter the WDA file format is described.

The .WDA file stores different kind of data:

- Text data
- Graphics data
- FELDHELL data
- Signal Analysis data
- SAT data
- Classifier data
- Classifier CodeCheck data
- Sonogram data

The .WDA file contains a header at the beginning that identifies the data stored in the file and provides additional information dependent on the stored data.

The .WDA files are binary files, every file has the following structure:

FileHeader	Data
64 Bytes	n Bytes

the data at the begin of the file is the file header, the size of the header is 64 Bytes. Every .WDA file stores the same information in the first 64 Bytes of the file. Depending on the data stored, the file header can have some additional information stored, which extends the size of the Header, but this will be described later.

File Header

The file header that is at the begin of every .WDA file stores the following information:

Signature	FileType	Version	LineCount	Pad	Pad2
8 Bytes	8 Bytes	4 Bytes	4 Bytes	8 Bytes	32 Bytes

The size of the file header is 64 bytes.

The **Signature** is always WDA

NOTE: by older versions it can be W51PC, W41PC or W40PC

The **FileType** is dependent on the stored data and can have the following values:

- Text
- Graphics
- FELDHELL
- SigAnal
- SAT
- Classifr
- CCC

- Sonogram

The **Version** is always “0x00020000” (Version A) or ” 0x00030000” (Version B).

LineCount contains the number of data lines stored. (NOTE: the data stored is line based, that is a data package represents the data of a line.)

Pad contains additional information to be stored.

Pad2 contains additional information to be stored.

NOTE: the following struct type could be used to extract the file header.

```
struct FileHeader
{
    char Signature[8];
    char FileType[8];
    LONG Version;
    LONG LineCount;
    char Pad[8];
    char Pad2[32];
};
```

The FileHeader struct has a size of 64 Bytes.

The Data structures

After the Header the specific data is stored. The data is divided into several data packages, in the file header the number of data packages is stored.

DataHeader	Data	DataHeader	Data		DataHeader	Data
12 Bytes	n Bytes	12 Bytes	n Bytes	...	12 Bytes	n Bytes

A data package contains a data header and the data itself.

DataHeader	Data
12 Bytes	n Bytes

The size of the data header is 12 Bytes.

The data header at the begin of each data package stores the following additional information:

PrevSize	Size	TIME
4 Bytes	4 Bytes	4 Bytes

In **PrevSize** the size of the preceding data is stored, **Size** stores the size of the data contained in this data package and in **TIME** the timestamp of the data is stored.

The data size value stored in **Size** indicates how many Bytes of data are stored after the data header for this data package.

NOTE: the following struct type could be used to extract the data header.

```
struct LineData
{
    LONG PrevSize; // size of the data line before.
    LONG Size;     // size of the data line.
    LONG TIME;     // time of the data received.
}
```

The LineData struct is 12 byte long.

NOTE: the data packages in a .WDA file can vary in length. Because of this the size of the data is stored in the data header.

The different FileHeaders and DataStructures

In the following chapters the file headers and data packages of the different .WDA file types are described.

Text data

The **FileType** stored in the file header is ”Text”.

Header data

This file type uses the ‘File Header’ described in chapter ”File Header” on page 273.

The following additional data is stored in the Header:

- In Pad[0] the Font type.
- In Pad[1] the Left to right Font type.
- In Pad[2] if Unicode characters are stored.

Data

This **FileType** uses the data structure described in chapter “The Data structures” on page 274 to store the data.

Every single line of a text document is stored in a separate data package, the length of the line is stored in the data header of the data package. The text data is stored in character values.

The characters stored in the file are from the type wchar_t, that is a character with the size of 2 bytes! That is each character of the Text lines occupies two bytes in the file.

SAT data

The **FileType** stored in the file header is “SAT“.

Header data

This file type uses the ‘File Header’ described in chapter ”File Header” on page 273.

The following additional data is stored in the Header:

In Pad[0] if the normal data or the extended data is stored in the file.

Data

This **FileType** uses the data structure described in chapter “The Data structures” on page 274 to store the data.

A data package in the .WDA file contains the data of one SAT session.

The SAT session data is written to a single string. The following values are written to the string:

- The Mode string value.
- The Service string value.

- The MES ID value.
- The File string value, of the file that contains the session data.
- The DateTime value.
- The Duration value.
- The Size value.
- The Termination string value.
- The Wavecom Card ID.
- The computer address.
- The flag value, that indicates if the session data file has already been displayed.
- The Transmitter ID value.

NOTE: the values are written to the string in the same order as listed above!

If not stored with _UNICODE enabled, then the string contains normal 8-bit characters values, from type char, otherwise the string contains 16-bit characters, from type wchar_t.

A char value occupies 1 Byte and a wchar_t value occupies 2 Bytes in the binary .WDA file.

Classifier data

The ‘FileType’ stored in the file header is “Classifr“.

Header data

This file type uses the ‘File Header’ described in chapter ”File Header” on page 273.

The following additional data is stored in the Header:

- In Pad[0] the Timestamp format is stored.

Data

This ‘FileType’ uses the data structure described in chapter “The Data structures” on page 274 to store the data.

A data package in the .WDA file contains the data of one classified signal.

The signal data of a signal detected by the classifier is written to a single string. The following values are written to the string:

- The Signal name string value.
- The Mode string value.
- The Modulation string value.
- The Center Frequency string value including the unit label.
- The Shift string value including the unit label.
- The Baudrate string value including the unit label.
- The Bandwidth string value including the unit label.

- The Confidence string value including the unit label.
- The Mode value.
- The Center Frequency value.
- The Shift value.
- The BaudrateA value.
- The BaudrateB value.
- The Bandwidth value.
- The Time stamp value.

NOTE: the values are written to the string in the same order as listed above!

If not stored with _UNICODE enabled, then the string contains normal 8-bit characters values, from type char, otherwise the string contains 16-bit characters, from type wchar_t.

A char value occupies 1 Byte and a wchar_t value occupies 2 Bytes in the binary .WDA file.

ClassifierCodeCheck data

The 'FileType' is "CCC ".

Header data

This file type uses the 'File Header' described in chapter "File Header" on page 273.

The following additional data is stored in the Header:

- In Pad[0] the Timestamp format is stored.

Data

This 'FileType' uses the data structure described in chapter "The Data structures" on page 274 to store the data.

A data package in the .WDA file contains the data of one classified signal or the CodeCheck data of a classified signal.

The data stored for the classier CodeCheck is divided into two parts, the Classifier part and the CodeCheck part.

A .WDA file contains at first the classifier data and then the CodeCheck data.

The Classifier data is stored in the way described in chapter "Classifier data" on page 276.

The data package which contains the text "CodeCheck Data Section" marks the begin of the CodeCheck data section.

The CodeCheck data of a classified signal is written to a single string. The following values are written to the string:

- The index value of the classified signal.
- The string value with all predicted modes.

- All detected modes(can be more than one), for a detected mode the following values are written to the string:
    - The Mode name string value.
    - The SubMode name string value.
    - The string value with the additional description.
    - The Hits value.

NOTE: the values are written to the string in the same order as listed above!

If not stored with _UNICODE enabled, then the string contains normal 8-bit characters values, from type char, otherwise the string contains 16-bit characters, from type wchar_t.

A char value occupies 1 Byte and a wchar_t value occupies 2 Bytes in the binary .WDA file.

Graphics data

The **FileType** stored in the file header is “Graphics”.

Header data

This file type uses the ‘File Header’ described in chapter ”File Header” on page 273.

The Phase value, the AspectRatio (could be stored in old Wavecom Data Files, for the actual Software it is not stored anymore) and the Flip Left/Right/Top/Bottom value are stored additionally to the default header.

The following additional data is stored in the Header, following the default header:

FileHeader	Phase	Pad	AspectRatio	FlipHV	Pad
64 Bytes	4 Bytes	4 Bytes	8 Bytes	4 Bytes	4 Bytes

- Phase: the Phase value.
- Pad: padding bytes for alignment (not used).
- AspectRatio: the AspectRatio value.
- FlipHV: the Flip Left/Right/Top/Bottom value.
- Pad: padding bytes for alignment (not used).

To the default file header with 64 bytes additional a block of 24 bytes is added that contains the Phase, the AspectRatio, the FlipHV and some padding bytes for alignment.

The Phase value occupies 4 Bytes followed by 4 padding bytes. The Aspect Ration occupies 8 bytes. The FlipHV (Flip horizontal vertical) value occupies 4 bytes followed by 4 padding bytes.

NOTE: the following struct type could be used to extract the data header.

```
struct GraphicsData
{
long     Phase;
    double AspectRatio;
    int      FlipHV;
};
```

Data

This **FileType** uses the data structure described in chapter "The Data structures" on page 274 to store the data.

A data package in the .WDA file contains the data of all pixels of one line in the graphic. The pixel data is stored in BYTES (8-bit type) values, that is one Byte in the .WDA file contains the value of an Pixel in the graphic.

FELDHELL data

The **FileType** is "FELDHELL".

Header data

This file type uses the **File Header** described in chapter "File Header" on page 273.

No additional data is stored in the Header.

Data

This **FileType** uses the data structure described in chapter "The Data structures" on page 274 to store the data.

A data package in the .WDA file contains the data of all pixels of one line in the graphic. The pixel data is stored in unsigned char values(8-bit type), that is one Byte in the .WDA file contains the value of an Pixel in the graphic.

Sonogram data

The 'FileType' stored in the file header is "Sonogram".

Header data

This file type uses the 'File Header' described in chapter "File Header" on page 273.

The following additional data is stored in the Header, following the default header:

FileHeader	DocSizeX	DocSizeY	CursorA	CursorB	Bandwidth
64 Bytes	4 Bytes	4 Bytes	8 Bytes	8 Bytes	4 Bytes

Translation	LowFreq Limit	HighFreq Limit	LowMag Limit	HighMag Limit	VideoFilterOn
4 Bytes	4 Bytes	4 Bytes	2 Bytes	2 Bytes	4 Bytes

- DocSizeX: the document width.
- DocSizeY: the document height.

- CursorA: the value of the cusorA.
- CursorB: the value of the cusorB.
- Bandwidth: the Bandwidth value.
- Translation: the Translation value.
- LowFreqLimit: the lower frequency limit value.
- HighFreqLimit: the higher frequency limit value.
- LowMagLimit: the lower magnitude limit value.
- HighMagLimit: the higher magnitude limit value.
- VideoFilterOn: the VideoFilter On/Off flag.

To the default file header with 64 bytes additional a block of 48 bytes is added.

The additional block contains display parameter used by the Wavecom GUI for displaying the stored data correctly.

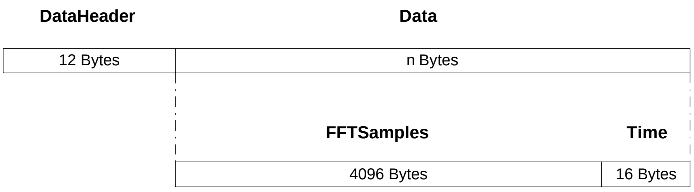
NOTE: the following struct type could be used to extract the data header.

```
struct SonogramData
{
    long lDocSizeX;
    long lDocSizeY;
    double dCursorA;
    double dCursorB;
    long lBandwidth;
    long lTranslation;
    long lLowFrequencyLimit;
    long lHighFrequencyLimit;
    short sLowMagnitudeLimit;
    short sHighMagnitudeLimit;
    BOOL boVideoFilterOn;
};
```

Data

This ‘FileType’ uses the data structure described in chapter “The Data structures” on page 274 to store the data.

The stored sonogram data has the following structure:



- FFT Samples: the first 4096 bytes of the stored data contain the 2048 sample values for the FFT.
- Time: the last 16 bite of the stored data contains the system time timestamp value of the received data(the additional timestamp is necessary because the default timestamp in the data header does not support milliseconds).

The data for the ‘Sonogram’ file types occupies 4112 bytes inside a data package after the data header.

A data package in the .WDA file contains the data points of one FFT sample and its timestamp value. The FFT sample data points are stored in short values(2-bit type), that is 2 Bytes in the .WDA file contains the value of one FFT sample data point.

NOTE: the following struct type could be used to extract the data.

```
typedef struct ST_SONOGRAM_DATA
{
    short asFFTSamp[2048];
    SYSTEMTIME Time;
} ST_SONOGRAM_DATA;
```

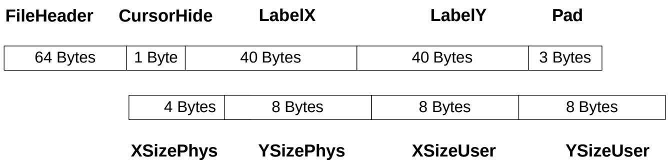
SigAnal data

The **FileType** stored in the file header is “SigAnal “.

Header data

This file type uses the ‘File Header’ described in chapter ”File Header” on page 273.

The following additional data is stored in the Header, following the default header:



- CursorHide: flag that indicates if the cursor are hidden.
- LabelX: the x-axis unit label string.
- LabelY: the y-axis unit label string.
- Pad: padding bytes for alignment (not used).
- XSizePhys: the physical width of the data range.
- YSizePhys: the physical height of the data range.
- XSizeUser: the width of the data range in the user interface.
- YSizeUser: the height of the data range in the user interface.

To the default file header with 64 bytes additional a block of 112 bytes is added.

The additional block contains display parameter used by the Wavecom GUI for displaying the stored data correctly.

NOTE: the following struct type could be used to extract the data header.

```
struct SigAnalData
{
    char     m_nCursorHide;
    char     m_strLabelX[40];
    char     m_strLabelY[40];
    long     m_Phis_xSize;
    double m_Phis_ySize;
    double m_User_xSize;
    double m_User_ySize;
};
```

Data

This **FileType** uses the data structure described in chapter "The Data structures" on page 274 to store the data.

A data package in the .WDA file contains the data of all data points of one line in the graphic. The data points are stored in long values(4-bit type), that is 4 Bytes in the .WDA file contains the value of one data point in the graphic.

Appendix

Questions & Answers

I got the following error message "An unnamed file contains an invalid path". Why?

When installing any WINDOWS operating system, a "Temp" folder is automatically created in your root directory. The decoder software uses that "Temp" folder to create the required temporary files. Please, check if a Temp folder is present. If not, just create a new one in your root directory, e.g. "**C:\Temp**".

Why is my fast CPU at 100 percent utilization when I run the FFT mode?

For graphics intensive tasks (e.g. FFT), the PC CPU uses as much processing power as is available to maximize the display refresh rate. If there is more than one FFT display (i.e. from two or more decoder cards), these will share the available processing power. This will not adversely affect the operation of any other decoder cards in the system.

The IF output of my receiver seems not to be suitable with 10.7 MHz IF input of the decoder card. Is there any solution?

The 10.7 MHz IF output of some receivers typically have a bandwidth of up to 500 kHz, and is intended for a spectrum analyzer. This bandwidth is too wide for the decoder IF input.

A solution is a slight modification of the receiver, i.e. to install a 455 kHz output in the receiver.

What is the maximum number of decoder cards that could be remotely controlled?

In theory, when accessing remote client cards, any number of cards may be controlled remotely from a single computer. There are, of course WINDOWS resource constraints, and network bandwidth constraints that would limit the number of clients that can be simultaneously connected.

For the average PC hardware, eight simultaneous clients is the recommended maximum.

Why does connecting to a remote decoder card sometimes take a long time?

Connecting to any decoder card on the network may take up to two minutes. The connection is made by Microsoft® DCOM, and the connection delay is the normal DCOM connection time. The wait cursor will appear while the connection is being made.

What should I do if a decoder card needs repair?

Contact your local distributor to arrange the return of your card. If necessary, it will be forwarded to WAVECOM for repairs.

Signal Interference

General

All microprocessors and personal computers emit strong broadband noise signals which propagate along the control and data lines. Strong noise signals are also often produced by printers without noise reduction features. Common noise sources include the unshielded cables for printer, monitor and mouse.

Antenna installation

The antenna is the main factor when it comes to fighting noise. A well-designed long-wire antenna, with a proper impedance matching feeder, installed well clear of any obstructions, seldom exhibits interference problems. In very simple installations where for instance an active antenna is deployed in very close proximity to the decoder or monitor, interference is bound to be present, especially in the 3 - 10 MHz range. Active antennas must always be mounted at least two meters away from any building part to be clear of the noise field which surrounds a building. It is equally important to provide a high quality grounding of the antenna mast (cold water mains).

Receiver

Receivers are often not sufficiently shielded or de-coupled, resulting in noise signals directly entering the receiver. Since many receiver types require an antenna impedance of 50 Ohm for correct matching, any deviation from this impedance results in a large increase in interference levels due to mismatching. This situation may be remedied by inserting an antenna tuner (matching device) between antenna and receiver.

HF Cabling

All HF cable plant inside the building must use shielded HF cables.

Grounding

The best grounding is provided by the cold water mains. Hot water or heating pipes are not necessarily grounded. Good quality, effective grounding of the receiving equipment is highly recommended - also for your personal safety.

Location of decoder

Despite multi-layer metallic shielding of the receiver, the PC may still radiate into the receiver if placed in close proximity. This problem may be solved by moving the PC or the receiver or both.

PCs and peripherals

PCs, printers, keyboards etc. can all be sources of heavy interference and noise if placed close to a receiver or an antenna. If possible ground the equipment and place ferrite loads on the cabling connecting the equipment.

Video Monitor

If at all possible, use a monitor which conforms to the latest Swedish MPR-II radiation standards or even better to the TCO-92 standards. The improvement in noise reduction offered by such equipment is significant and interference originating from these monitors can be expected to be negligible.

LAN

Computer networks using coaxial cabling with BNC plugs produce very high noise radiation. To combat this noise, install your antenna at least 5 m away from the building.

Conditions of Sale

General

These general conditions of sales are binding if no other conditions have been declared as applicable in the quotation or the order confirmation of WAVECOM ELEKTRONIK AG.

Customer orders are binding only if WAVECOM ELEKTRONIK AG has confirmed them in writing.

Prices

The list prices are net, and exclude VAT, shipping and packing costs, unless otherwise agreed. WAVECOM ELEKTRONIK AG reserves the right to adapt its prices to offset cost increases, e.g. salaries, material costs, and exchange rate fluctuations.

Delivery time

The delivery time is specified in the confirmation of order/contract. The delivery time may be extended due to unforeseen circumstances such as acts of God (epidemics, earthquake, etc), war, as well as delivery delays from our material suppliers.

Dispatch

The method of dispatch may be selected by the customer. Without specific shipping instructions from the customer, we reserve us the right to arrange the dispatch by any forwarder/courier of our choice. Any complaints regarding damage, delays or loss must be forwarded to WAVECOM ELEKTRONIK AG in written form within 48h from the receipt of the goods. Complaints of suspected bad packing must be forwarded to WAVECOM on the date of receipt.

Return of goods

The return of defect goods requires written approval of WAVECOM ELEKTRONIK AG before the dispatch. For a return during the warranty period, the costs of the shipping the item(s) back to the customer will be paid by WAVECOM ELEKTRONIK AG. The charges for the shipping the item(s) to WAVECOM ELEKTRONIK AG must be paid by the customer. For goods returned after the warranty period, the shipping costs for both ways must be fully paid by the customer.

Please, take great care when returning your goods to us. The customer is responsible for returning the goods to the supplier without damage. We recommend that you use the package material that was used for the delivery. Our decoding cards require "HIGHSHIELD ELECTROSTATIC SHIELDING". Observe precautions for handling electrostatic discharge sensitive devices! Protect the card against mechanical stress.

Insure your returned goods.

Payments

Customer orders can only be accepted against advance payment by bank transfer, postal money order, letter of credit, check or credit card. For letter of credit payments, we charge an additional administration fee.

Reservation of ownership

The delivered goods remain the property of WAVECOM ELEKTRONIK AG until the invoice in total is fully paid.

Cancellation

Cancellations of orders must be made in writing and have to be confirmed by WAVECOM ELEKTRONIK AG. Any additional administrative costs already incurred by WAVECOM ELEKTRONIK AG, must be paid by the customer.

Changes of Order Quantities

Changes in the quantities of an order already placed may result in a change of the applicable discount. The unit cost may be adjusted to reflect this change.

Legal Domicile

The Legal Domicile of WAVECOM ELEKTRONIK AG is Buelach, Switzerland. The buyer declares that for any legal claim against WAVECOM ELEKTRONIK AG, he waivers his legal domicile, and hereby accepts the legal domicile of Buelach. This contract is based on Swiss law.

Warranty

Despite careful testing of our equipment, component or functional failures may occur. WAVECOM ELEKTRONIK AG grants you a warranty for a period of 24 months from date of delivery. Defective components will be replaced or repaired free of charge. No liability is taken for any other claims which may arise due to consequential damage arising from the use of this product. Damage resulting from non-authorized modifications to this equipment by third parties is hereby disclaimed.

Shipping costs for equipment returned to WAVECOM ELEKTRONIK AG will be paid by the customer. In case of repairs within the warranty period, WAVECOM ELEKTRONIK AG will carry the costs of return shipping to the customer.

Obligation

The products of WAVECOM ELEKTRONIK AG are sold on the basis of technical specifications valid at the time of sale. WAVECOM ELEKTRONIK AG has no obligations to upgrade or modify equipment already sold.

Copyright

The software of all versions of the W51PC and W61PC decoders is the intellectual property of WAVECOM ELEKTRONIK AG and protected by international copyright law. Any copying of the software is prohibited without the express and prior consent in writing of WAVECOM ELEKTRONIK AG and punishable by law. In addition all warranty claims will become void.

Liability

Information contained on this publication may be changed at any time without prior notice. Despite careful preparation, this publication may contain errors or omissions and WAVECOM ELEKTRONIK AG is not liable for any resulting losses or damages.

Laws and Regulations

Before using our equipment, take note of the laws and regulations of telecommunications authorities in your country. It is the responsibility of the users of the equipment to determine whether the reception of the transmissions which may be decoded, is permitted or not. The manufacturer or vendor is not liable for violations of law of copyright or telecommunication regulations.

Declaration of Conformity

Conformity of W61PC

WAVECOM NACHRICHTENTECHNIK

WAVECOM ELEKTRONIK AG
Hammerstrasse 8
CH-8180 Buelach
Switzerland

Phone +41 44 872 70 60
FAX +41 44 872 70 66
info@wavecom.ch
www.wavecom.ch

Konformitätserklärung
Declaration of Conformity

WAVECOM ELEKTRONIK AG

erklärt, dass das Produkt
declares that the product

CE

Geräteart: Datendecoder
Data decoder

Typbezeichnung: W61PC
Type W61PC

mit den Vorschriften folgender Europäischer Richtlinien übereinstimmt :
complies with the requirements of the European Directives :

89/336/EWG Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit
(geändert durch 91/263/EWG, 92/31/EWG, 93/68/EWG und 93/97/EWG).
Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (amended by 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC)

Die Konformität mit den Richtlinien wird nachgewiesen durch die Einhaltung folgender Normen:
Conformity to the Directives is assured through the application of the following standards:

EN55022:1998 + A1:2000, EN55024:1998 + A1:2001, EN61000-6-2:2005

Anmerkungen:
Remarks
Die Messungen wurden durch das akkreditierte Prüflabor der Siemens Schweiz AG durchgeführt. Die Messprotokolle können auf Wunsch eingesehen werden.
The tests were carried out by the accredited testing laboratories of Siemens Switzerland Ltd. Test reports may be inspected on demand.

Bülach, 06.01.2006 *(Head of Quality Assurance)* (Head of Development)

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften im rechtlichen Sinne.
This declaration certifies conformance with the above mentioned Directives. Affirmation of attributes in a legal sense is not included.
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.
Security declarations given in the product documentation have to be considered.

Conformity of W61LAN

WAVECOM NACHRICHTENTECHNIK

WAVECOM ELEKTRONIK AG
Hammerstrasse 8
CH-8180 Buelach
Switzerland

Phone +41 44 872 70 60
FAX +41 44 872 70 66
info@wavecom.ch
www.wavecom.ch

Konformitätserklärung
Declaration of Conformity

WAVECOM ELEKTRONIK AG

erklärt, dass das Produkt
declares that the product

CE

Geräteart: Datendecoder
Data decoder

Typbezeichnung: W61LAN
Type W61LAN

mit den Vorschriften folgender Europäischer Richtlinien übereinstimmt :
complies with the requirements of the European Directives :

89/336/EWG	Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit (geändert durch 91/263/EWG, 92/31/EWG, 93/68/EWG und 93/97/EWG). *Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (amended by 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC)*
73/23/EWG	Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedsstaaten betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen (geändert durch RL 93/68/EWG des Rates). Council Directive on the approximation of the laws of the Member States relating to electrical equipments for uses within certain voltage limits (Low Voltage Guideline) (amended by RL 93/68/EEC of the Council).

Die Konformität mit den Richtlinien wird nachgewiesen durch die Einhaltung folgender Normen:
Conformity to the Directives is assured through the application of the following standards:

EN55022:1998 + A1:2000, EN55024:1998 + A1:2001, EN61000-6-2:2005,
EN61000-3-2:2000, EN61000-3-3:2001, EN50371:2002

Anmerkungen:
Remarks
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Manufacturer Address

WAVECOM ELEKTRONIK AG

Hammerstrasse 8

CH-8180 Buelach

Switzerland

Phone: +41-44-872 70 60

Fax: +41-44-872 70 66

E-mail: info@WAVECOM.ch

Web: www.wavecom.ch

Registration Form

We added an online product registration form on the Internet.

For the registration go to the following page:

http://www.wavecom.ch/HTML/product_registration.htm

Glossary of Terms

active window

The window on the screen where the next action will take place. The active window is indicated by a colored title bar and border.

AF-IN

The AF input has a range of 0 – 16.000 Hz. This input should be used when the source is an AF output (line or speaker) or a 12.0 or 12.5 kHz IF output used in professional digital recorders.

alert

A warning or notice of an error in the form of a message, a sound from the computer's speaker, or both.

AMBE

Advanced Multi-Band Excitation speech coding

ANSI

An acronym for the American National Standards Institute, an organization that sets standards for a variety of programming languages and systems.

AOR

Atlantic Ocean Region

APC

Adaptive Predictive Coding

ASCII

An acronym for American Standard Code for Information Interchange, pronounced "ASK-ee." It is a code in which the numbers from 0 to 127 stand for letters, numbers, punctuation marks and other characters. ASCII code is standardized to facilitate transmitting text between computers or between a computer and a peripheral device.

Baudrate

The speed in a 2FSK transmission. The duration of a bit is 1/Baud. At 50 Baud a bit is 20ms long.

Broadcast

Public or private radio station transmitting music, news...

Buffer

A temporary holding area in the computer's memory where information can be stored. In editing, it is an area in memory where cut or copied data is held, sometimes called the clipboard. See also: clipboard and type-ahead buffer.

Clipboard

The holding place for what you last cut or copied; a buffer area in memory. Information contained on the clipboard can be inserted (pasted) into other documents and other WINDOWS applications.

Context sensitive

Able to perceive the situation in which an event occurs. For example, context sensitive help presents information specific to the particular task you are performing, rather than presenting just a general list of commands.

Control key

A specific key, usually abbreviated as "Ctrl", that produces control characters when used in combination with character keys.

Database management system

(DBMS) - A software system for organizing, storing, retrieving, analyzing and modifying information.

Default

A pre-set response to a question or prompt. The default is automatically used by the computer if you don't supply a different response. Default responses prevent a program from stalling or crashing if no value is supplied by the user.

Default button

The push button with a bold border in dialogues. The default button often has a dotted-line border around the button name. The default button is chosen when you press "**Enter**" (or Ctrl+Enter depending on your configuration).

Default font

Used font if no other font is defined

DIS

The DIS input (Discriminator) has a range of 0 – 20 kHz. This input is supported by a few VHF-UHF receivers and facilitates the reception of ”Direct FSK” signals like POCSAG or PACKET-9600. The advantage of this input is the easy handling. Only the gain has to be adjusted. There is no need for an adjustment of the center or the translation frequency. DIS is only released for ”Direct FSK” modes.

Disable

To make an item unavailable for use. Disabled items reflect the WINDOWS color settings for disabled commands, and generally appear dimmed and cannot be chosen.

Enable

To make an item, such as a menu option, available to be acted upon. When enabled, items no longer appear dimmed or in the WINDOWS color setting for disabled commands and can be chosen by the user.

EOD

End-Of-Data

Error message

A message displayed to tell the user about an error or problem in the execution of a program or in the user's communication with the system. An error message is often accompanied by a beep.

EXT-DEM-IN

The EXT-DEM-IN input must be used if an external demodulator is to be connected. The minimum input level is TTL level (LO = 0 V, HI = +5 V) and the maximum is RS-232C level (LO = -12 V, HI = +12 V). Note that utilizing this facility will disable certain W51PC functions. Thus this input should be employed for special purposes only.

FFSK

Fast Frequency Shift Keying.

FFT

Fast Fourier Transform

File type

The categories of files specified by file extensions: APP, DBF, PRG, CDX, FRX, and so on.

GFSK

Gaussian Frequency Shift Keying

GUI

Graphical User Interface

HF-IN

The IF-IN-VAR has a range of 14 kHz – 1.5 MHz. Most receiver IF's are within this range.

Hot key

An underlined letter in a menu or dialogue that you can type to immediately choose an item.

IF

Intermediate Frequency

IF-IN-10.7

The IF-IN-10.7 input has a range of 10.685–10.715 MHz (or 21.385 – 21.415 MHz). This IF is common for VHF-UHF receivers.

IF-IN-21.4

The IF-IN-21.4 input has a range of 21.385–21.415 MHz. This IF is common for VHF-UHF receivers.

IF-IN-VAR

The IF-IN-VAR has a range of 14.000–1.500.000 Hz. Most receiver IF's are within this range.

IMBE

Improved Multi-Band Excitation speech coding

Insert mode

The default text-editing mode in which any character you type is inserted at the cursor position and the text to the right of the cursor is shifted to the right.

IOR

Indian Ocean Region

Keyboard shortcuts

The keystroke combinations that you can use to choose menu options instead of using the mouse.

LAN

Local Area Network

LES

Land Earth Station

LNA

Low Noise Amplifier

Loop

A section of a program that executes repeatedly until a limit or condition is met, such as a variable reaching a specified ending value.

Mark

Application	Condition	Condition
Voltage to signal ground	Negative (-)	Positive (+)
Conventional term	MARK	SPACE
Binary digit value	1	0
Timing signal state	Off	On
FSK signal state	Lower frequency	Higher frequency

MATLAB

MATLAB® is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. This collection includes the following topics.

Menu bar

A horizontal strip that appears at the top of the screen and contains menu pads.

Menu name

A word, phrase or icon on the menu bar that designates one menu. Selecting the menu pad highlights the name and causes the menu options to appear.

Menu options

Commands, found on menus, that perform specific actions. When you choose a menu option, you are telling the program what action to take.

Menu pads

The menu names found on the menu bar.

Menu system

The combination of the menu bar, menu pads, menus and menu options.

MES

Mobile Earth Station

MFSK

Multi Frequency Shift Keying

Minimize

The act of causing a window to become an icon that includes the title of the window.

Modal

Describes the state of a window or dialogue when it does not allow another window or dialogue to be brought in front of it until that window or dialogue is dismissed, for example, the Expression Builder dialogue.

MPDS

Mobile Packet Data System

NA

Not Available.

NCSC

Network Control Station Channel

Network

A collection of interconnected, individually controlled computers, together with the hardware and software used to connect them. A network allows users to share data and peripheral devices (such as printers and storage media), to exchange electronic mail, etc.

Non-modal

A window or dialogue that allows another window or dialogue in front of it while it is open, for example, the Command window.

On-line help

A reference guide, accessible while using the software, that provides additional information about commands, functions, and the interface.

Option

Different additional options are available from WAVECOM.

In the manual, options are marked with (Option).

Options are only available to government bodies.

OSI-Layer

OSI (Open Systems Interconnection) is a standard description or "reference model" for how messages should be transmitted between any two points in a telecommunication network.

Paste

To place the contents of the clipboard at the insertion point.

Path name

The full name by which an operating system identifies a file. A path name is a sequence of directory and file names, each preceded by a backslash, that specifies the path from device to directory to file that the operating system takes to locate that file.

PB

Passband

PC

Personal Computer

Pointer

A small solid box or arrow on the screen that follows the movement of the mouse and shows where your next action will take place.

POR

Pacific Ocean Region

Professional

Items only available in the professional software version are marked with (Professional).

Professional versions are only available to government bodies

PSTN

Public Switched Telephone Network

RHCP

Right Hand Circular Polarization

Right-clicking

Clicking with the pointing devices right button..

Scroll

To move through the contents of a window or so that a different part becomes visible.

Scroll bars

The controls that are used to view text that extends beyond the edge of a window. A window can have vertical and/or horizontal scroll bars.

SELCAL

Selective call systems are an efficient supplement to voice traffic. One method was the so-called single-tone-mode using five different tone frequencies, another one the two-tone-modes, where the call number is transmitted as frequency combinations.

Developments led to the five-tone-sequence systems. The five digits are often divided into two groups. The first digits work as radio net flags, the last three digits are user call numbers.

The entire call number is transmitted by consecutive tones in decade sequence. When two identical digits are to be transmitted consecutively, then an eleventh frequency is used as a repetition identifier. If there more than two identical digits are to be transmitted the repetition tone is appended to the digit tone (e.g. 22222 is transmitted as f2 fw f2 fw f2, where f2 is the tone for "2" and fw is the repetition tone).

In most systems the accuracy of the single frequencies has to be within +1/-1.5% of the nominal value.

Modifications of the tone allocation and tone duration has led to numerous systems despite many standards.

Only the EURO (EuroSignal) system uses six consecutive tones. The worldwide telephone signaling standard DTMF mode transmits two simultaneous tones.

Server

See file server.

Shift

The difference between two tones in a FSK transmission

shoc RSM

Software and database to control receivers and decoders produced by shoc Inc, R.Haenggi

Size control

A screen element found on WINDOWS that allows you to change the window size.

SNAC

Single Network Access Code

SNR

Signal-to-Noise

Space

Application	Condition	Condition
Voltage to signal ground	Negative (-)	Positive (+)
Conventional term	MARK	SPACE

Binary digit value	1	0
Timing signal state	Off	On
FSK signal state	Lower frequency	Higher frequency

Spinner

A control that allows you to increment or decrement numbers either by typing the numbers or clicking the UP and DOWN arrow keys.

String

An item of information consisting of a sequence of text characters.

SW

Software

TDM

Time Division Multiplex

TDMA

Time Division Multiple Access

Text editing window

A window in which text is displayed and can be scrolled.

Text editor

The part of the software that allows you to modify text files.

Text file

A file which contains information expressed in text form and whose contents are interpreted as characters encoded using the ASCII format.

Thumb

A gray box in the scroll bar that indicates the relative position in the text. If you want to move through the text rapidly you can drag the thumb up and down.

Unicode Font

The Unicode standard is intended to provide a 'unique, universal, and uniform' encoding for each character in all living languages (plus a few dead ones). One font (WAVECOM Unicode) is automatically installed on your computer. Other Unicode fonts with are available on the market.

unlock

To remove the restriction on the use of a disk or a file so that it can be changed, deleted or renamed. *See also: lock.*

Utility

Transmission in RTTY or FAX

Wildcard

A character that may be used to represent a sequence of characters in a path name. A common wildcard character is the asterisk (*). As an example, if you request a listing of *.TXT files in a particular application, you would see a list of all files ending with the extension TXT.

WINDOWS

Microsoft WINDOWS™ Operating System.

Word-wrap

The automatic continuation of text from the end of one line to the beginning of the next, so that you don't have to press the Enter key at the end of each line you type. If word-wrap is set off, the text you type may extend beyond the edge of the window.

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