# TECHNICAL DESCRIPTION OF
# DATA AND TELEGRAPH ANALYZER W4100DSP

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## INSTALLATION



## INTRODUCTION

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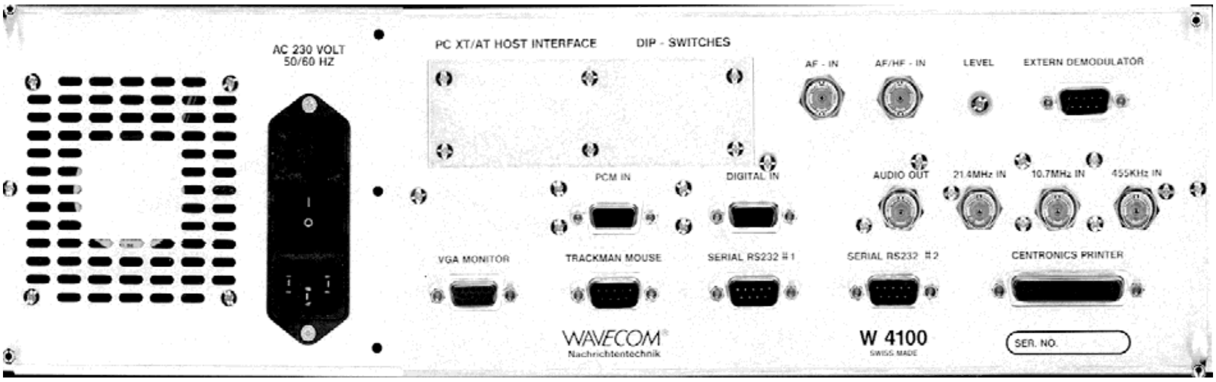
# INSTALLATION

Before connecting any peripheral equipment to the data and telegraph analyzer W4100DSP all devices should be powered off to avoid damages. Experience shows that damage often occurs due to heavy static build-ups. Because of this the metal case of the W4100DSP which is grounded through the power mains should be touched before installation of any peripheral equipment.

## COMPONENTS OF THE W4100DSP REAR PANEL




## CONNECTING THE POWER CABLE

Connect the included power cable to a 230V/50Hz power mains outlet and to the plug marked "AC 230 VOLT 50/60 Hz". A 1A mains fuse is located in a drawer in the upper part of the combined mains connector and power on-off switch. The W4100DSP is also available in a 115 Volts version with a 2A mains fuse.

## CONNECTING THE MONITOR

Connect a VGA or multi sync colour monitor to the rear DB-15 plug marked "VGA MONITOR". A matching cable is included in the complete monitor package. If an older type EGA plug is used, an adapter (DB-9 female to DB-15 male) may be obtained in most computer stores.

Practically any monitor may be adapted to the interface. Several brands of monitors have been tested.

The VGA video signal of the W4100DSP is compatible with PC-ATs having a resolution of 640 x 480 pixels. The red, green and blue color signals are analog. Please notice the paragraph "Setting of the DIP switches" of this section, where the selection of H-sync and V-sync polarity is explained.

Some PHILIPS and EIZO monitors have been tested. These models comply to the MPR II or TCO-92 radiation standard.

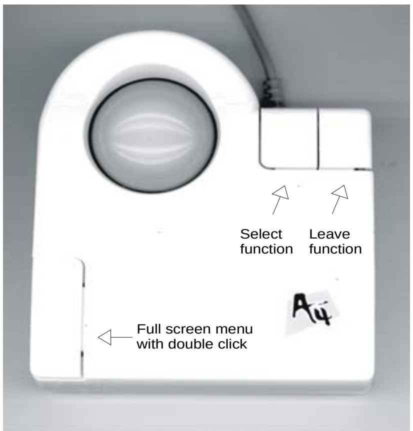
# TRACKMAN MOUSE

The A4 TrackMan Mouse included in the complete W4100DSP package, is connected to the rear DB-9 plug marked "TRACKMAN". The switch on the right side of the mouse must be set in position "3" , e.g. PC-mode or LogiTech data format. Position "2" corresponds to the Microsoft data format. This format is not utilized with the W4100DSP.

The plug is pinned as a standard, serial RS-232 interface.

The desired menu field is selected by moving the ball of the trackball, the selected field will then appear with a light blue border. Pressing the left-hand trackball key will activate the selected function. This is equal to a keypad ENTER function. Pressing the right hand trackball key will deactivate the selected function or take you back to the preceding menu.

Pressing the lower left trackball key twice quickly will pop-up a full screen menu. A more in-depth description of the operation of the trackball may be found in the "INTRODUCTION" section of this manual.




# AF-IN, HF-IN AND IF-INPUTS

Input to the various demodulators of the W4100DSP is obtained via the input plugs marked "AF-IN", "AF/HF-IN", "455 KHZ IN", "10.7 MHZ IN" or "21.4 MHZ IN". An HF or IF output is common in professional receivers. Receivers equipped with an internal demodulator may be connected to the W4100DSP using the plug marked "EXTERN DEMODULATOR". The line or loudspeaker output of the receiver is connected to the "AF-IN" inputs. If available the receiver line output should always be used. Otherwise the phone or loudspeaker outputs may be used.

All other inputs are designed for connection to IF outputs. All inputs are *equally suitable* for the decoding of HF and VHF/UHF modes. Detailed technical specifications of the inputs may be found in the appendix "TECHNICAL SPECIFICATIONS".

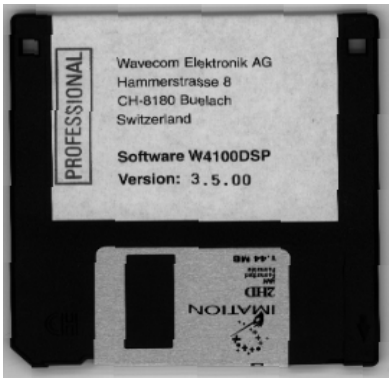
The sensitivity of all inputs

is software selected using the "SETUP\GAIN" or the “DEMODULATOR\GAIN" menu, which is included in all mode menus. The 0-100 range corresponds to an input sensitivity of 0.01 Vpp to 5 Vpp for maximum drive.

The translation frequency is adjusted by using the "SETUP FUNCTIONS \ DEMODULATOR" menu or the "DEMODULATOR \ TRANSLATION" menu included in most mode menus. The W4100DSP employs high stability DDS frequency generation, the smallest step being 1 Hz on all inputs. In addition to the analog inputs the W4100DSP also has a digital input which conforms to the RACAL data format ("DIGITAL IN"). The sensitivity of this input is fixed at 0 dB so receiver output must be adjusted to this level.

The front plate level indicator ("LEVEL") indicates the input signal level. When the red part of the indicator is turned on, the A/D converter is overloaded and the quality of the demodulator output is decreased.

# PROGRAMME DISK




Write-protect tab

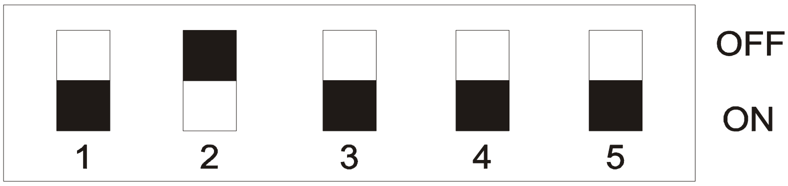
To load the W4100DSP software, place the enclosed 3 1/2" disk in the floppy drive. The file format is PC-compatible and the files may be freely copied using any PC-AT 3 1/2" disk drive. The MASTER.ARJ or APPLIK.GZ (for new boot-program version 4.2) file contains the compressed data for the master processor, and the LOADER.LOD, MASTER.LOD and SLAVE.LOD files contain the program for the two DSP processors (SLAVE).

The program files have a size of approximately 1.5 MBytes (version 3.4.05) so the loading and expanding of the program will take about 8 1/2 minutes.

It is important that the disk write-protect tab always be placed in the write-protect position which is the case when both square holes of the rear side of the disk are open. The disk may then remain in the disk drive. If the tab is not in the write-protect position there is a risk of destroying data when the W4100DSP is powered off.

After the W4100DSP has powered up, the boot program stored in EPROMs starts. The boot program loads the runtime software into system memory.

# DIP SWITCH SETUP




| Schalter | ON | OFF |
|---|---|---|
| 1 | Standard Monitor | Compaq VGA Monitor |
| 2 | Development system | Program from floppy |
| 3 | Standard Video Synch | CSynch |
| 4 | VSynch negative | VSynch positive |
| 5 | HSynch negative | HSynch positive |

After removing the W4100DSP rear cover plate marked "PC XT/AT HOST INTERFACE/DIP SWITCHES" a bank of five DIP-switches is accessible.

**SWITCH 1** switches on a Compaq type of VGA monitor. This monitor has a displacement of the horizontal position, but does not have a potentiometer for correction. For most other types of monitors this switch must be in position ON. If this switch is left in its OFF position some multisync monitors will turn dark after booting has been completed. The video signal of the boot loader always follows the H-synch switch position.

**SWITCH 2** indicates to the processor whether the program will be loaded from the floppy drive or the PC-Host interface. For loading from the floppy drive the switch must be in position OFF. For program development the switch must be ON. Thus software may be directly downloaded from a PC-AT. Any changes will only be effective after a device reset. This may be performed by pressing the "LOAD-RESET" key or powering the W4100DSP down and up again.

**SWITCH 3** changes the mode of the video sync signals. Most monitors employ separate H- and V-Sync signals, and thus the switch must be left ON. However certain industrial monitors expect both sync signals to be available on the H-line. For these monitors the switch must be OFF.

**SWITCH 4 and 5** provide a toggle of the polarity of the sync signals. The manufacturers of monitors have not been able to agree to a standard video sync polarity. However modern monitors will often be able to automatically sense the polarity. The correct position of switch 4 and 5 must therefore be found depending of the type of monitor used. As most monitors employ negative sync signals switches 4 and 5 may be left ON.

# PC/AT HOST INTERFACE

This 40 pin plug placed next to the bank of dip-switches provides for directly downloading of software from a PC-AT. For this purpose a PC add-on card manufactured by WAVECOM is necessary. This interface makes possible simple and efficient software development. The add-on card is only available with the source code. To avoid damages, the PC and W4100DSP should always be powered on or off simultaneously.

# EXTERNAL DEMODULATOR

If an external demodulator is to be connected then this input must be used.

Connect ground to pin 5, V1 data to pin 3, and F7B V2 data to pin 4. The minimum input level is TTL level (LO = 0.8 V, HI = 2.4 V) and the maximum is RS-232C level (LO = -12 V, HI = + 12 V).

This input is activated using the "SETUP FUNCTIONS\DEMODULATOR" menu.

Note that utilizing this facility will disable certain W4100DSP functions. Thus this input should be employed for special purposes only.

## 455 kHz-IN, 10.7 MHz-IN AND 21.4 MHz-IN INPUTS

All IF inputs are designed for connection to receiver IF outputs. All inputs are *equally suitable* for the decoding of HF and VHF/UHF modes.

The POCSAG, INFOCALL and GOLAY modes employ direct frequency modulation. An error free decoding is only possible at IF level.

The IF output of the receiver should be directly connected to the corresponding W4100DSP IF input using a BNC-BNC coax cable. The IF input signals are directly converted and decoded in the W4100DSP. Signals within an input voltage range from 10 mVpp to 5 Vpp are decoded without errors. Professional receivers produce a sufficient IF level, whereas amateur equipment will often need to be modified.

The bargraph TUNING indicator serves as a tuning aid. Correct tuning is achieved if the signal is displayed symmetrically around the bargraph center.

# PCM-IN INPUT

The digital PCM input of the W4100DSP utilizes a standard interface. Input must conform to the digital HDB3 signal format.

This input is compatible with the output interface of satellite demodulators and ISDN lines. The PCM input is employed when decoding 2.048 Mb/s PCM signals. Via the DSP processors a channel is selected and output to a digital-analog converter.

# DIGITAL-IN INPUT

The "DIGITAL-IN" input of the W4100DSP utilizes a standard interface. Modern digital HF and VHF-UHF receivers employing DSP (Digital Signal Processing) techniques have direct digital output interfaces. The W4100DSP decodes this input signal. The interface conforms to the RACAL standard.

# AF-OUT OUTPUT

The AF-OUT output of the W4100DSP utilizes a standard interface. It has a 12-bit D/A (digital-analog) converter followed by a low pass filter. The output may be the AF signal of a PCM channel or it may be used as an output for test signals.

# SERIAL INTERFACES RS-232 #1 AND RS-232 #2

At serial interface #1 data is available in serial format. This interface is software configured.

The "REMOTE CONTROL" RS-232 interface is used for remoting the W4100DSP. If a printer is connected to a serial interface it is necessary to ensure that compatibility exists between sending and receiving equipment.

The following parameters must be in agreement:

**Baudrate:** The baud rate is a measure of the serial interface data transfer speed. In the "SETUP FUNCTIONS\Serial #1" menu the following speeds may be selected:

300, 600, 1200, 2400, 4800, 9600 or 19200 baud

19200 baud is recommended as a standard speed for "SERIAL #1". For the "REMOTE CONTROL" interface the baud rate should not exceed 9600 baud.

**Data bits:** 7 or 8 data bits may be selected giving character sets of 128 or 256 characters. For example the ISO code table contains the German national characters ä, ö, ü within the first 128 bit combinations (123, 124, 125 decimal). However, the IBM PC code table defines these characters as decimal 132, 148, 129 and double s as 225.

Thus to print the national characters of non-English languages the interface must be set to 8 data bits.

**Stop bits:** 1 or 2 stop bits may be selected. One stop bit is normally adequate.

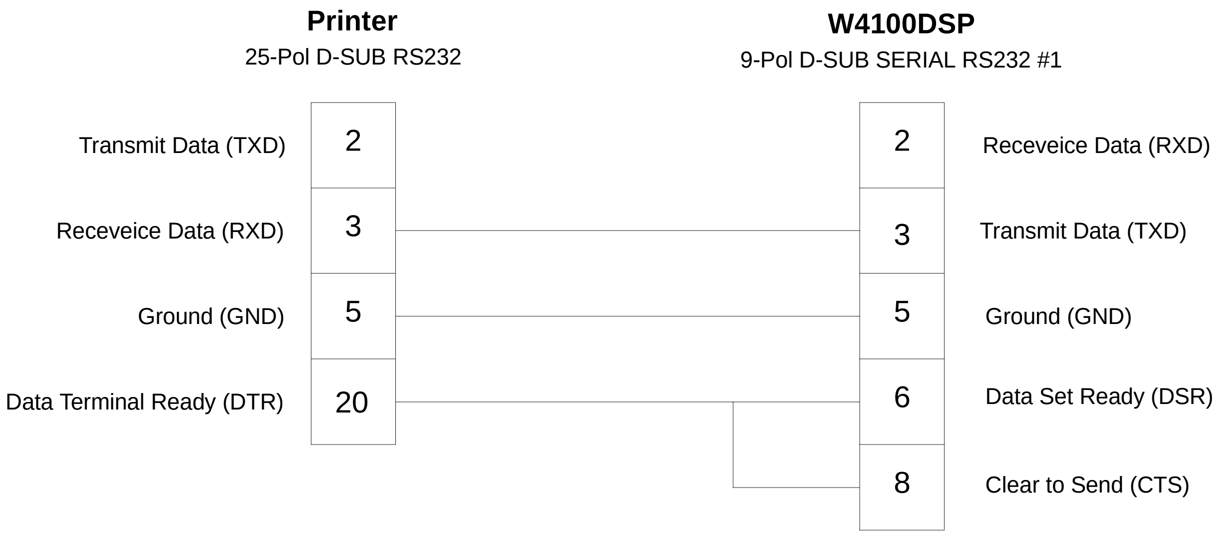
**Parity:** The parity function provides a degree of error detection and correction. As the printer cannot ask for repetition of characters received in error, parity control may be skipped ("No parity"). Options are NO, EVEN and ODD parity. No parity is recommended as standard.

**Remote address 0-99:** The address of the W4100DSP when remotely controlled may be set in the "SETUP\REMOTE CONTROL" menu. Value is 0.

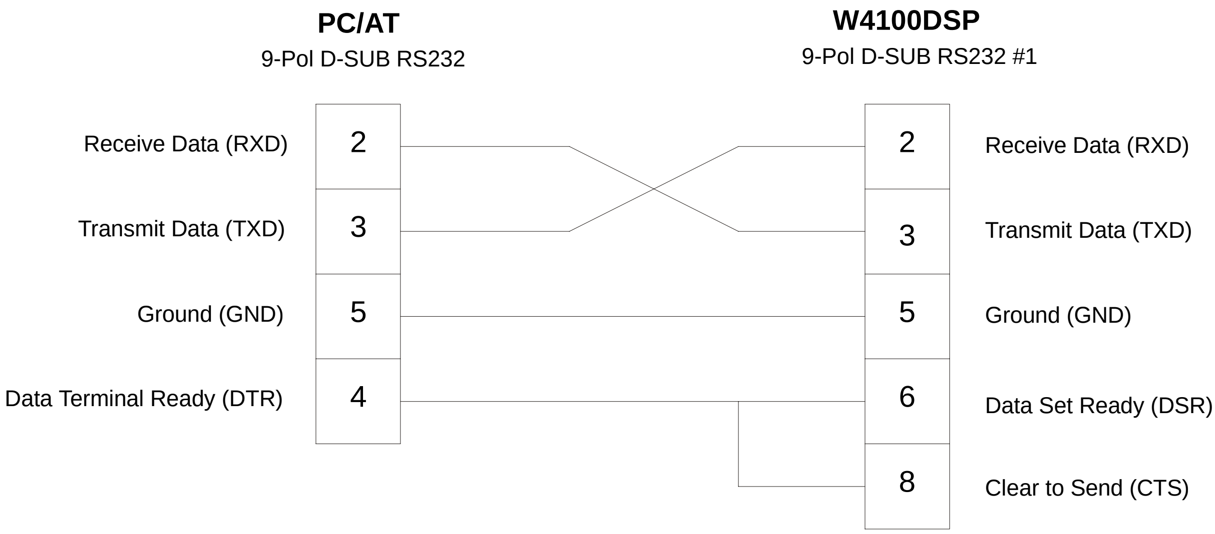
Output to serial output #1 is permanently on and is not controlled by the "PRINT-ON" or "PRINT-OFF" functions. The parallel interface may be switched on and off using the "PRINT-ON" and "PRINT-OFF" functions.

Note that, in all fax modes, output is NOT sent to the serial interface due to the huge amount of data contained in fax pictures.

# CONNECTION OF A SERIAL PRINTER




# CONNECTION OF A PC/AT




A terminal emulator program loaded in the PC/AT must control the transfer of data from the serial interface. This program handles transfer of data to the PC and the subsequent storage on a floppy or hard disk. Afterwards the ASCII files may be edited using an editor program. Many shareware terminal programs are available in the PC market. A program having a freely definable character map is recommended. This will enable use of national characters like ä,ö or ü.

# CENTRONICS PRINTER

The standard Centronics interface is used for connecting a parallel printer.

The printer type may be software selected using the menus "SETUP FUNCTIONS", "PRINTER", and "PRINTER TYPE".

Centronics printer cable length should not exceed 2m. The configuration of the DB-25 connector is identical to standard PC convention, and all standard computerprinter cables may be utilized.

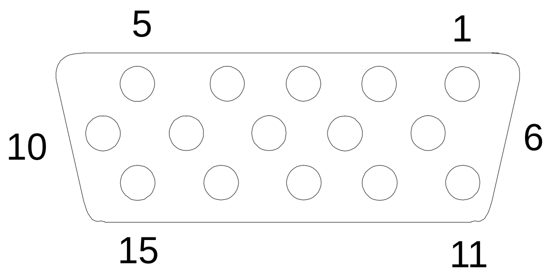
The print screen-function is at present implemented for the HP PAINTJET, HP 500C, HP 550C, HP 560C, HP 660C and HP 850C.

## CONNECTION OF A CENTRONICS INTERFACE PRINTER

| Centronics Printer (36-pin connector) signal | Pin | W4100DSP (25-Pol D-SUB connector) pin | Signal |
|---|---|---|---|
| Strobe | 1 | 1 | Strobe |
| Data 1 | 2 | 2 | Data 1 |
| Data 2 | 3 | 3 | Data 2 |
| Data 3 | 4 | 4 | Data 3 |
| Data 4 | 5 | 5 | Data 4 |
| Data 5 | 6 | 6 | Data 5 |
| Data 6 | 7 | 7 | Data 6 |
| Data 7 | 8 | 8 | Data 7 |
| Data 8 | 9 | 9 | Data 8 |
| Acknlg | 10 | 10 | Acknlg |
| Busy | 11 | 11 | Busy |
| PE | 12 | 12 | PE |
| SLCT | 13 | 13 | SLCT |
| Autofeed | 14 | 14 | Autofeed |
| Error | 32 | 15 | Error |
| Init | 31 | 16 | Init |
| Slct-In | 36 | 17 | Slct-In |
| Ground | 19 bis 30 | 18 bis 25 | Ground |

# CONNECTORS

## CONNECTOR VGA-MONITOR (15-POL DSUB JACK)

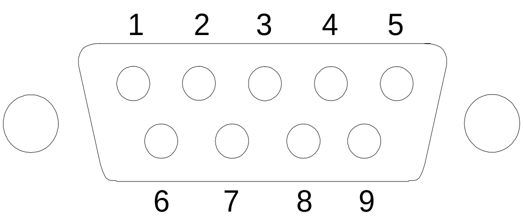



1 Analog red
2 Analog green
3 Analog blue
13 HSynch
14 VSynch

Ground
5, 6, 7, 8, 10, 11

| Connector | Signal | Function |
|---|---|---|
| Pin 1 | Analog red signal | Analog 0.7 VPP positive |
| Pin 2 | Analog green signal | Analog 0.7 VPP positive |
| Pin 3 | Analog blue signal | Analog 0.7 VPP positive |
| Pin 13 | Horizontal synch signal | Synch 31.5 KHz / TTL-Level positive or negative |
| Pin 14 | Vertical synch signal | Synch 60 Hz / TTL-Level positive or negative |
| Pin 5,6,7 | Ground | |
| Pin 8,10,11 | Ground | |

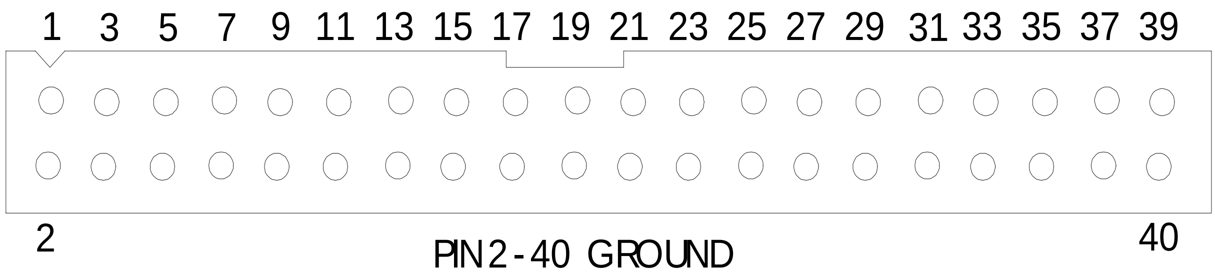
## CONNECTOR TRACKMAN MOUSE (9-POL DSUB PLUG)




2 Receive data (RXD)
3 Transmit data (TXD)
4 Data terminal ready (DTR)
5 Ground
6 Data set ready (DSR)
7 Request to send (RTS)
8 Clear to send (CTS)

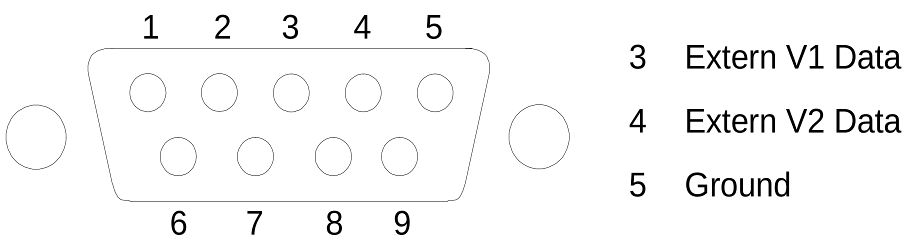
| Connector | Signal | Function |
|---|---|---|
| Pin 2 | RXD | Receive Data (Received Data) |
| Pin 3 | TXD | Transmit Data (Transmitted Data) |
| Pin 4 | DTR | Data Terminal Ready |
| Pin 5 | GND | Ground |
| Pin 6 | DSR | Data Set Ready |
| Pin 7 | RTS | Request To Send |
| Pin 8 | CTS | Clear To Send |
| Pin 1 | NC | not connected |
| Pin 9 | NC | not connected |

# CONNECTOR PIN-OUT PC/AT HOST INTERFACE



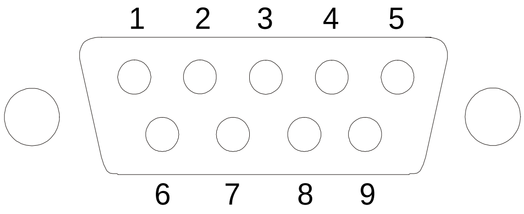

| Connector | Signal | Function |
|---|---|---|
| Pin 1 to<br>Pin 15 | Host Data 0 to<br>Host Data 7 | 8 Bit data bus from/to PC |
| Pin 17 | HWrite | Host Write Strobe |
| Pin 19 | HRead | Host Read Strobe |
| Pin 21 | HFS0 | Host Function Select 0 |
| Pin 23 | HFS1 | Host Function Select 1 |
| Pin 25 | HLDS | Host Lower Data Select |
| Pin 27 | HUDS | Host Upper Data Select |
| Pin 29 | HINT | Host Interrupt |
| Pin 31 | HRDY | Host Ready |
| Pin 33 | HEN | Host Enable Strobe |
| Pin 35 | HDIR | Databus Direction |
| Pin 37 | HCS | Host Chip Select |
| Pin 39 | EXTRESET | Extern Reset / Power On Control |

# CONNECTOR PIN-OUT EXTERN DEMODULATOR (9-POL DSUB PLUG)




| Connector | Signal | Function |
|---|---|---|
| Pin 3 | Extern V1 Data | Input for external demodulator<br>Level TTL up to +/- 12 Volts RS232 |
| Pin 4 | Extern V2 Data | Input F7B Signal<br>Level TTL up to +/- 12 Volts RS232 |
| Pin 5 | Ground | Ground |

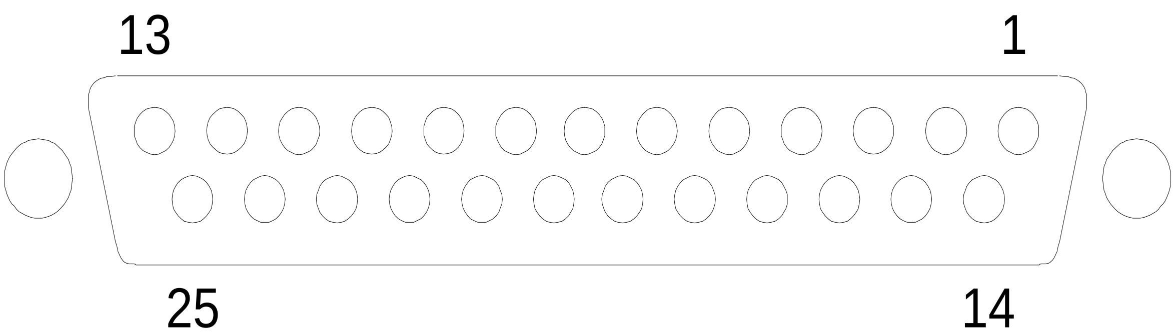
## CONNECTOR PIN-OUT SERIAL RS232 #1 AND REMOTE CONTROL




2 Receive data (RXD)
3 Transmit data (TXD)
4 Data terminal ready (DTR)
5 Ground
6 Data set ready (DSR)
7 Request to send (RTS)
8 Clear to send (CTS)

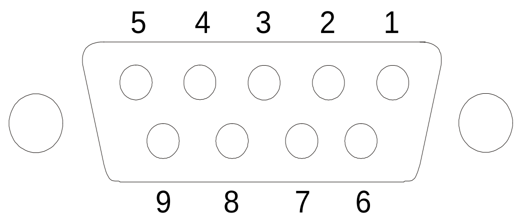
| Connector | Signal | Function |
|---|---|---|
| Pin 2 | RXD | Receive Data |
| Pin 3 | TXD | Transmit Data |
| Pin 4 | DTR | Data Terminal Ready |
| Pin 5 | GND | Ground |
| Pin 6 | DSR | Data Set Ready |
| Pin 7 | RTS | Request To Send |
| Pin 8 | CTS | Clear To Send |
| Pin 1 | NC | Not connected |
| Pin 9 | NC | Not connected |

## CONNECTOR PIN-OUT CENTRONICS PRINTER (25-POL DSUB JACK)



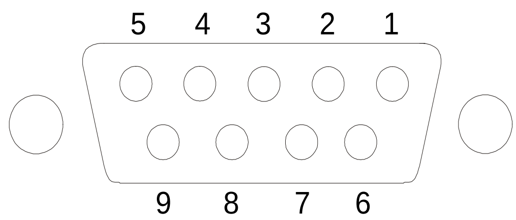

| Connector | Signal | Function |
|---|---|---|
| Pin 1 | STROBE | Data ready command for printer |
| Pin 2 to | DATA 1 to | Printer data parallel |
| Pin 9 | DATA 8 | Printer data parallel |
| Pin 10 | ACKNLG | Confirmation-signal data takeover |
| Pin 11 | BUSY | Confirmation-signal for reception readiness |
| Pin 12 | PE | no paper when HIGH |
| Pin 13 | SLCT | Confirmation-signal ON-LINE when HIGH |
| Pin 14 | AUTOFEED | automatic line feed when LOW |
| Pin 15 | ERROR | Printer in Error when LOW |
| Pin 16 | INIT | New initialisation of the printer when LOW |
| Pin 17 | SLCT-IN | DC1/DC3 Code active when HIGH |
| Pin 18-25 | GROUND | Ground |

# CONNECTOR PIN-OUT DIGITAL IN (9-POL DSUB PLUG)




| Connector | Signal | Function |
|---|---|---|
| Pin 2 | DATAEXT+ | Serial data, balanced + |
| Pin 7 | DATAEXT- | Serial data, balanced - |
| Pin 1 | CLKEXT+ | Bit clock, balanced + |
| Pin 6 | CLKEXT- | Bit clock, balanced - |
| Pin 4 | FSEXT+ | Frame sync, balanced + |
| Pin 9 | FSEXT- | Frame sync, balanced - |
| Pin 5 | GND | Ground |
| Pin 3 and 8 | NC | Not connected |

# CONNECTOR PIN-OUT PCM IN (9-POL DSUB PLUG)

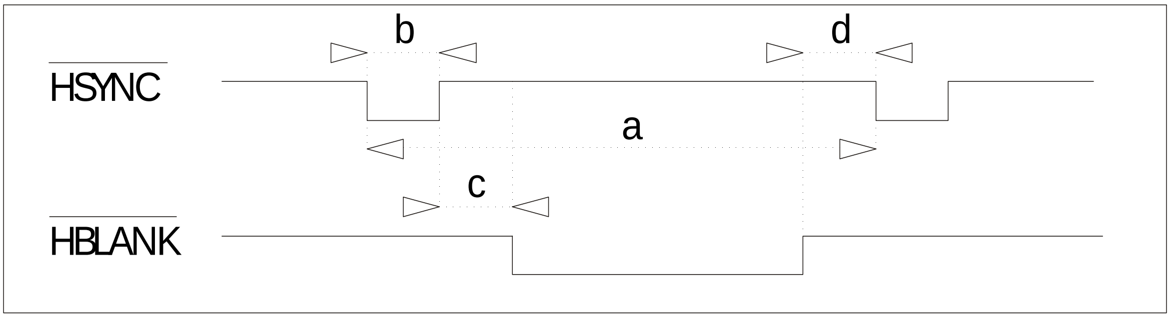



| Connector | Signal | Function |
|---|---|---|
| **Input PCM:** | | |
| Pin 6 | PCM+ | Serial data, balanced + |
| Pin 7 | PCM- | Serial data, balanced - |
| Pin 1,2,3,8,9 | GND | Ground |
| **Input SERIAL (V1/V2 is Strobe):** | | |
| Pin 4 | SERDAT | Serial data |
| Pin 5 | SERSTR | Bit clock |
| Pin 1,2,3,8,9 | GND | Ground |

# TIMING RELATIONS OF THE VGA VIDEO INTERFACE

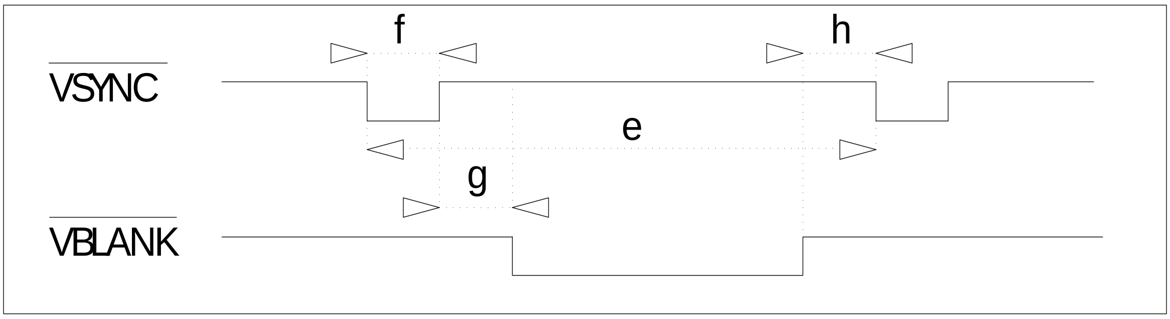
**Horizontal Timing**

| | | |
|---|---|---|
| Pixelclock: | 25 MHz | |
| (a) HSYNC Frequency: | **31.565 KHz** | / 792 pixels = 31.68 us |
| (b) HSYNC Width: | 2.08 us | |
| (c) Back Porch: | 2.72 us | |
| (d) Front Porch: | 1.28 us | |




**Vertical Timing**

| | | |
|---|---|---|
| Line cross: | 31.68 us | |
| (e) VSYNC Frequency: | **59.7843 Hz** | / 528 lines |
| (f) VSYNC Width: | 2 Z | |
| (g) Back Porch: | 30 Z | |
| (h) Front Porch: | 16 Z | |




The technical specifications of the VGA video interface conform to the PC standard. The timing relations shown above may however be useful when selecting a VGA LCD display.

# USING THE W4100DSP

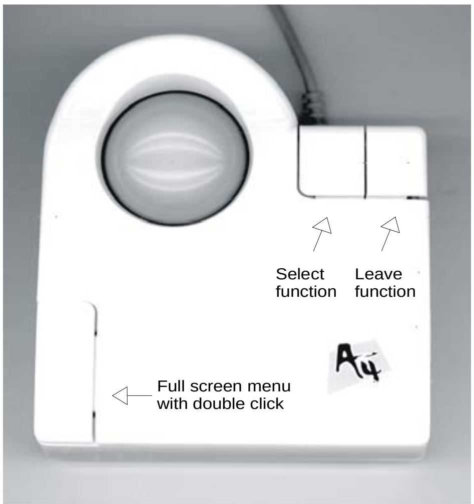
After loading of the W4100DSP application software the WAVECOM logo with the software version is displayed. After this task has been completed the main menu appears in the lower left part of the screen.

| MAIN MENU | | | |
|---|---|---|---|
| HF-Modes | VHF/UHF-DIR | VHF/UHF-IND | Satellite-Modes |
| Setup Functions | | | |

## FUNCTION OF THE TRACKMAN MOUSE AND THE FRONT CURSOR KEYS

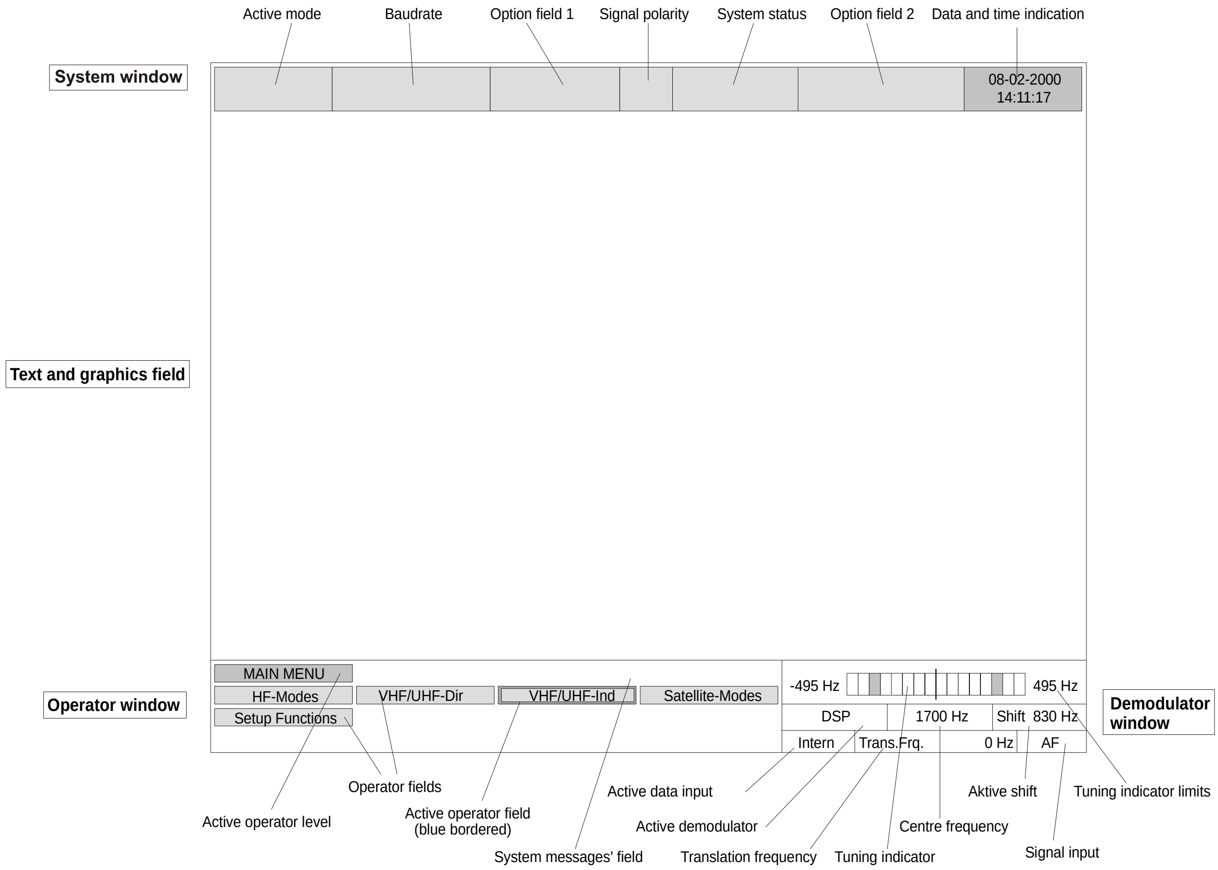
The operation of the W4100DSP is completely controlled by a menu system which in turn is controlled by a trackball or by cursor keys. The trackball consists of a moving ball and three keys. Moving the ball will take the operator from one field of the menu to another field. A selected field will appear with a light blue border line. Clicking the upper left key will activate a field with a light blue border, clicking the upper right key will deactivate it.
If the operation of the equipment is done using the front panel "UP", "DOWN", "LEFT", and "RIGHT" cursor keys, these keys are equivalent to moving the trackball in the same directions. The "ENTER" key is equivalent to the left trackball key and activates a function. If the “ESCAPE” key is pressed the function is deactivated, this key being equivalent to the right trackball key. Double clicking the lower left trackball key will display a full screen menu.

## TRACKMAN MOUSE A4TECH

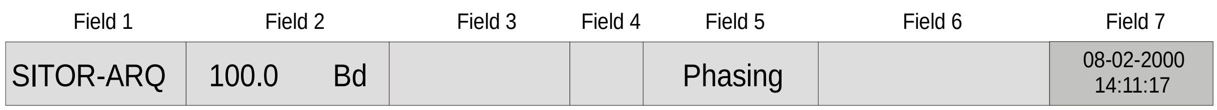


# USER INTERFACE

The screen is sub-divided into four sections: system window, text and graphics window, operator window and demodulator window.




# SYSTEM WINDOW




The system window displays information about the status of the software.

Field 1: Mode indication
Field 2: Baud rate indication
Field 3: Miscellaneous messages
Field 4: Signal polarity indication (N = normal, I = inverted)
Field 5: Signal and system state (e.g. Phasing, Synch, Traffic or Idle)
Field 6: Miscellaneous messages
Field 7: Time and date indication

# OPERATOR FIELD

Each menu field of the "MAIN MENU" will activate a submenu when the left trackball key is pressed. For instance if the STANDARD field is activated the "STANDARD" menu will appear.

# STANDARD MENU

| STANDARD | | | |
|---|---|---|---|
| Analysis | SITOR-AUTO | SITOR-ARQ | SITOR-FEC |
| BAUDOT | ASCII | CW-Morse | Packet-300 |
| PACTOR | | | |

By moving the trackball once more, a mode may be selected and by pressing the left hand trackball key this mode may be activated. For instance after activating the SITOR-ARQ mode the menu for this mode is displayed containing the fields "Signal Analysis", "Auto", "Demodulator", "Options", "100.0 Baud", "96.0 Baud var" and "Force letter".

The SITOR-ARQ mode will start if one of the fields "100.0 Baud", "96.0 Baud var" or "Auto" is activated. Then in the system window the mode "SITOR", the baud rate and the system status "PHASING" will be displayed while the software will attempt to synchronize on a SITOR-ARQ signal.

If it is desired to leave the activated function this is simply done by clicking the right hand trackball key, and the preceding menu will appear.

# DEMODULATOR FIELD

In the tuning indicator field a bargraph is displayed. The width of the indication is automatically related to the selected shift. Additionally the limits of the shift indication is displayed on each side of the indicator.

In the “Active Demodulator” field the selected demodulator type is displayed.

In the “Centre Frequency“ field the centre frequency of the selected demodulator is displayed.

In the “Active Shift” field the amount of shift is displayed.

In the “Active Data Input” field, internal or external demodulator is indicated.

The “Translation Frequency” field indicates the selected translation frequency.

The “Signal Source” field indicates whether the AF, HF, 455 kHz, 10.7 MHz or 21.4 MHz source is selected.

# FULLSCREEN MENU

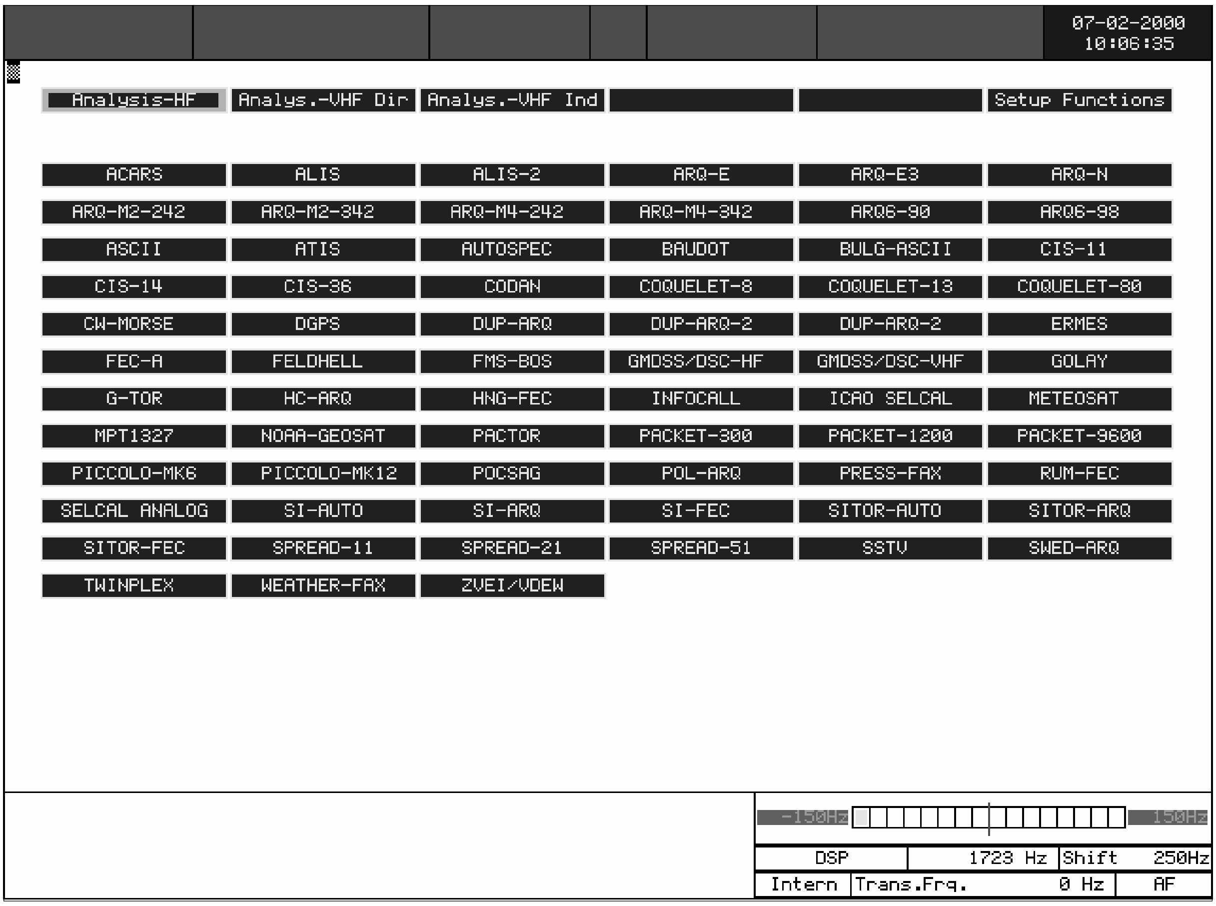
The W4100DSP offers two approaches for software menu control. One option is to use the menu field in the lower, left hand screen part.

The other option is to use a full-screen menu by double-clicking the lower, left hand trackball key. The full-screen menu displays the modes in alphabetical order. By turning the trackball ball a mode, an analysis function or the set-up menu may be selected.

Clicking the left hand trackball key or pressing the front plate “ENTER” key will activate the selected function.

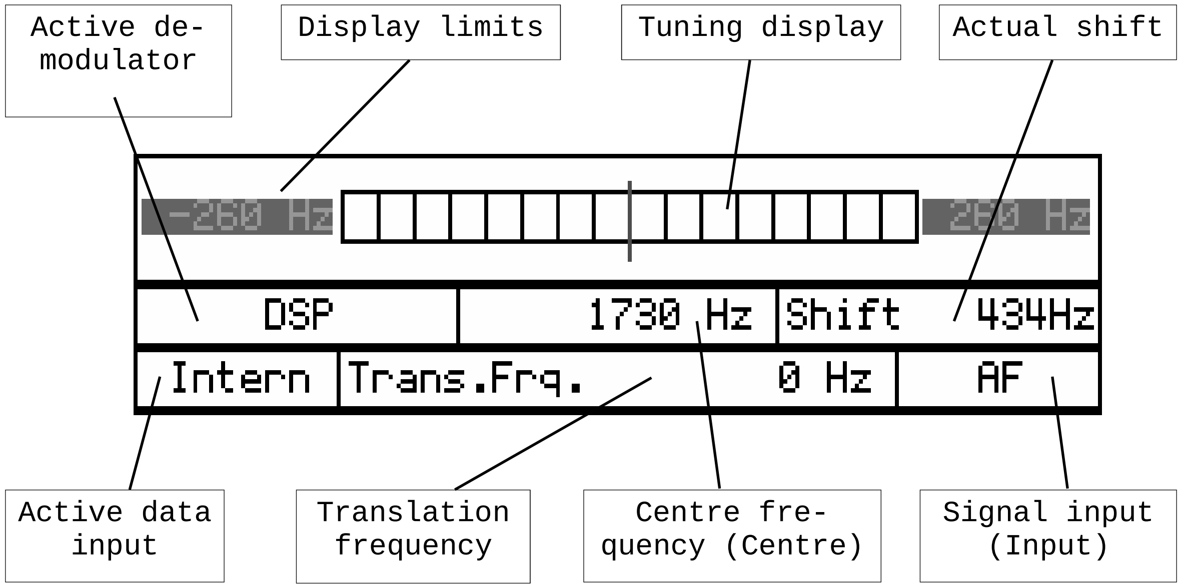
"AUTO MODE" is always activated if this mode is available.

It is possible to select the full screen menu from any function. Pressing the right hand trackball key or the front plate ESCAPE key will clear the full screen menu and the "MAIN MENU" will appear in the operator field.

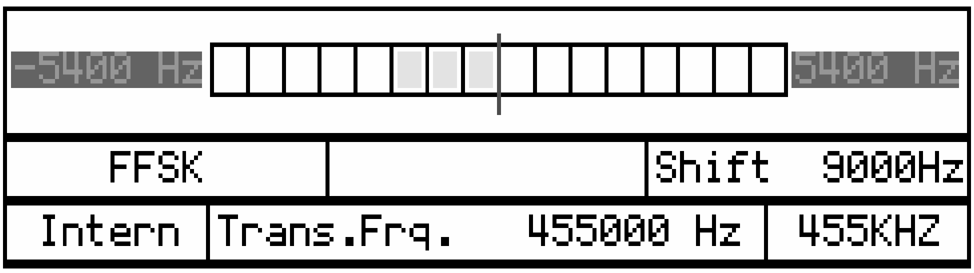


# THE DEMODULATOR WINDOW

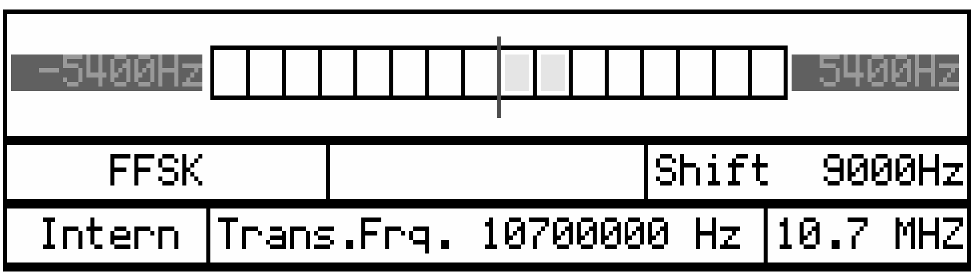
## EXAMPLE OF ACTIVE AF/INPUT




## EXAMPLE OF ACTIVE IF-INPUT 455 KHZ




## EXAMPLE OF ACTIVE IF-INPUT 10.7 MHz



# FEATURES OF THE DSP DEMODULATORS

The demodulator has its own message field placed in the lower, right hand screen area.

The upper part of this field is assigned to a bargraph tuning indicator. The magnitude of the indication is automatically related to the instantaneous frequency shift. Additionally the lower and upper limits of the shift are displayed on each side of the bargraph.

In the left field the active demodulator is indicated. Nine different demodulators are available.

**DSP-MODE:**
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 an amplitude normalization takes place. 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.

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

**FFSK and GFSK:**
Depending on the mode the FFSK and GFSK demodulator is automatically selected. Basically this demodulator utilizes the I/Q principle (Hilbert). However, filters are adjusted to accomodate the special demands in these modes.

**MFSK:**
This demodulator handles multifrequency 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. Simultaneous tones may also be demodulated. 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.

**CW-MORSE:**
The CW-demodulator utilizes a steep FIR filter and automatic amplitude control. The AGC attack time may adjusted according to 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").

**AM FAX:**
Satellite weather charts are transmitted using AM. This demodulator also uses the I/Q method. However, the amplitude of the signal is calculated instead of its frequency.

In the centre field of the demodulator window the centre frequency to which the W4100DSP has been adjusted is displayed and in the right field the value of the frequency shift. The centre frequency and the shift may both be manually adjusted by using the "DEMODULATOR" submenu or automatically using the "AUTO" option.

**DPSK:**
With 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. In the following phase comparator the phase difference is calculated from the integrator and the delayed signal.

DPSK is almost exclusively used for short wave data links.

**BPSK:**
BPSK has two phase shifts at +/- 180 degrees. For carrier recovery a Costas loop is used. A Costats loop is a PLL with a special phase comparator which removes the payload data from the PLL loop. Then the input signal is downconverted to baseband 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.

**QPSK:**
Carrier recovery is mandatory to demodulate QPSK. As QPSK has phase shifts at +/- 45 and +/- 135 degrees the signal must be suared 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 downconverts the signal to baseband, and the resulting signal is the data signal.

QPSK is almost exclusively used for satellite data links.

# "DEMODULATOR" MENU

| | | | |
|---|---|---|---|
| Demodulator | | | |
| Select Mode | Shift | Center Frq. | Translation Frq. |
| V1/V2 is intern | Input | Gain | |
| | | | |

Nearly all modes have a "DEMODULATOR" submenu. Using this menu the demodulator settings may be changed. This will not influence an active mode or stop it. An exception is made in "Select Mode" when changing demodulator type. Due to the difference in signal propagation time for the various demodulators synchronization may be lost depending on the selected mode. The mode must then be restarted by selecting a fixed or variable baud rate.

When entering AUTO MODE measurements are stopped immediately to prevent AUTO MODE from overwriting the manually selected values.

## SELECT MODE

Using this menu field either the DSP or the Mark-Space mode may be selected. The FFSK-GFSK, MFSK, CW and AM-FAX demodulators are tied to the corresponding modes and are automatically selected menu field. The "Selected Mode" is not displayed in this modes.
After activating the menu field the active demodulator type is displayed. When moving the trackball ball, the demodulator types will appear. The selected demodulator is activated clicking the left hand trackball key. Clicking the right hand trackball key will leave the function without any changes.

## SHIFT

In this submenu the shift may be manually adjusted in steps of 1 Hz.

The trackball ball or the front plate cursor keys perform two functions. Moving the ball forwards or backwards (cursor keys "UP" or "DOWN") will change the value, and moving the ball to the left or right (cursor keys "LEFT" or "RIGHT") will move the decimal position.

Depending on the active mode the shift range is 50 Hz - 3500 Hz (HF modes, indirect modes) or 50 Hz to 16000 Hz (direct modes).

# CENTRE FRQ.

In this menu the center frequency may be adjusted insteps of 1 Hz by moving the trackball ball or the front panel cursor keys.

An additional field displays the effective center frequency which is the sum of the selected center frequency and the translation frequency. If the input from the receiver is within the AF range then the translation frequency will most likely be zero.

The modes using DIRECT modulation (POCSAG, PACKET-9600) do not have a centre frequency, and thus the TRANSLATION frequency setting is equal to the effective center frequency. The "Center Frq." menu field is not displayed in these modes.

# TRANSLATION FRQ.

Adjusting the translation frequency and the centre frequency will adapt the W4100DSP input frequency to the frequency of a receiver IF output.

The minimum translation frequency resolution available with the W4100DSP is 1 Hz. The effective centre frequency is the sum of the translation frequency and the centre 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 centre frequency.

Selection of one of the three fixed frequency IF-inputs will also automatically set the translation frequency to the corresponding value and display it.

To use the translation frequency method has the advantage, that its value only has to be entered once leaving the center frequency as the only parameter to be adjusted.

For the “HF-1000” HF receiver the translation frequency is adjusted 453.300 Hz and the BF0 frequency to 1700 Hz (CW mode). In auto mode and all other adjustments the translation frequency should not be changed any more.

## V1/V2 IS INTERN - V1/V2 IS EXTERN - V1/V2 IS STROBE

Clicking this toggle field the digital bit stream may be switched from the internal demodulators to an external demodulator. The external source on the “EXTERN DEMODULATOR” input must be at least at TTL level, maximum being +/- 12 V (RS232 level). “V1/V2 is Strobe” selects the “SERIAL” input function using the PCM IN plug.

Various functions, e.g. baud rate measurement, are not available with external bit streams.

# INPUT

| Input | | | |
|---|---|---|---|
| AF | HF | IF455 KHz | IF10.7 MHz |
| IF21.4 MHz | Digital 3791 | PCM | |
| | | | |

This menu field connects the demodulator to the corresponding input. The active input is displayed in the lower right hand field. The function of these inputs is detailed in the chapter "INSTALLATION".

"Digital 3791" selects the "DIGITAL-IN" input.

## FUNCTION BANDWIDTH AT CW-MORSE

In CW-MORSE mode an additional “Bandwidth” menu field is found.

It is a well-known fact that decoding CW-MORSE is difficult. Thus in this mode the DSP demodulator serves as a high selectivity digital filter. Adjustment of the bandwidth is done activating the menu field "Bandwidth".

The bandwidth is adjustable from 50 Hz to 1200 Hz. Normal values are between 500 and 800 Hz. Bandwidths below 200 Hz make the tuning of the receiver difficult. For keying speeds above 300 BPM the filter bandwidth must be increased to 800 - 1200 Hz.

## FUNCTIONS AM-OFFSET AND AM-GAIN AT METEOSAT

Weather satellite fax transmissions consist of an AM modulated carrier. Because of this the signal strength of the input signal will influence demodulation.

Utilizing "AM-GAIN" and "AM-OFFSET" the W4100DSP may be adapted to the signal source. Both adjustments will mutually influence each other.

"AM-OFFSET" is adjustable within a range of 0 to 2047. With a "METEOSAT" signal present "AM-OFFSET" is adjusted until the bargraph is clearly driven into saturation. Next "AM-GAIN" is adjusted to place the shift symmetrically around the centre. The range of adjustment is between 0 and 100.

Correct adjustment will yield weather pictures having very good contrast.

The selected values are stored in non-volatile memory. Thus this adjustment is only necessary once. However when downloading a new software version it is unfortunately unavoidable to overwrite the stored values.

# "OPTIONS" MENU

| Options | | | |
|---|---|---|---|
| Video MSI is off | Print MSI isoff | Printer is off | LTRS-FIGS Norm. |
| IAS is on | | | |

## VIDEO MSI IS ON - VIDEO MSI IS OFF

"Multiple Scroll Inhibit" (MSI) is a function which will suppress multiple linefeeds (LF). In addition, a software generated Carriage Return (CR) 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. If these carriage returns were not removed the text would quickly disappear.

## PRINTER MSI IS ON - PRINTER MSI IS OFF

Activating this toggle field the MSI function is switched on and off for the data output on the video interface, parallel Centronics interface, and the serial interface #1.

## PRINTER IS ON - PRINTER IS OFF

Using this toggle field will activate or deactivate output to the parallel interface, but not the serial interface #1. The output on serial #1 is always active (on) and is independent of the Centronics interface.

## LTRS-FIGS NORM. - LTRS ONLY - FIGS ONLY - UOS MODE

LTRS (letters) and FIGS (figures) designates the Baudot 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 corresponding to the menu field value "LTRS-FIGS norm.".

Special alphabets, e.g. Chinese,

comprise only letters so forcing a shift into lower case mode may be an advantage ("LTRS only").

Selecting the "LTRS only" 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 ("FIGS only").
The Unshift On Space (UOS) function forces a shift into lower case after time 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 "LTRS only" mode, "UOS MODE" 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.

# IAS IS "ON" - IAS IS "OFF"

IAS is the abbreviation for ISO-ASYNCHRONOUS and SYNCHRONOUS modes. Iso-asynchronous modes have start and stop elements like Baudot, but the codewords 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 centre 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 baudrate determination.

In modes 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 ("Var. 300.0 Baud") 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.

During bad propagation conditions in the HF bands it may be advantage to activate the IAS function. Based on the measured and reduced phase error, smaller correction values are used, and thus bit glitches and the corresponding loss of synchronism are prevented.

# FRONT PANEL COMPONENTS

## SYSTEM LEDs

Six LEDs are placed on the front panel in the SYSTEM field. The **SYNCH** and **PHASING** LEDs indicate that the software is attempting to synchronize to the received signal. If the correct synchronization is achieved the LEDs are turned off, and the **TRAFFIC**, **IDLE** , **REQUEST** or **ERROR** LEDs will indicate the actual status of the received mode.

**TRAFFIC** indicates that the received station is effectively transmitting data, be it text or fax.

**IDLE** indicates that the W4100DSP software has synchronized to the signal. However, no data is transferred which is quite common in case of full duplex stations. To maintain synchronization full duplex stations transmit a repeating bit pattern. In case of simplex stations an IDLE bit pattern is also inserted into the bit stream when no data is transferred to maintain the link.

The **REQUEST** led indicates that the ARQ station being monitored has received a character in error and now requests a repetition. During the request cycle the characters are repeated and the W4100DSP will stop output. Requests will be repeated until the receiving station sees the received character to be error free.

The **ERROR** led indicates that the W4100DSP software has detected a data error. The ERROR indication has the highest priority of all status messages.

Status messages for synch, phasing, traffic, idle, RQ and error are displayed in the top screen status messages' field.

## TUNING- AND LEVEL-BARGRAPH

The **Tuning Indicator** is a tuning aid. Most data transmission modes utilize two keying frequencies, Mark and Space. When correctly tuned these two frequencies will be placed symmetrically to the centre of the tuning indicator (the centre of display line). A detailed instruction on how to tune correctly is found in the "Introduction" section of this manual.

The **LEVEL-indicator** indicates the level of the input signal. In conjunction with the DSP, additional logic circuitry produces a continuous, stable indication very similar to the SLOW AGC function of a short wave receiver.

When correctly adjusted all green bar elements will be turned on if a very strong signal is present. When a red LED is continuously on, the demodulator is overloaded. Level adjustment is made in the "DEMODULATOR\GAIN" menu.

# CURSOR KEYS

The **ENTER, ESCAPE, CURSOR UP, CURSOR DOWN, CURSOR RIGHT** AND **CURSOR LEFT** keys may substitute the trackball. Using the Up, Down, Left and Right cursor keys the desired menu field may be selected. The selected function is then activated using the ENTER key or the succeeding sub-menu is called. The ESCAPE key is used when leaving a selected and activated function or when going back to the preceding menu level. Using the cursor keys the W4100DSP may be operated very efficiently without a track ball.

# DATA LEDs

These LEDs display the B and Y levels (also called Mark and Space) detected by the demodulator or a digital input via the EXTERN DEMODULATOR input. V1-DATA is used to indicate the two keying states of a normal FSK transmission (F1B) and V2-DATA is used to indicate the keying states of the second channel in a F7B transmission.

## LOAD-RESET, PRINT ON-OFF, PRINT SCREEN AND REMOTE ON-OFF KEYS

Using the **PRINT ON-OFF** key or software the Centronics printer interface may be toggled on or off.

The **LED PRINT ON** indicates that the data output on the Centronics interface has been activated by the software and that data is being output.

Using the **REMOTE ON-OFF** key the blocking may be deactivated or the W4100DSP pre-configured for permanent remote operation. If the W4100DSP receives a valid control character on serial interface #2 the remote mode is automatically activated and all other controls deselected.

The **REMOTE ON LED** indicates that the W4100DSP may only be operated in remote mode via the serial interface. All trackball and front panel key functions are blocked except the LOAD-RESET key and the REMOTE ON-OFF key itself.

The **LOAD-RESET** key initiates a complete restart of the device similar to power up - this means that a real hardware reset is generated. The program is also reloaded from the diskette.

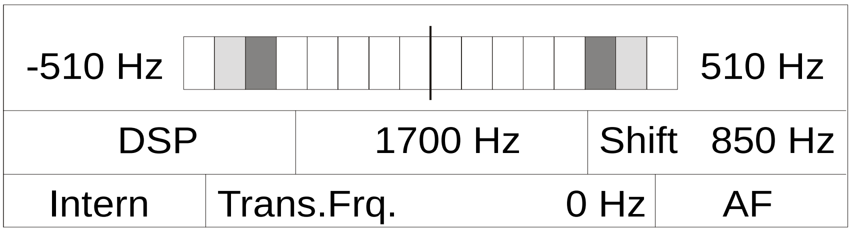
The **PRINT-SCREEN** key produces a complete screen print out of the actual screen content. The print screen function supports HP Deskjet 500C, 550C, 560C, 660C, HP 850C and HP Paintjet color printers. Before using print screen a printer driver for one of these printers must be activated in the "SETUP FUNCTIONS" \ "PRINTER" \ "PRINTER TYPE" menu. After pressing the PRINT SCREEN key a message is displayed "Screen dump in progress". The W4100DSP multitasking kernel takes care of the screen dump without affecting an active mode or the operation of the unit.

# TUNING RADIO DATA SIGNALS

Most modes have an "AUTO" option. If this option is activated the W4100DSP will automatically tune to the received FSK signal. First the software measures the mark and space frequencies, calculates the shift and determines the resultant centre frequency. Then the demodulator is automatically adjusted to the correct shift and centre frequency.

## TUNING A FSK (F1B) SIGNAL

Tuning with DSP demodulator
Shift 850 Hz, Center frequency 1700 Hz




Most 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 tuned relative to centre of the tuning indicator.

## TUNING A TWINPLEX (F7B) SIGNAL

Tuning with DSP demodulator,
Shift 115-170-115 Hz, Center frequency 1700 Hz

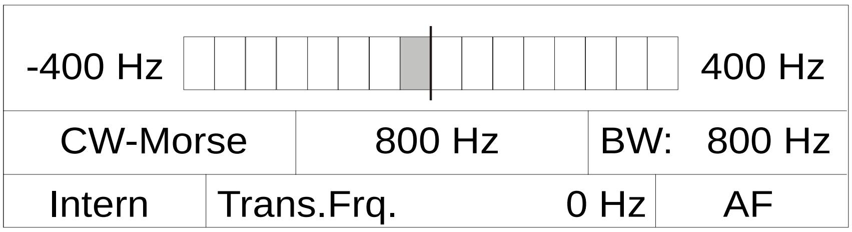

In Twinplex mode four frequencies are keyed to increase the data transfer rate. These frequencies may be asymmetrically grouped (e.g. 115-170-515 Hz).

In the Twinplex menu an option gives the operator a choice of six pre-selected shifts in the menu item "Fixed shifts".

The tuning of twinplex transmissions must always be done in such a way that the two INNER frequencies are symmetrical relative to the tuning indicator centre.

# TUNING A CW-MORSE SIGNAL

Automatically 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. This modulation is output by the receiver as a tone.

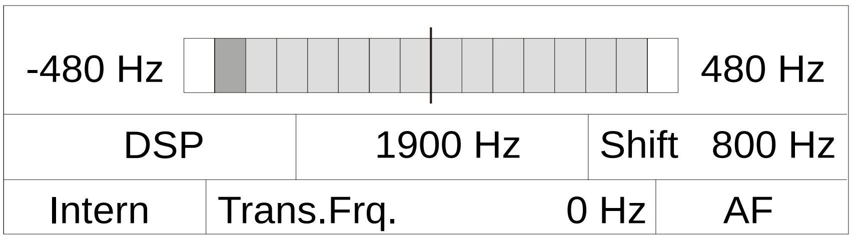
With no signal (tone) present the bargraph will remain turned off, whereas when a signal is present one bargraph element will turn on at a position determined by the value of the beat frequency relative to the selected centre frequency.

The bandwidth of the CW demodulator may be adjusted between 50 and 1200 Hz. As a standard adjustment a bandwidth of approximately 600-800 Hz is recommended. In case of unstable transmission the bandwidth must be increased up to 1000 Hz. The narrower the bandwidth, the better the SNR of the demodulator. The automatically adjusted FIR filter provides an optimized SNR.

In addition to the bandwidth the centre frequency may be changed from 600 Hz to 1800 Hz, the centre frequencies 800 Hz and 1000 Hz being standard.

# TUNING A WEATHER-FAX SIGNAL

Tuning a DSP demodulator,
Shift 800 Hz, Centre frequency 1900 Hz

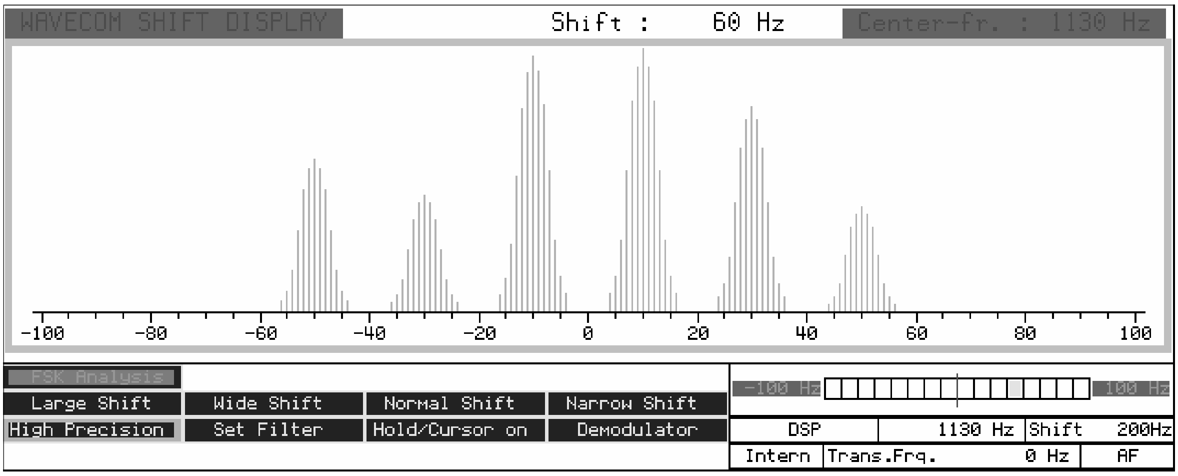



Weather and press facsimile signals transmitted in the HF bands are frequency modulated. Satellite transmissions from e.g Meteosat are amplitude modulated.

In all modes the tuning of the FM or generated AM signal is done symmetrically around the centre of the bargraph. Weather chart signals containing no grey 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 bargraph will be more intensively lit.

# TUNING A PICCOLO-MK6 SIGNAL

Selecting "Signal Analysis" with pre-selection "Narrow Shift"
High Precision Mode, Center frequency 1700 Hz

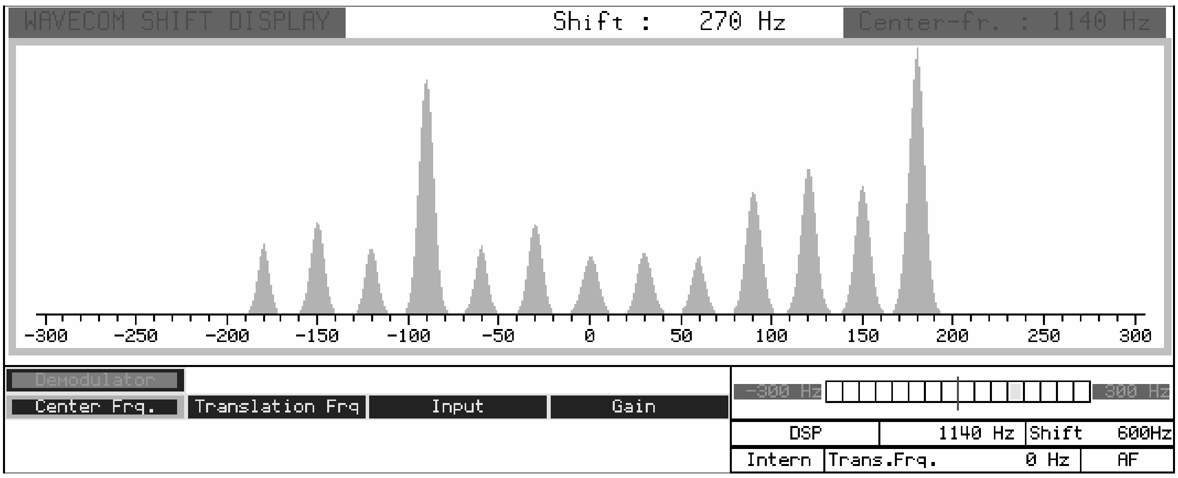



MFSK signals like PICCOLO or COQUELET employ from six to thirteen tones. Therefore tuning is most easily done using the "Signal Analysis" software. The downmost field displays graphically the various tones which have been sampled over a certain time interval. In this case the signal shown is a PICCOLO-MK6 transmission. By tuning the receiver or changing the WAVECOM center frequency in the menu field "Center Frq." the tones must be symmetrically grouped around the center "0".

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

# TUNING A COQUELET-13 SIGNAL

Selecting "Signal Analysis" with DSP-MODE
Pre-selection "Normal Shift", Center frequency: 1140 Hz



# TUNING AN ERMES SIGNAL

## Selecting ERMES with High Precision Mode, Center frequency 1700 Hz


The Europe-wide ERMES paging system is one of the very few modes in which the IDLE state (no information) is not symmetrical to centre frequency. There fore the VHF-UHF receiver must be adjusted in such a way that the two IDLE state indications are shifted four steps to the night (dark fields). Only when information is transmitted (TRAFFIC stak) may the two light fields be observed.

# FUNDAMENTALS OF TELETYPE TRANSMISSIONS

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 W4100DSP. It is assumed that the user is familiar with the general working of telecommunication systems, in particular radio systems.

By **digital information** we mean information which is represented by discrete states of the transmission medium. In contrast to this **analogue** information is represented by an infinite continuum of states. For example live music is analogue 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, shortwave link, satellite link or any other way of connecting two points for communications is called a **channel**.

# BITS, CODEWORDS and CODES

The basic building block of data and telegraph signalling 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 signalling unit called a **Baud (Bd).**

Bits are assembled into patterns or **codewords** with a certain length which is expressed in number of bits. The codewords 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 the digitised speech.

Codewords are assembled into **alphabets** or **codes**. In some codes the codewords 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. Codewords are composed of dots - the smallest unit -, dashes and spaces, one dash being equal to three dots. "E" is the shortest word represented by a dot equal to one '1' and 0 (zero) is the longest codeword represented by dash-dash-dash-dash-dash" equal to 19 dots, '1110111011101110111' in binary notation. The reason for the unequal length of the codewords is 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 is 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 25 = 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).

# SYNCHRONISATION

To enable the receiving end of a data or telegraph link to interpret the received codewords in a meaningful way, the receiver must first be **synchronized** to the incoming bitstream, and next achieve codeword **phase**. Basically the receiver will search for a certain bit pattern in the bitstream and when found transmitter and receiver are synchronized.

Before the widespread use of electronic circuits all telegraph devices were of electromechanical 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 codewords 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 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 codewords 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 like transmissions a leading preamble of either a sequence of alternating zeros and ones and/or a repeated fixed pattern is often used for synchronization purposes.

# TELEGRAPH SPEED, BITRATE AND BAUDRATE

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

The **telegraph speed** or **baudrate** is the inverse of the duration of one channel signalling unit and has the unit Baud (Bd). So if one channel signalling unit has a duration of 10 ms, then the telegraph speed is equal to 1/0,001 = 100 Bd. If the channel has only two signalling levels, e.g. 0V and +5V, bitrate is equal to baudrate, i.e 100 bps.

If four levels were used below, the baudrate would still be 100 Bd, but now the bitrate would be doubled to 200 bps, each baud representing two bits.

By signalling levels is meant the different values a signalling unit may assume - for binary signalling 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.

# SHIFT, MARK AND SPACE

In principle to transmit telegraph information on a radio path you only need a transmitter which is keyed on and off. However due to the high level of disturbances frequency shift keying (FSK) is used. In this mode the transmitter is continously on, but transmits alternately on two different frequencies, one representing "Mark" level and the other "Space" level. The difference between the two frequencies (frequency deviation) is called the "Shift" and may for instance be 170, 425 or 850 Hz.

# ONE-WAY TRAFFIC, SIMPLEX AND DUPLEX

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

If information is sent only in one direction it is referred to as **one-way traffic**.

If information is sent in both directions, but one in direction at a time it is referred to as **simplex**.

If information is sent in both directions simultaneously it is referred to as **duplex**.

# INCREASING THE DATA THROUGHPUT

Ongoing efforts are being made to exploit as much as possible of a given channel capacity. One way is to process data to be transmitted in such a way that redundant information is removed before transmission. 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.
The removal of redundant information is called **compression**. The ratio between the size of the original data and the compressed data depends on the nature of the data and the efficiency of the compression technique. These techniques are used in commonly known compression software like PKZIP, ARJ and LHARC. Compression is used in the PACTOR mode.

In **frequency multiplex (FDM)** a carrier frequency is modulated with a number of sub carriers within a standard telephony channel from 0.3 kHz to 3 kHz. 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.

In **time multiplex (TDM)** 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 bitstream, 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.

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 digitised secure voice, computer network access and image or file transfer often uses **parallel transmission**. The serial codewords are fed to a serial-to-parallel converter and then to the sub carrier modulators of a FDM.

# ENCRYPTION

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

**Encryption** may be **on-line** or **off-line**. On-line encryption takes places at transmission time, whereas off-line encryption is done before transmission, usually in the form of coding the clear language 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.

**Bit transposition** replaces bits in one position in a codeword with bits in another position.

**Shift-register encryption** uses one or more shift-registers into which the clear language message is shifted and extorted 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 initialised to the same value - the seed.

# DATA PROTECTION

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

To protect the data extra - redundant - information must be added to the 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 - one-way, simplex or duplex - channel codes and protocols have been devised to detect or correct transmission errors or to both detect and correct errors.

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

One 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 released. This code has no correcting capability.

Another ARQ code is the ARQ-1A **parity code**. The codewords 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. 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 one-way systems there is of course no return channel so the IRS cannot request repetitions. Therefore the codes used must very robust and be able to correct errors at the receiving end - **Forward Error Correction (FEC)** is used.

One of the worst enemies of one-way 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 codewords 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 codeword 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 **convolution 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 are extorted to form the value of the parity bits. After convolution the bits are interleaved to further improve noise immunity. FEC-A is such a code.

# DUPLEX MODES HF

## DUPLEX MODES MENU

| DUPLEX | | | |
|---|---|---|---|
| Analysis | ARQ-E | ARQ-E3 | ARQ-N |
| ARQ-M2-342 | ARQ-M2-242 | ARQ-M4-342 | ARQ-M4-242 |
| DUP-ARQ | DUP-ARQ-2 | POL-ARQ | BULG-ASCII |

Full duplex mode is used when in case of point-to-point connections there is a need for simultaneous two-way communication. In case of voice communication duplex permits simultaneous and independent directions of speech like an ordinary telephone connection. Full duplex data communications is used when there is a need for a very high data throughput in both directions (e.g. on the main radio links of diplomatic networks) and where terminal equipment, which uses special protocols operating in full duplex, is employed.

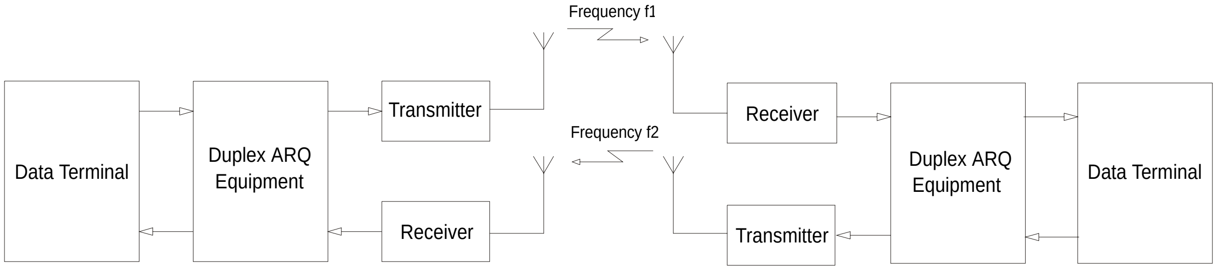
Full duplex connections need separate receiving and transmitting antennas at each station. As reception and transmission are simultaneous an efficient antenna decoupling is necessary.

Full duplex equipment transmits an acknowledgement on frequency f2 for data blocks received on f1. Should any one of the two frequencies be subject to disturbances, the transfer of data in either direction becomes impossible.

By employing ARQ-data protection equipment and the corresponding coding it is possible even on poor short wave links to obtain levels of errors so low that the link quality is comparable to that of a telephone line and therefore permits an unlimited data transfer.

Modern ARQ equipment is not only capable of teletype transmission, but computer data, fax data, etc. may also be transferred.

## FULL DUPLEX MODES



# SIMPLEX MODES HF

## SIMPLEX MODES MENU

| SIMPLEX | | | |
|---|---|---|---|
| Analysis | SITOR-ARQ | TWINPLEX | SI-ARQ |
| SWED-ARQ | ARQ6-90 | ARQ6-98 | HC-ARQ |
| PACTOR | ALIS | SI-AUTO | G-TOR |

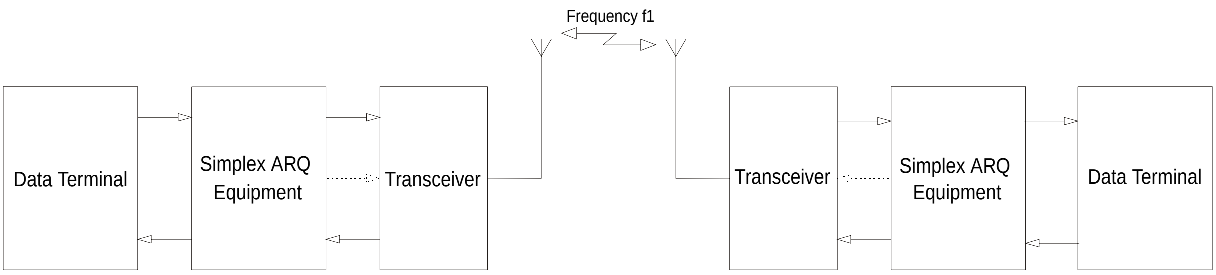
The simplex mode is based on the rapid switching of receiving and transmitting directions during the data transfer. In this way a two-way link is established between two radio stations, but only in one direction at a time. While it is possible in principle to employ FEC, ARQ is mainly employed.

When employing ARQ a data block of distinctive length (e.g. 30 bits) and with additional control information is transmitted. This permits the receiving station to perform an error check.

After transmitting a data block the direction of transmission is changed. The receiving station informs the transmitting station whether the received data block must be repeated. Then the direction of transmission is changed again. The transmitting station transmits the next data block if the preceding block was acknowledged or repeat it if the acknowledgement was negative or no acknowledgement at all was received. This procedure is repeated approximately once per second. By transferring the necessary control sequences a change of direction is continuously possible.

Based on historic reasons these type of systems are designated as simplex systems in spite of their half duplex characteristics. A decisive factor in the choice of system is the cost. Full duplex systems need another antenna with its own mast displaced from the first one, another receiver and a remote control system for the displaced receiver.

## SIMPLEX MODES



# FEC MODES HF

## FEC MODES MENU

| FEC | | | |
|---|---|---|---|
| Analysis | FEC-A | SITOR-FEC | SI-FEC |
| AUTOSPEC | SPREAD-11 | SPREAD-21 | SPREAD-51 |
| HNG-FEC | RUM-FEC | DUP-FEC-2 | |

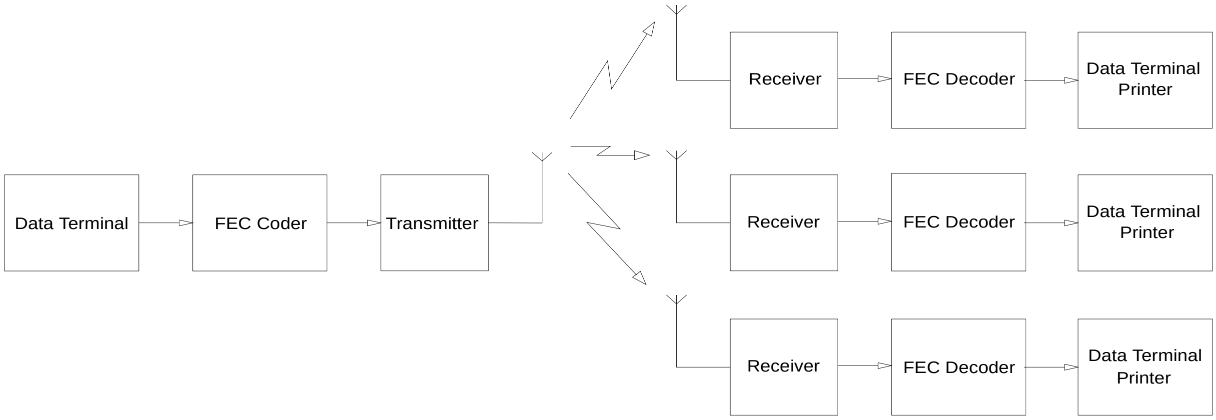
FEC modes (Forward Error Correction) base on a one-way data transfer from one transmitting station to one or more receiving stations. It is also used in cases where the receiving station may not transmit (radio silence). Earlier systems used unprotected 50 Baud transmission, but in modern systems today efficient error correcting devices are utilized. The employment of error correcting codes means a marked increase in transfer quality.

A simple way of error correction is to transmit the same data on several channels but delayed in relation to each other. A more efficient error correction is obtained by using a convolution code. This coding method employs shift registers and modulo two addition. The multiplexing circuit transmits information and parity bits alternately. The number of control bits is equal to the number of information bits.

Another method of FEC is block coding. A parity block is added to a data block of a randomly chosen length. The parity block is constructed by the binary division of the bits of the data block by a generator or parity polynomial. Inside the transmitter this division results in a parity block, that then is transferred to the data block.

The data transfer quality may also be improved noticeably - with a very reasonable effort - by utilizing interleaving techniques.

## FEC MODES



# MFSK MODES HF

## MFSK MODES MENU

| MFSK | | | |
|---|---|---|---|
| Analysis | Piccolo-MK6 | Piccolo-MK12 | Coquelet-8 |
| Coquelet-13 | Coquelet-80 | ALIS-2 | |

Multi Frequency Shift Keying (MFSK) systems are quite often heard on short-wave. Systems transmitting one tone at a time or several tones at the same time may be encountered. Even fast simplex systems use MFSK with a tone duration of only 4 ms.

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 in the element period in MFSK compared with binary transmissions having the same baud rate. This produces a substantial increase in the insensivity to multipath propagation and noise.

Early Piccolo versions (Mark 1, 2 and 3) employed 32 tones. Each tone represented a character of the ITA-2 telegraph alphabet. Later it was found that two sequential tones improved the SNR. The more recent Piccolo Mk 6 uses two times six possible tones each having a duration of 50 ms. This results in 36 possible combinations of which 32 are necessary for the transfer of ITA-2 characters. Piccolo Mk12 uses 12 tones so that the transfer of ASCII characters is possible.

The Coquelet-8 and Coquelet-13 modes employ the same principle of transmission. Coquelet-8 has additional tone combinations, which are used for improving transmission reliability. Coquelet-13 is an asynchronous system.

MFSK modes have small spacing between adjacent tones. Though the distance between adjacent tones in the early 32 tone Piccolo versions was only 10 Hz, the recent versions use 20 Hz spacing. For Piccolo Mk6 this means a total necessary bandwidth of 180 Hz, and for Piccolo Mk12 300 Hz. The tone spacing necessary to avoid inter symbol interference is calculated as the inverse of the tone duration.

MFSK systems as COQUELET-80 also employ forward error correction or are full duplex-ARQ or simplex systems as ALIS-II 8FSK.

# VHF/UHF DIRECT MODES

## VHF/UHF DIRECT MODES MENU

| VHF-UHF DIRECT | | | |
|---|---|---|---|
| Analysis | POCSAG | GOLAY | INFOCALL |
| ERMES | PACKET-9600 | | |
| | | | |

Contrary to what is the case on short-wave many different types of transmission may be encountered in the VHF-UHF bands. Pure data transmission systems, as known from the HF bands, are quite rare with satellite transmissions as an exception.

Compared to the baudrates used on the HF bands the rates on the VHF-UHF bands are high. POCSAG employs 512, 1200 and 2400 Baud, adaptive GOLAY 300 or 600 Baud ERMES 3125 Baud and INFOCALL, FMS-BOS, ATIS, MPT-1327/1343 and ZVEI-VDEW 1200 Baud. New commercial modes employ speeds up to 9600 Baud, while radio amateurs with special transmission and reception equipment already work with 9600 Baud GFSK.

The modulation methods used on HF: 2FSK, 4FSK and GFSK are also used on VHF-UHF. FFSK is a special implementation of the FSK modulation; the frequency shift is achieved with well-defined phase states. Modern systems like ERMES and MODACOM use an extended 4-PAM/FM modulation (Gaussian) scheme. At present phase modulation is an exception in the VHF-UHF bands.

POCSAG, INFOCALL and GOLAY are pure FEC systems with extensive error detection and correction capabilities. The digital signal systems FMS-BOS and ATIS are ARQ simplex systems. If a call has not been acknowledged within a certain time the call is repeated.

A detailed description of the various systems may be found in the "MODES" section of this manual.

A characteristic of the VHF/UHF transmission modes is the way in which the carrier is modulated. Some like POCSAG, ERMES mode or PACKET-9600 use DIRECT (carrier) modulation. The modes may only be decoded using the receiver IF signal output.

Other systems like MPT1327/1343, PACKET-1200 and ACARS utilize INDIRECT modulation. Here the carrier is modulated with another carrier. To demodulate INDIRECT modes the receiver demodulator is necessary and the signal can thus only be taken from the receiver AF output. A detailed description of the carrier modulation methods may be found on the end of this chapter.

# VHF/UHF INDIRECT MODES

## VHV-UHF INDIRECT MODES MENU

| VHF-UHF INDIR | | | |
|---|---|---|---|
| Analysis | SELCAL analog | PACKET-1200 | MPT-1327 |
| ACARS | ATIS | FMS-BOS | ZVEI-VDEW |
| GMDSS/DSC-VHF | | | |

Contrary to what is the case on short-wave many different types of transmissions may be encountered in the VHF-UHF bands. Pure data transmission systems, as known from the HF bands, are quite rare with satellite transmissions as an exception.

Compared to the baudrates used on the HF bands the rates on the VHF-UHF bands are high. Most indirect modes uses 1200bps, and ACARS 2400 bps.

The most common modulation methods used on VHF/UHF are 2FSK, FFSK, 4FSK and GFSK. FFSK is a special implementation of the commonly used FSK modulation; the frequency shift is achieved with well-defined phase states. Modern systems like ERMES and MODACOM use an extended 4-PAM/FM modulation (Gaussian) scheme. At present phase modulation is an exception in the VHF-UHF bands.

The digital signaling systems FMS-BOS, MPT-1327, ACARS and ATIS are simplex ARQ systems. If a call has not been acknowledges within a predetermined time window, the call is repeated.

PACKET-1200 is originally based on the X.25 protocol. In this mode the data blocks are repeated until the reciever acknowledges error free reception.

The analog selective call systems ATIS and GMDSS/DSC are one-way systems without an acknowledgement, if this is not explicitly requested. A more detailed description of the various systems may be found in the "MODES" section of this manual.

All indirect modes - subcarrier modulation - are compatible with commonly found voice equipment. The digital information is carried over the voice channel as FSK. Thus the device may used for voice and data transmission. An exception is ACARS because air radio per tradition utilizes AM.

Decoding indirect modes can only take place using the receiver NF output. The receiver serves as demodulator of the FM or AM carrier, while the W4100DSP demodulator processes the subcarrier modulation.

A more detailed description of the carrier modulation methods may be found at the end of this chapter.

# FAX MODES

## FAX-SSTV MODES MENU

| | | | |
|---|---|---|---|
| FAX-SSTV-HELL | | | |
| Analysis | WEATHER-FAX | PRESS-FAX | SSTV |
| FELDHELL | | | |

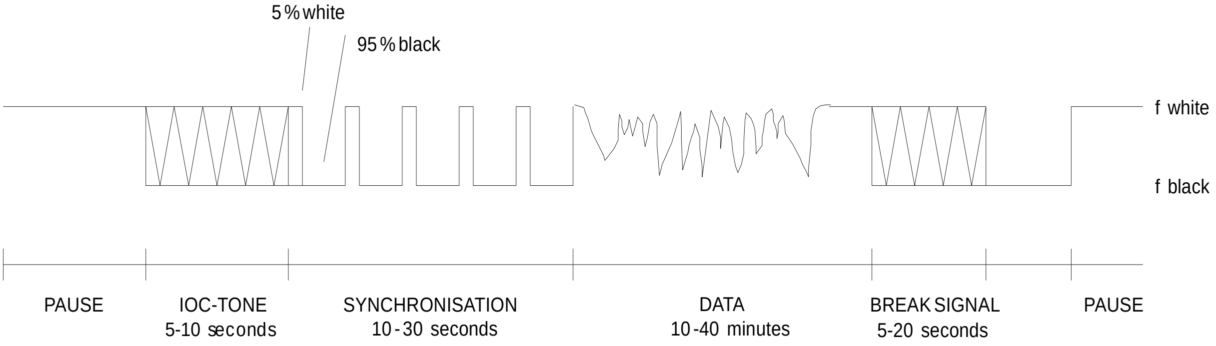
Weather charts to be transmitted are fastened to a revolving drum and illuminated by a light source. The drum is then scanned by a light sensor moving along the axis of the drum. The voltage output from this sensor is converted into tone frequencies modulating the transmitter.

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. It has a duration of 5-10 seconds and is very well suited for exact tuning purposes. This tone conveys 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. These carry the RPM information and the receiver is now synchronized so that the picture will start in the right position.

Subsequently the transmission of the picture begins properly. The output to the video monitor has a resolution of 640 x 480 pixels and 16 grey levels. Output to a graphics printer is done via the Centronics parallel interface. Weather-FAX pictures are continuously printed, so the printer should at least be able to print 150 characters/min.

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



# CARRIER MODULATION PROCEDURES

The HF and VHF/UHF modes decoded by the W 4100DSP use different carrier modulation methods.

The most frequently used modulation techniques are 2FSK using two tone frequencies, MFSK with four or more tones and phase modulation methods 2PSK, 4PSK and 8PSK. The DSP demodulator handles the demodulation of these modulation methods.

The **HF-transmission, INDIRECT FM modulation, INDIRECT AM modulation** and **DIRECT FM modulation** modes must be distinguished. Depending on the mode AF and HF inputs (HF modes) may be used, or only AF or IF inputs.

## SSB (SINGLE SIDE BAND)

Most modes in HF bands use SSB modulation with suppressed carrier and AF subcarrier frequency shift to emulate the direct keying of the carrier frequency in previous use. Decoding can be done from the AF- or IF output (USB, LSB, CW or FAX demodulator).

## DIRECT FM

PAGER modes and PACKET-9600 Bit/s on VHF/UHF use DIRECT (carrier) FM modulation. The shift may be 3000 Hz to 9000 Hz. Decoding is only possible from the receiver IF output.

The latest generation of receivers (e.g. ICOM and AOR) provides a direct discriminator output for decoding these modes.

## INDIRECT FM

Modes using INDIRECT modulation (subcarrier modulation) are double modulated. One method is to modulate a frequency modulated carrier with FSK (Frequency shift keying). For decoding, the receiver FM demodulator output is required. Examples of INDIRECT modulation are PACKET-1200, ATIS, analog and digital tone call systems. Decoding is only possible from the receiver AF output.

## INDIRECT AM

Another method of INDIRECT modulation (subcarrier modulation) uses AM carrier modulation, which in turn is FSK modulated. For decoding the receiver AM demodulator output is required.

ACARS is an example of this method. Decoding is only possible from the receiver AF output.

# BAUDRATES, SPEEDS AND CARRIER MODULATION

| TRANSMISSION MODE | BAUDRATE, SPEED | CARRIER MODULATION |
|---|---|---|
| ACARS | 2400 | INDIRECT AM |
| ALIS | 228.6 | SSB |
| ALIS-2 | 240.82 | SSB |
| ARQ-E | 48,64,72,75,86,96,192,288 | SSB |
| ARQ-E3 | 48,50,96,100,192 | SSB |
| ARQ-N | 96 | SSB |
| ARQ-M2-242 | 96 | SSB |
| ARQ-M2-342 | 96,200 | SSB |
| ARQ-M4-242 | 192 | SSB |
| ARQ-M4-342 | 192 | SSB |
| ARQ6-90 | 200 | SSB |
| ARQ6-98 | 200 | SSB |
| ASCII | 110, 150, 300 | SSB |
| ATIS | 1200 | INDIRECT FM |
| AUTOSPEC | 68.5 | SSB |
| BAUDOT | 45,50,75,100,180 | SSB |
| BULG-ASCII | 110, 150, 180, 200, 300 | SSB |
| CCIR | 100 ms | INDIRECT FM |
| CCITT | 100 ms | INDIRECT FM |
| CIS-11 | 100 | SSB |
| CIS-14 | 96 | SSB |
| CIS-36 | 10, 20, 40 | SSB |
| COQUELET-8 | 75 ms, 37.50 ms | SSB |
| COQUELET-13 | 75 ms | SSB |
| COQUELET-80 | 37.50 ms, 75 ms | SSB |
| CW-MORSE | 20 - 400 BPM | SSB or CW |
| DGPS | 100, 200 | SSB |
| DUP-ARQ | 125 | SSB |
| DUP-ARQ-2 | 250 | SSB |
| DUP-FEC-2 | 125, 250 | SSB |
| DTMF | 70 ms | INDIRECT FM |
| EEA | 40 ms | INDIRECT FM |
| EIA | 33 ms | INDIRECT FM |
| ERMES | 3125 Baud | 4-PAM/FM |
| EURO | 100 ms | INDIRECT AM |
| FEC-A | 96, 144, 192, 288 | SSB |
| FMS-BOS | 1200 | INDIRECT FM |
| GOLAY | 300/600 | DIRECT FM |
| G-TOR | 100/200/300 adaptive | SSB |
| HC-ARQ | 240 | SSB |
| HNG-FEC | 100.05 | SSB |
| ICAO SELCALL | 1000 ms | SSB |
| INFOCALL | 1200 | DIRECT FM |
| METEOSAT | 240 RPM, IOC288 | INDIRECT AM |
| MPT1327/1343 | 1200 | INDIRECT FM |
| NATEL | 70 ms | INDIRECT FM |
| NOAA-GEOSAT | Drum Speed 120 RPM, IOC576 | INDIRECT AM |
| PACTOR | 100/200 adaptive | SSB |
| PACKET-300 | 300 | SSB |
| PACKET-1200 | 1200 | INDIRECT FM |
| PACKET-9600 | 2400, 4800, 9600 | DIRECT FM |
| PICCOLO-MK6 | 50 ms, 25 ms | SSB |
| PICCOLO-MK12 | 50 ms, 25 ms | SSB |
| POCSAG | 512, 1200 | DIRECT FM |
| POL-ARQ | 100, 200 | SSB |
| PRESS-FAX | 120 RPM | SSB |

| TRANSMISSION MODE | BAUDRATE | CARRIER MODULATION |
|---|---|---|
| RUM-FEC | 164.5, 218.3 | SSB |
| SI-AUTO | 96, 200 | SSB |
| SI-ARQ | 96, 200 | SSB |
| SI-FEC | 96, 200 | SSB |
| SITOR-AUTO | 100 | SSB |
| SITOR-ARQ | 100 | SSB |
| SITOR-FEC | 100 | SSB |
| SPREAD-11 | 102.6 | SSB |
| SPREAD-21 | 102.6, 68.5 | SSB |
| SPREAD-51 | 102.6 | SSB |
| SSTV | 8, 16, 32 s | SSB |
| SWED-ARQ | 100 | SSB |
| TWINPLEX | 100 | SSB |
| VDEW | 100 ms | INDIRECT FM |
| WEATHER-FAX | 60, 90, 120 RPM | SSB |
| ZVEI-VDEW | 1200 | INDIRECT FM |
| ZVEI-1 | 70 ms | INDIRECT FM |
| ZVEI-2 | 70 ms | INDIRECT FM |

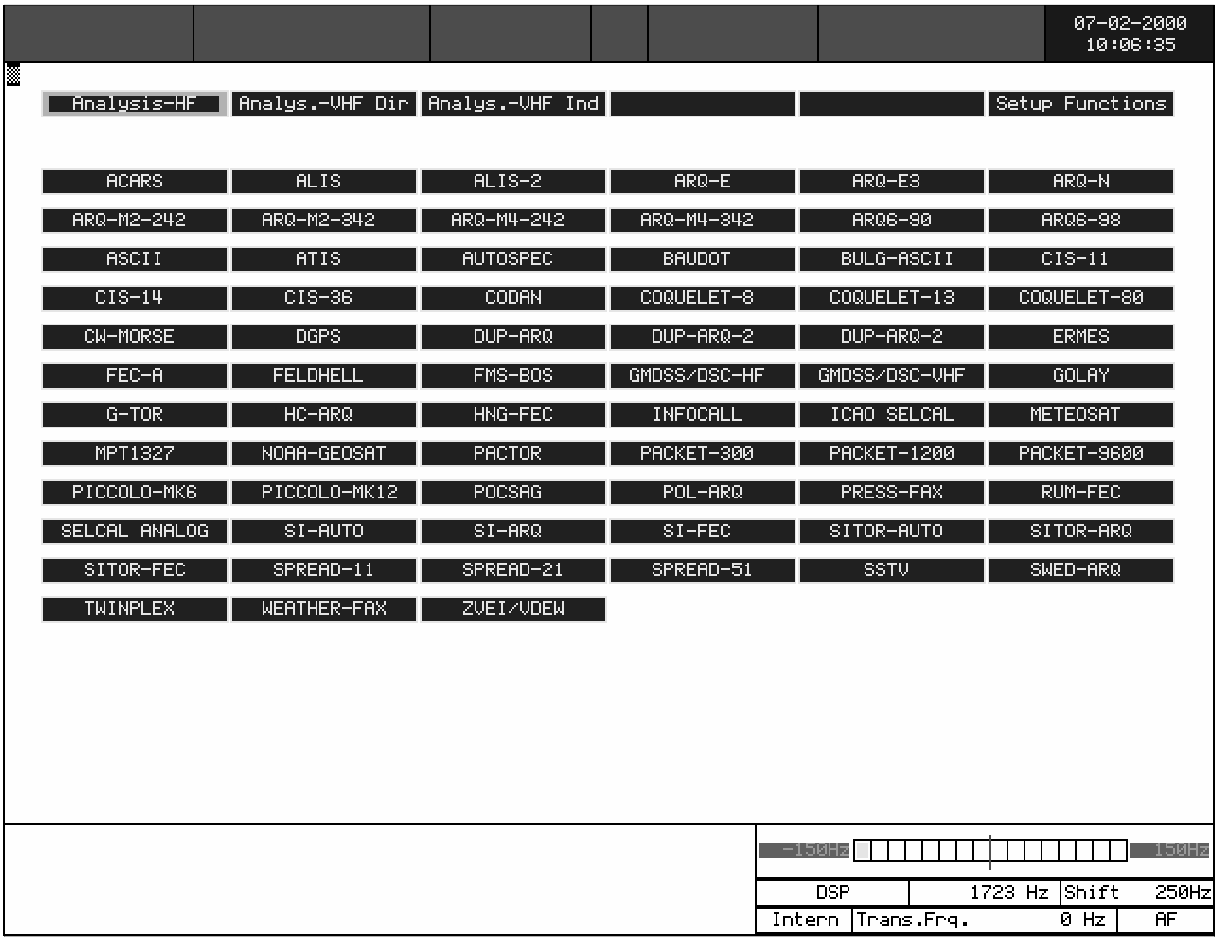
# OPERATING MODES

A double click on the lower, left hand trackball button results in the display of a full screen menu. This action immediately terminates all operating modes and input functions which might have been active. By moving the trackball any desired function may then be selected.

By clicking the left hand button the selected mode is then started in AUTO mode.

By clicking the right hand trackball button the entire screen is cleared and the main menu is displayed.

# FULLSCREEN MENU

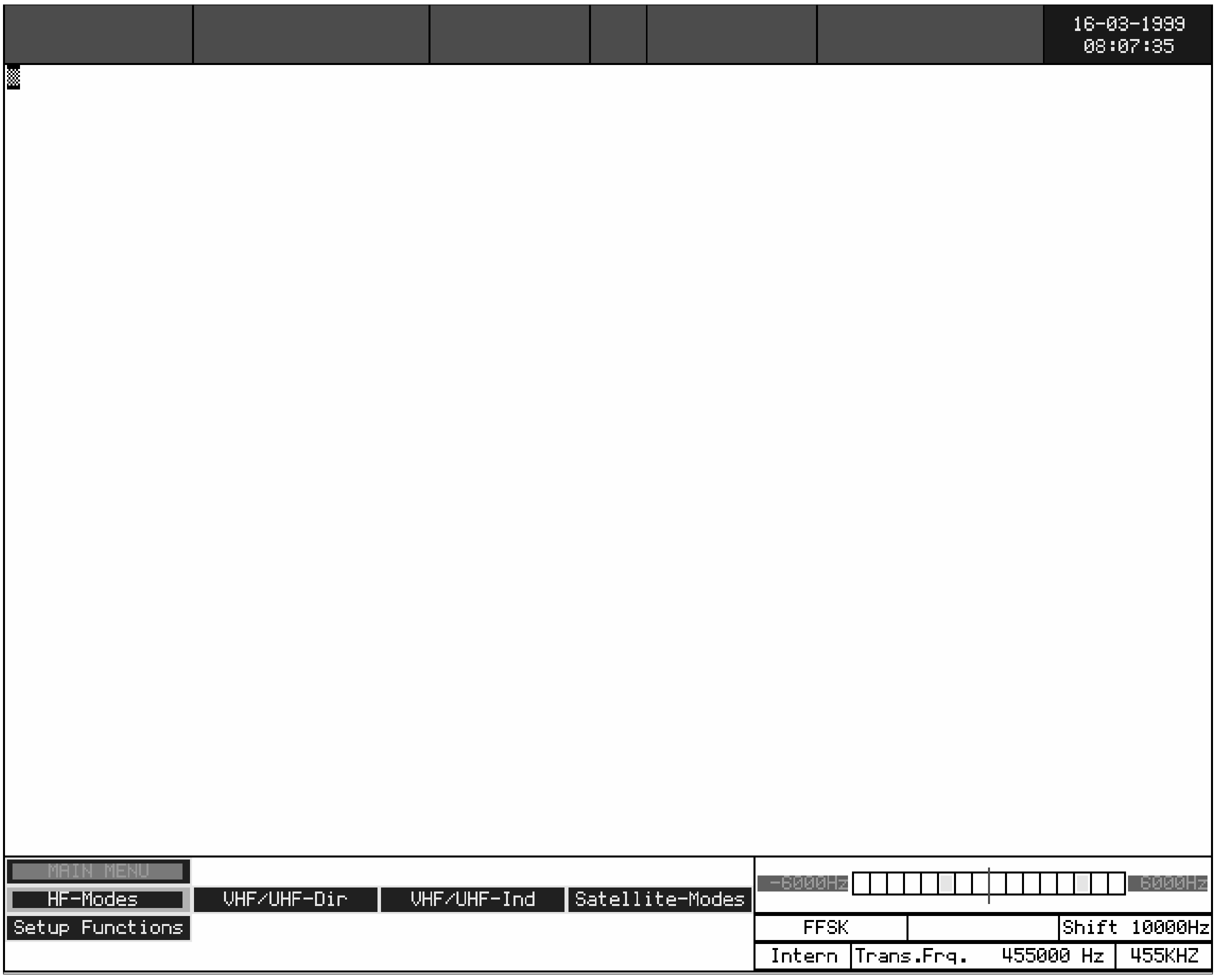


# MAIN MENU

The main menu incorporates all sub menus relating to operating modes as well as analysis and set-up functions. Menu interaction takes place by turning or "moving" the trackball and clicking on the desired function.

The WAVECOM software is based on a multitasking kernel and can handle more than one task concurrently. The control of and interaction with the menu system occurs without any interruption of an active function. This allows for example the shift and centre frequency to be set in the "Demodulator" submenu without interference to or disruption of the currently active operating mode.

# SCREEN DISPLAY MAIN MENU




The descriptions of the operating modes which follow, are arranged in alphabetical order. Future extensions and updates can thus be incorporated more easily.

# ACARS

| | |
|---|---|
| Frequency range | VHF/UHF Modes |
| Frequency Europe | 131.725, 131.525, 131.825 MHz |
| USA | 131.550, 130.025, 129.125, 131.475 MHz |
| Japan | 131.450 MHz |
| Center frequency | 1800 Hz |
| Shift | 1200 Hz |
| Baudrate | 2400 Bit/s |
| Systems | Packet oriented ARQ (CSMA/CD) |
| Modulation | INDIRECT-AM |
| Receiver setting | AM 12.0 KHz, narrow |
| Signal source | AF (only) |

**A**ircraft **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 NRZI 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.

To start monitoring ACARS, select “2400.00 Baud“. As only one speed is used presently, the ACARS menu does not offer the option of manually selecting a speed.

# ACARS FRAME

| | |
|---|---|
| Pre code | 16 characters, binary '1' |
| Bit synch | 2 characters „+„ , „*„ |
| Characters synch | 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<br>STX (02h) - when no text ETX (03h) |
| Text | 220 characters maximum<br>Only printable characters |
| Suffix | 1 character<br>If single or terminal block ETX, otherwise ETB (17h) |
| Block Check Sequence | 16 bits CRC sum |
| 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) to 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 retransmission. 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.

# 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 W4100DSP generated characters)

| | |
|---|---|
| **(#8)** | W41PC generated message number |
| **06-11-1996 18:43:32** | W4100DSP generated timestamp (optional) |
| **M=** | Mode Category A = A,<br>Category B = 0..29 |
| **ADDR=** | Aircraft address<br>(aircraft registration or flight identifier) |
| **TA**= | Technical acknowledgement<br>(downlink 0..9, uplink A..Z, a..z, NUL (00h) |
| **ML=** | Message Label (message type) |
| **B=** | Uplink/Downlink Block Identifier<br>(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 broadcasts. 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**.

# ALIS

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 228.66 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# ALIS OPERATING MENU

| ALIS | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 228.67 Baud | 96.0 Baud Var | Force LTRS-FIGS | ITA-2 |
| ECC is on | | | |

ALIS is a simplex system and operates at a speed of 228.66 Baud on the radio link.

ALIS is described in the report of the ITU Reports of the CCIR 1990 “Fixed Service at frequencies below about 30 MHz”. The abbreviation ALIS is derived from <Automatic Link Set-up>.

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 operating states. The CRC checksum enables detection and correction of transmission errors.

The acknowledgement block has a length of 16 bits. 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 Baudot.

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

# ALIS-2

| | |
|---|---|
| Frequency range | HF |
| System | SIMPLEX |
| Baudrate | 240.82 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF, HF or IF |

## ALIS-2 OPERATING MENU

| ALIS-2 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 240.80 Baud |
| 96.0 Baud Var | | | |

ALIS-2 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 derived from Automatic Link-Setup.

ALIS-2 are 8FSKmodulated. 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 baudrate 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.

# ARQ — E

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 46.2 - 288.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# ARQ-E OPERATING MENU

| ARQ-E | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 48.0 Baud | 72.0 Baud | 85.7 Baud | 96.0 Baud |
| 192.0 Baud | 96.0 Baud var | ITA-2 | Force LTRS-FIGS |

The duplex ARQ-E systems operate at speeds of 48, 64.3, 72, 85.7, 96, 192 and 288 Baud on the radio link.

Synchronisation for the ARQ-E operating mode 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 synchronisation to an ARQ-E system has been achieved, the detected repetition rate is displayed (4 ,5 or 8 cycles). This parameter gives certain clues as to identical transmission nets.

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.

For short-wave transmissions the synchronous full duplex ARQ (Automated Request) modes have become very significant. The five inner data steps correspond to the ITA-2 alphabet.

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, four or seven characters preceded by the RQ character.

To maintain synchronisation between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic is transmitted.

# ARQ-E3

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 48.0 - 288.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## ARQ-E3 OPERATING MENU

| ARQ-E3 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 48.0 Baud | 72.0 Baud | 96.0 Baud | 100.0 Baud |
| 192.0 Baud | 96.0 Baud var | ITA-2 | Force LTRS-FIGS |

ARQ-E3 systems often operate at speeds of 48, 50, 96, 192 and 288 Baud on the radio link.

Synchronisation for the ARQ-E3 operating mode 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 synchronisation to an ARQ-E3 system has been achieved, the detected repetition rate is displayed (4 or 8 cycles). This parameter gives certain clues as to identical transmission nets.

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 being monitored. ARQ-E3 employs the ITA-3 alphabet (balanced 3:4 mark-space ratio) for data transmission and error detection.

For short-wave transmissions synchronous full duplex ARQ (Automated Request) modes have become very significant.

Full duplex systems transmit the RQ character after having detected an erroneous character or in the presence of excessive signal distortions. The opposite station subsequently repeats the last three or seven characters preceded by the RQ character. .

To maintain synchronisation between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic is transmitted.

# ARQ—N

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 96.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## ARQ—N OPERATING MENU

| ARQ-N | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 48.0 Baud | 72.0 Baud | 86.0 Baud | 96.0 Baud |
| 192.0 Baud | 4 Cycles | 96.0 Baud var | Force LTRS-FIGS |

Known ARQ-N systems operate exclusively at a speed of 96 Baud on the radio link.

The synchronisation 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 (like ARQ-E). Character inversion (as in the case of ARQ-E or ARQ-E3) is not defined for ARQ-N. The lack of the 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.

For short-wave transmissions the synchronous full duplex ARQ (Automated Request) modes have become very significant.

Full duplex systems transmit the RQ character after having detected an erroneous characters or in the presence of excessive signal distortions. The remote station subsequently repeats the last three characters preceded by the RQ character.

To maintain synchronisation between the two stations both transmitters operate continuously and send the idle bit pattern if no traffic is transmitted.

# ARQ-M2-342 AND ARQ-M2-242

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 96.0 and 200 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## ARQ-M2-342 AND ARQ-M2-242 OPERATING MENU

| ARQ-M2-342 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 85.7 Baud | 96.0 Baud | 200.0 Baud | 96.0 Baud var |
| LTRS-FIGS A | LTRC-FIGS B | Print Auto | |

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 the 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 which allows error detection. The ITA-3 is a balanced code in which each character has a mark-space bit ratio of 3:4. ARQ-M2-342 and ARQ-M2-242 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 recognised by the rhythmic blinking of the ERROR LED.

# ARQ-M4-342 AND ARQ-M4-242

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 192.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## ARQ-M4-342 AND ARQ-M4-242 OPERATING MENU

| ARQ-M4-342 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 172.0 Baud | 192.0 Baud | 96.0 Baud Var | Print Auto |
| LTRC-FIGS A | LTRC-FIGS B | LTRC-FIGS C | LTRC-FIGS D |

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.

For transmission, the ITA-3 7 bit alphabet is used which allows error detection to be made. All characters in the ITA-3 alphabet have a 3 to 4 ratio between mark and space bits (balanced code). ARQ-M4-342 and ARQ-M4-242 systems are full duplex systems.

Full duplex systems send the remote 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 recognised by the rhythmic illumination of the ERROR LED.

# ARQ6-90 AND ARQ6-98

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 200.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## ARQ6-90 OPERATING MODE

| ARQ6-90 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 200.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | |

## ARQ6-98 OPERATING MENU

| ARQ6-98 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 200.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | |

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 received in error.

The two systems only differ in the duration of the request cycle interval.

A complete cycle for ARQ6-90 has a duration of 450 ms of which the data block is 210 ms and interval is 230 ms.

A complete cycle for ARQ6-98 has a duration of 490 ms of which the data block is 210 ms and interval is 280 ms.

# ASCII

| | |
|---|---|
| Frequency range | HF-MODES |
| System | STANDARD |
| Baudrate | 50.0 - 800 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# ASCII OPERATING MENU

| ASCII ITA-5 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 110 Baud | 150 Baud | 200 Baud | 300 Baud |
| 96.0 Baud Var | 8 Data Bits | Parity off | US-ASCII |

For the ASCII standard baud rates from 110 to 300 Baud are available. Non-standard baud rates may be selected using the ”96.0 Baud var” menu item.

The ASCII code, which is adapted as the CCITT ITA-5 alphabet, is used for all kinds of data transfer of information between computers or computer based equipment. The code consists of a start bit, 7 data bits, one parity bit (optional) and 1 or 2 stop bits.

The parity bit allows error detection to be made. The number of ”1”’s are 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, the parity bit should also be ”1”.

The ASCII code does not distinguish between a ”Letters” or ”Figures” case as do Baudot because 7 or 8 data bit ASCII has 128 or 256 possible bit combinations. This cover most symbol requirements.

Asynchronous ASCII is also used in certain duplex ARQ systems in conjunction with CRC calculation for error detection.

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.

# ATIS

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | SELCAL digital |
| Baudrate | 1200 bit/s |
| Modulation | INDIRECT FM |
| Receiver setting | FM 12 KHz narrow |
| Signal source | AF (only) |

# ATIS OPERATING MENU

| ATIS | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 1200.00 Baud |

ATIS is an abbreviation of "**A**utomatic **T**ransmitter **I**dentification **S**ystem". ATIS is used in the VHF-UHF radio systems on the Rhine river 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 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 call-sign, 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 identifier**:

| | | | | | |
|---|---|---|---|---|---|
| Z | Albania | O | Austria | O | Belgium |
| L | Bulgaria | D | Germany | F | France |
| 9 | Croatia | H | Hungary | P | Netherlands |
| H | Liechtenstein | L | Luxembourg | H | Poland |
| Y | Romania | O | Slovak Rep. | H | Switzerland |
| O | Czech Rep. | T | Turkey | E | Ukraine |
| U | Russia Federation | Z | Macedonia | Y | Latvia |
| E | Estonia | L | Lithuania | S | Slovenia |
| Y | Yugoslavia | | | | |

# AUTOSPEC

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 68.5 and 102.63 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## AUTOSPEC OPERATING MENU

| AUTOSPEC | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 62.3 Baud | 68.5 Baud | 102.63 Baud | 137.0 Baud |
| 96.0 Baud Var | ECC is on | Force LTRS-FIGS | |

The parity dependant repeat transmission of the 5 data bits is easily recognised by ear for certain character combinations. The IDLE signal also has a distinctive ”sound”. Various stations utilise the now quite old AUTOSPEC mode in FDM (Frequency Division Multiplex) systems.

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 the ”ECC is ON/OFF” menu field (ECC refers to Error Correction Control).

The standard baud rate for AUTOSPEC is 68.5 Baud.

# BAUDOT

| | |
|---|---|
| Frequency range | HF-MODES |
| System | STANDARD |
| Baudrate | 45.45 - 180.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# BAUDOT OPERATING MENU

| BAUDOT | | | |
|---|---|---|---|
| Analysis | Auto | Auto sync | Demodulator |
| Options | 45.5 Baud | 50.0 Baud | 75.0 Baud |
| 100.0 Baud | 96.0 Baud Var | ITA-2 | Force LTRS-FIGS |

For the BAUDOT the ”Auto” option starts the process of automatically setting up the demodulator and determining the baud rate and signal polarity.

The menu fields ”45.5 Baud”, ”50.0 Baud”, ”75.0 Baud” or ”100.0 Baud” allow 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 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 synchronisation. 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 the synchronisation if lengthy periods of signal loss is experienced or a pre-defined error rate is exceeded.

A Baudot codeword consists of a start bit, 5 data bits and either 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 ”Options\Bit inversion” any of the 32 bit inversion patterns may be pre-selected.

Synchronous Baudot uses 7 bits and is especially used for online crypto systems.

The Baudot code has been the most common telegraph code used as a result of the widespread use of tele printers, 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 tele printer networks and equipment.

# BULG-ASCII

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 110 - 1200 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## BULG-ASCII OPERATING MENUE

| BULG-ASCII | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 110 Baud | 150 Baud | 180 Baud | 200 Baud |
| 300 Baud | 600 Baud | 96.0 Baud Var | TRANSPARENT |

For BULG-ASCII the standard baud rates 110 to 300 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 ARQ and 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.

In the ALPHABET/TRANSPARENT menu field is selected, the serial interface output is fully transparent. This enables the user to decode other ASCII modes (Note: The XON/XOFF protocol has been removed from the remote control interface #2 to enable this feature).

A number of different ASCII modes may be monitored having different frame lengths. Often the systems are adaptive so that the baudrate is dependent on the propagation conditions.

BULG-ASCII is not implemented as REMOTE COMMAND.

# CIS-11

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# CIS-11 OPERATING MENU

| CIS-11 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 100.0 Baud | 96.0 Baud Var | 3-SHIFT-CYR | Force LTRS-FIGS |

CIS-11 operates at a speed of 100 Baud on the radio link.

Synchronisation for the CIS-11 operating 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 consists of 11 bits. Data bits 1 - 5 contain the M2 character. The data bits are arranged in reverse order 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 synchronisation between the two duplex stations, both transmitters operate continuously and transmit idle characters should no traffic is transferred.

# CIS-14

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 96.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# CIS-14 OPERATION MENU

| CIS-14 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 96.0 Baud | 96.0 Baud Var | LTRS-FIGS A | LTRS-FIGS B |
| Print Auto | | | |

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, centre frequency and baud rate.

CIS-14 is a full duplex system using two frequencies.

As is the case for other 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 Analysis” the simple data format of CIS-14 with only two parity bits may unfortunately lead to unavoidable detection errors.

# CIS-36

| | |
|---|---|
| Frequency range | HF |
| System | DUPLEX |
| Tone duration | 25, 50 or 100 ms 10 |
| Baudrate | 20 or 40 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF or IF |

# CIS-36 OPERATING MENU

| | | | |
|---|---|---|---|
| CIS-36 | | | |
| Analysis | Demodulator | Options | Tone 100.00 ms |
| Tone 50.00 ms | Tone 25.00 ms | Force LTRS-FIGS | ITA-2 |
| Nor. Polarity | ECC is on | | |

CIS-36 is operating with speeds of 10, 20 or 40 baud which is equivalent to tone durations of 100, 50 or 25 ms.

This mode is started by selecting "Tone 100.00 ms" or another tone duration.

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. 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 of the middle frequency group (between tone 18 and 19).

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.

10 Baud speed is used for manually transmitted operator messages and are mostly unencrypted. The automatic switching of the tone length is initialised by control sequences.

When the real message 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.

# CODAN SELCAL

| | |
|---|---|
| Frequency range | HF |
| System | SIMPLEX SELCAL |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF or IF |

# CODAN OPERATING MENU

| | | | |
|---|---|---|---|
| CODAN | | | |
| Analysis | Demodulator | Options | 100.00 Baud |
| ASCII | | | |

CODAN SELCAL operates with 100.0 baud and can be started by selecting "100.00 Baud".

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 leader 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.

# COQUELET-8

| | |
|---|---|
| Frequency range | HF-MODES |
| System | MFSK |
| Tone duration | 37.5 or 75.0 ms |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## Coquelet-8 OPERATING MENU

| Coquelet-8 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | Tone 37.50 ms |
| Tone 50.00 ms | Tone 75.00 ms | Force LTRS-FIGS | ITA-2 |

Coquelet-8 is a MFSK (Multiple Frequency Shift Keying) system and like the PICCOLO translates an ITA-2 character to a sequence of two tones.

In the case of Coquelet-8 the first group of tones contains 8 tones 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 75.0 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 (7.5 Bit).

## TONE ASSIGNMENT OF COQUELET-8

| Group I (1. Tone) | | | | | | | | Group II (2. Tone) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 5 | 6 | 7 | 8 |
| 773 | 800 | 826 | 853 | 880 | 907 | 933 | 960 | 880 | 907 | 933 | 960 |

# COQUELET-13

| | |
|---|---|
| Frequency range | HF-MODES |
| System | MFSK |
| Tone duration | 75.0 ms |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## Coquelet-13 OPERATING MENU

| Coquelet-13 | | | |
|---|---|---|---|
| Signal Analysis | Demodulator | Options | Code Table 0 |
| Tone 75.00 ms | Tone 50.00 ms | Force LTRS-FIGS | ITA-2 |

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.

## TONE ASSIGNMENT OF COQUELET-13

| Group I (1. Tone) | | | | | | | | Group II (2. Tone) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 5 | 6 | 7 | 8 |
| 773 | 800 | 827 | 853 | 880 | 907 | 935 | 960 | 773 | 880 | 907 | 933 | 960 |

# COQUELET-80

| | |
|---|---|
| Frequency range | HF-MODES |
| System | MFSK |
| Tone duration | 37.5, 50.0 or 75 ms |
| Modulation | SSB or DIRECT-FSK |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF or IF |

## COQUELET-80 OPERATING MENU

| Coquelet-80 | | | |
|---|---|---|---|
| Signal Analysis | Demodulator | Options | Tone 37.5 ms |
| Tone 50.00 ms | Tone 75.00 ms | Force LTRS-FIGS | ITA-2 |

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 BAGHDAD80 or the ITA-2 (ROMAN) alphabet. Similar to COQUELET-8 the transmission of a character is done by two tone assignments called group 1 and group 2 (GROUP1 and GROUP2).

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

| Group I (1. Tone) | | | | | | | | Group II (2. Tone) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 5 | 6 | 7 | 8 |
| 773 | 800 | 827 | 853 | 880 | 907 | 935 | 960 | 773 | 880 | 907 | 933 | 960 |

# CW-MORSE

| | |
|---|---|
| Frequency range | HF-MODES |
| System | STANDARD |
| Modulation | CARRIER KEYING or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# CW-MORSE OPERATING MENU

| | | | |
|---|---|---|---|
| CW-MORSE | | | |
| Auto | Sync Auto | Manual Speed | Demodulator |
| Options | Latin Morse | AGC on | Normal Speed |

The "Auto" function will automatically detect Morse keying speeds within the range of 20 - 400 BPM (Characters per minute). The keying speed is continuously updated and displayed.

The "Sync Auto" function offers Morse re-synchronization without erasing already decoded text.

The "Manual bpm" function allows the user to enter fixed speed. This option becomes useful when receiving machine generated transmissions of long duration. The fixed setting results in improved noise immunity.

The bandwidth setting has a major influence on the reception quality. The bandwidth may be set to any value in the range from 50 Hz to 1200 Hz. For normal use a setting of 100 - 200 Hz is recommended.

The centre frequency can be set to any value between 600 and 2000 Hz via the "Centre Freq." function. The centre frequency is nominally 800 Hz which is dictated by the quartz filters of professional receivers while other receivers work with 1000 Hz.

Using the "Latin Morse" menu field the output can be toggled between Cyrillic Morse and Latin Morse.

The main problem in handling manual keying lies with too short character breaks or pauses or signal interference. Too short pause intervals make the decoding of two or more characters, which have been keyed in sequence, impossible (e.g. CQ). Signal interference may be erroneously interpreted as either "dashes" or "dots".

The software reports an error condition (ERROR) if the recognisable parameters (dot/dash) or the inter-word or inter-character breaks deviate too much from the standard, and consequently error-free decoding cannot be maintained.

# DGPS

| | |
|---|---|
| Frequency range | HF |
| System | SELCAL digital |
| Baudrate | 100.0 and 200.0 Baud |
| Modulation | Minimum-Shift-FSK |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF, HF or IF |

# CW-MORSE OPERATING MENU

| | | | |
|---|---|---|---|
| DGPS | | | |
| Analysis | Demodulator | Options | 100.00 Baud |
| 200.00 Baud | 96.00 Baud Var. | MSG Type 3,7,16 | |
| | | | |

DGPS (Differential Global Positioning System) data is mainly transmitted in the medium 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 which is deliberately deteriorated. The DGPS principle is based on the transmission of correction data by a reference station, the position of which has been determined with high exactitude by traditional position finding measurements. With the correction data an absolute accuracy of up to 4 meters can be achieved.

Transmissions are mostly done in 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 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 the 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 “3,7,16” is chosen in the “Message Type” option field, words 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. By selecting the “All frame hdrs” option, all frame headers are displayed regardless of the message type.

RTCM v.2.0 and 2.2 are not completely compatible, but both systems are used. This may lead to erroneous interpretation of certain of 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).

# DUP-ARQ

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 125.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## DUP-ARQ OPERATING MENU

| DUP-ARQ | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 125.0 Baud | 96.0 Baud Var | Nor. Polarity | Force LTRS-FIGS |

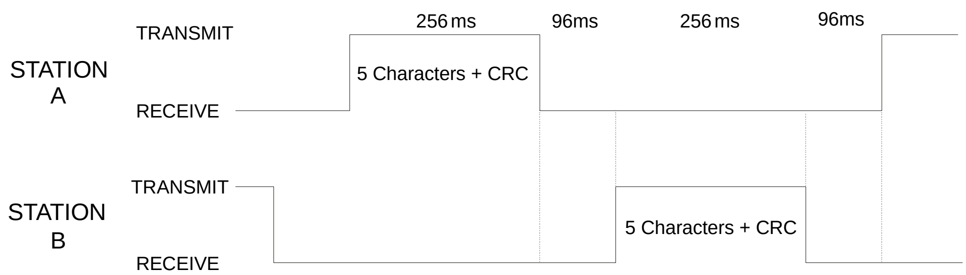
DUP-ARQ operates at a speed of 125 Baud on the radio link.

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 sending 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 transmissions 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 stations A and B 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 programmed by selecting the "Polarity" menu field. Polarity switch-over do not cause a loss of signal synchronisation.



# DUP-ARQ-2

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 250.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## DUP-ARQ-2 OPERATING MENU

| DUP-ARQ-2 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 250.0 Baud | 96.0 Baud Var | | |
| | | | |

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 or 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 stations A and B may transmit at different frequencies.

# DUP-FEC-2

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 125.0 und 250.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# DUP-FEC-2 OPERATING MENU

| | | | |
|---|---|---|---|
| DUP-FEC-2 | | | |
| Analysis | Auto | Demodulator | Options |
| 125.0 Baud | 250.0 Baud | 96.0 Baud Var | US-ASCII |
| Nor. Polarity | | | |

DUP-FEC-2 is a further development of the DUP-ARQ-2 system. 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 total 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 transmitted 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.

# ERMES

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PAGER |
| Symbol rate | 3125 Baud |
| Data rate | 6250 bps |
| Modulation | 4-PAM/FM |
| Receiver setting | FM narrow, 15-30 kHz |
| Signal sources | IF |

# ERMES OPERATING MENU

| ERMES | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 3125.00 Baud |

**Introduction**
ERMES is a new Europe-wide high speed paging system with a 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 now 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-). Transmissions are within the range form 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 coded 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 second 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.

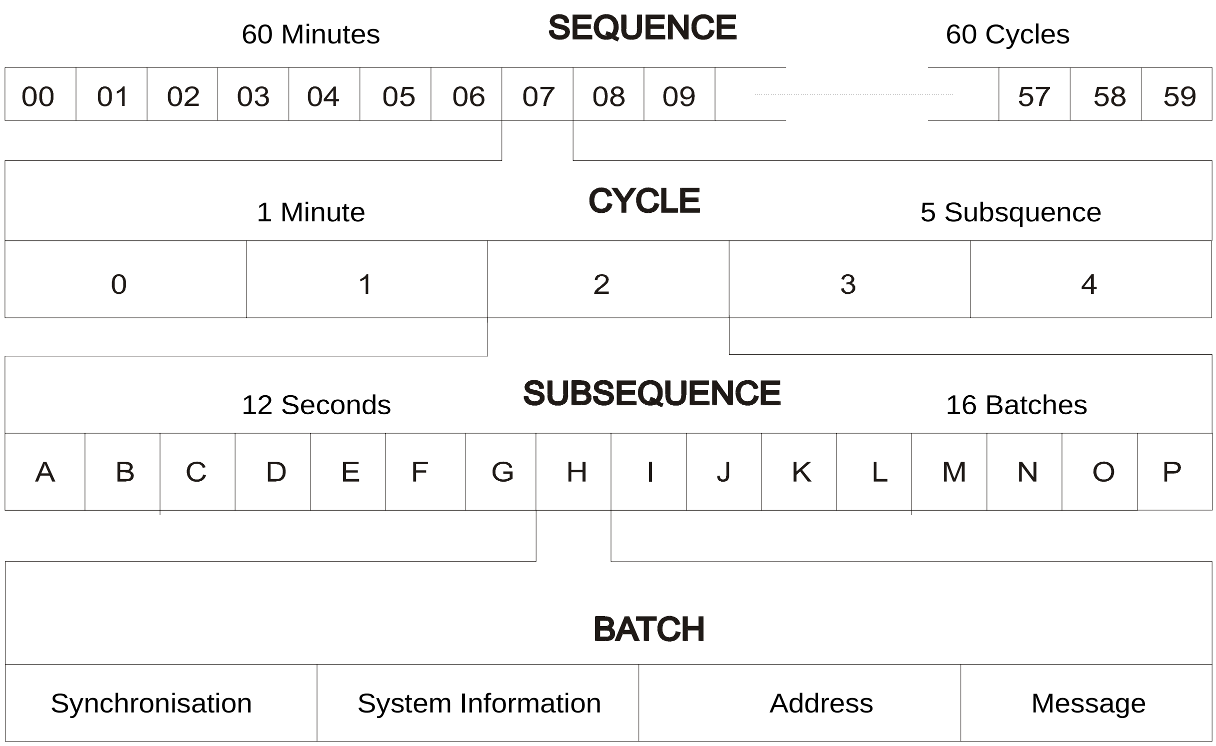
Each cycle is subdivided into five subsequence’s of 12 seconds each. In order to maintain synchronism between networks the subsequence number (command SSN = 0) is transmitted preceding every UTC minute marker.

A subsequence may also have a duration of less than 12 seconds. The remaining time is uses for transmitter switching.
Each subsequence 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.

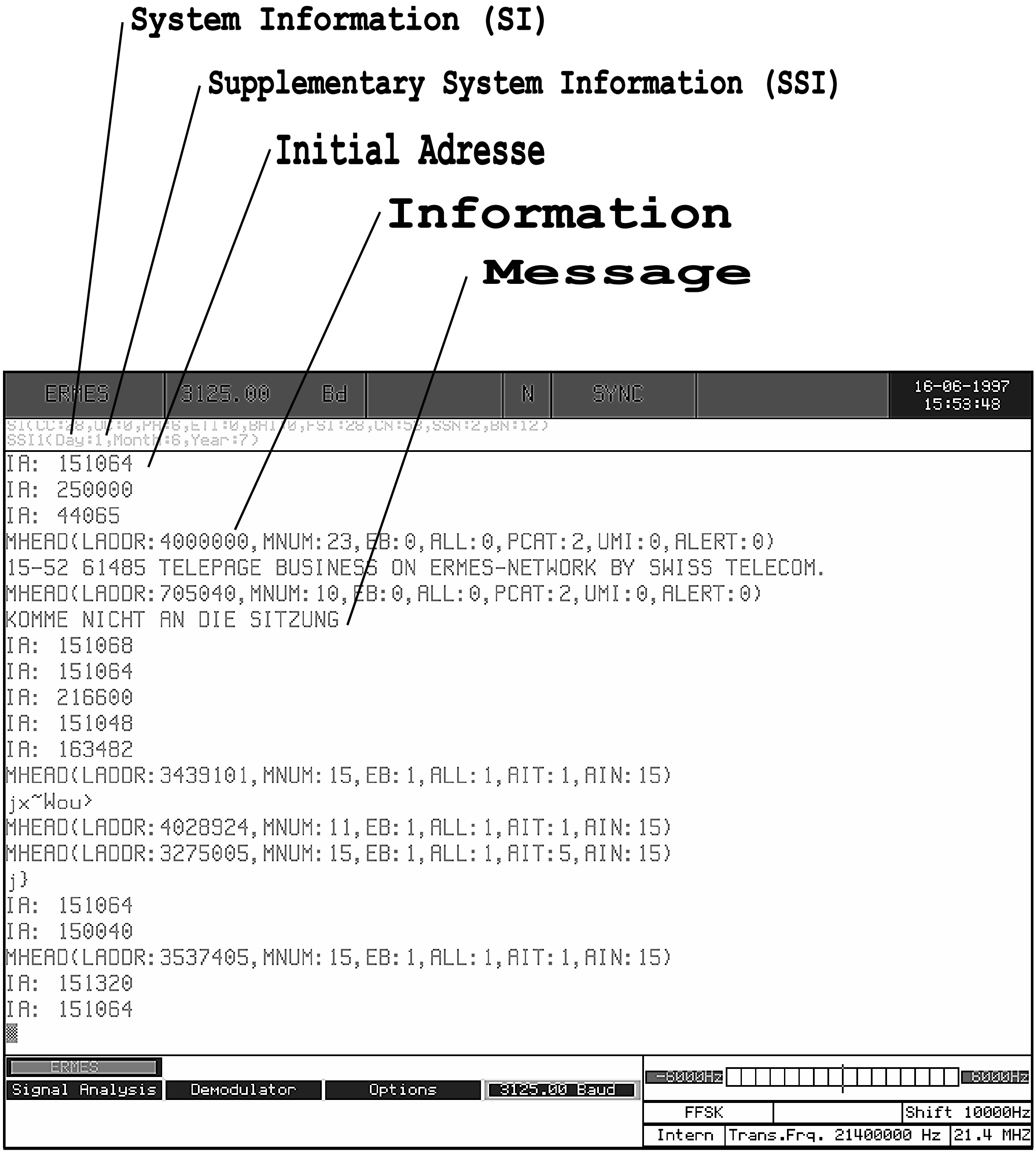
The receiver addressing only takes place within the appropriate batch. After decoding its address the receiver will wait on the same frequency for data. Data may be transmitted within the same batch, within another subsequence batch or within subsequent subsequence's.

Each batch is subdivided into four parts: Synchronization, system information, address and text.

# PROTOCOL STRUCTURE



# ERMES SCREEN DISPLAY



# SYSTEM INFORMATION

Within the system subdivision of a batch, network and system information is transmitted. The system information is divided into two parts, System Information (SI) and Supplementary System Information (SSI).

The W4100DSP continuously displays both parts on two upper screen status lines designated “SI” and “SSI” respectively (abbreviations in parenthesis are displayed by the W4100DSP).

## SYSTEM INFORMATION OF THE STATUS LINE (SI)

| | | | |
|---|---|---|---|
| Country code (CC) of transmitting network (7 bits) | Operator Code (OC) of the network operator (3 bits) | PA code (PA) paging area code (6 bits) | ETI (ETI) external traffic indicator (1 bit) |

| | | | | |
|---|---|---|---|---|
| BAI (BAI) border area indicator (1 bit) | FSI (FSI) frequency subset indicator (5 bits) | Cycle (CN) cycle number (6 bits) | SSN (SSN) subsequence number (3 bits) | BATCH (BN) batch number (4 bits) |

Depending of the value of the SSIT 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. The contents of SSI status line is automatically changed depending on the actual transmission.

## SYSTEM INFORMATION OF THE STATUS LINE (SSI)

Supplementary field (SSIT = 0000)

| | | |
|---|---|---|
| Zone (Zone) zone number (3 bits) | Hour (Hour) local hour (5 bits) | Date (Date) local date (5 bits) |

Supplementary field (SSIT = 0001)

| | | |
|---|---|---|
| Day (Day) Day 1 shall be monday (3 bits) | Month (Month) Month 1 shall be January (4 bits) | Year (Year) Year zero shall 1990 (7 bits) |

# DATA FORMAT

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)<br>full local address of the receiver<br>(22 bits) | Message Number (MNUM)<br>individual / group calls (5 bits) | External bit (EB)<br>local or external receiver (1 bit) | All (ALL)<br>additional info (1 bit) | VIF<br>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<br>for future definition<br>(1 bit) | Paging Category (PCAT)<br>00 tone 01 numeric<br>02 alphanumeric<br>03 transparent<br>(2 bits) | UMI (UMI)<br>Urgent indicator<br>0 normal message<br>1 urgent message<br>(1 bit) | ALERT (ALERT)<br>alert (alarm) signal indicator<br>type 0 - 7<br>(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)<br>Additional information type<br>long message, remote programming, miscellaneous, additional character set, temporary address pointers and more | AIN (AIN)<br>Additional information number<br>urgent alert 0-7, non-urgent alert 0-7, paging area, identity code, add or replace data in pager, country code and more |

# FEC-A

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 96.0 - 288.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# FEC-A OPERATING MENU

| FEC-A | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 96.0 Baud | 144.0 Baud | 192.0 Baud | 96.0 Baud Var |
| ECC is on | S-Reg. 72 Bits | OSI Level 0 | ITA-2 |

The FEC-A mode is started by selecting a standard baud of ”96 Baud”, ”144 baud” or ”192 Baud”. Frequency shift and baud rate are determined using ”Signal Analysis”. For automatic tuning ”Auto” may be selected.

The synchronisation or idle state easily recognised by its sound. It is an alternating mark-space keying sequence (mark-space ratio approx. 40%-60%).

FEC-A uses a convolution error correction scheme based on data bits being read into a shift register, the length of which may be changed in the case of FEC-A. Values of 72 and 128 bits are common. Shift register length is set using ”S-REG. 72 bits”/”S-REG. 128 bits” menu field. 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 is OFF”), the length of the shift register will not affect decoding. 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 bitstream is used for the convolution error correction and thus each codeword consists of 14 bits.

# FELDHELL

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FAX-SSTV-HELL |
| Baud rate | 122.5 Baud |
| Modulation | Carrier keying AM |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## FELDHELL OPERATING MENU

| | | | |
|---|---|---|---|
| FELDHELL | | | |
| Analysis | 96.0 Baud Var | 122.5 Baud | Start / Stop |
| Demodulator | Nor. Polarity | Options | |

Feldhell 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 7 columns x 14 lines. Pixels are always sent in pairs.

The original Hell system was a very simple mechanical one with a 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 synchronisation besides of nominal helix speed was used. Speed differences showed up as raising 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.

By selecting ”122.5 Baud” or ”Variable rate” reception is started. Selecting ”Polarity” will determine normal or inverse screen colour. ”Start/Stop” starts or halts the output.

In the ”Demodulator” submenu the special function fields ”AM-Gain” and ”AM-Offset” are placed. Centring 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.

Printer output is to the parallel interface only.

# FMS—BOS

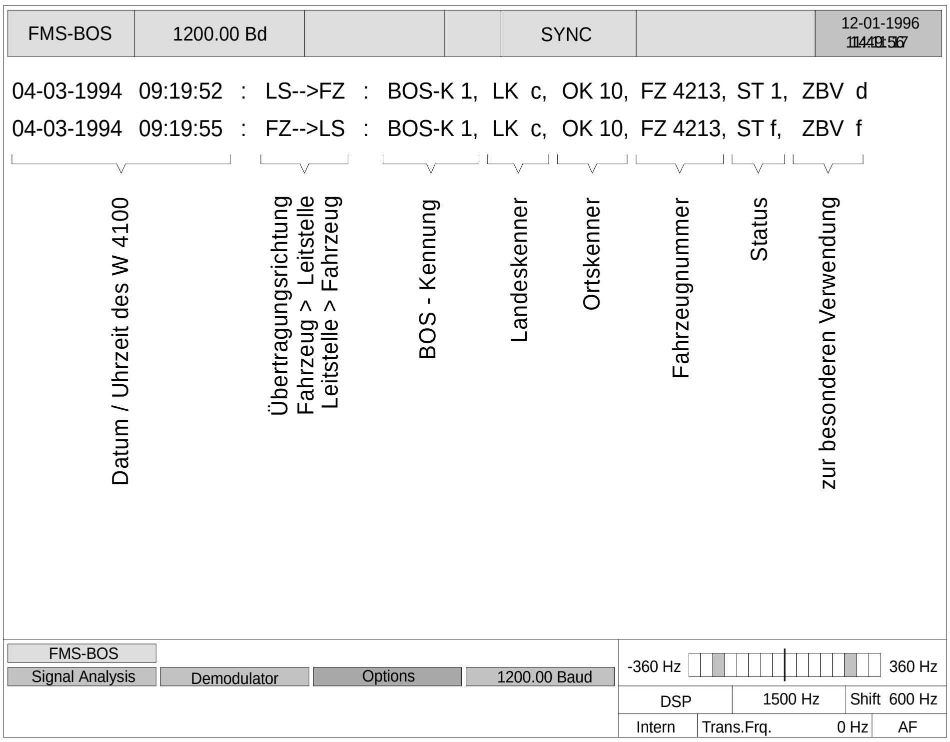
| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | SELCAL digital |
| Baudrate | 1200 bit/s |
| Modulation | INDIRECT FM |
| Receiver setting | FM 12.0 KHz narrow |
| Signal source | AF (only) |

# FMS—BOS OPERATING MENU

| FMS-BOS | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 1200.00 Baud |

FMS-BOS is a radio signalling system for security authorities and organisations. The system allows for a major reduction in message interchange between mobile forces and a control centre by digital transmission of abbreviated telegrams. The construction of the FMS-BOS telegram is very similar to the digital selective calling system ZVEI.

FMS-BOS operates at 1200 bit/s using FSK modulation of 1200 Hz and 1800 Hz tones.



The FMS-BOS data telegram always has 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.

For data protection, a 7 bit Abram son code redundancy block is appended to the data block. This is followed by a single stop bit which is however not tested.

The 40 information bits are assigned to six different parameters.

As FMS data messages do 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.

The next field shows the direction of transmission. Two possibilities exist:

**Mobile to Control**
**Control to Mobile**

In Germany the BOS and state identifiers are allocated as follows:

| **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 organisation | c |
| Miscellaneous rescue services | d |
| Civil protection services | e |

| **State identifier** | **Character** |
|---|---|
| Federal | 1 |
| Baden - Würtemberg | 2 |
| Bavaria I | 3 |
| Berlin | 4 |
| Bremen | 5 |
| Hamburg | 6 |
| Hessen | 7 |
| Lower Saxony | 8 |
| Nordrhein-Westfalen | 9 |
| Rheinland-Pfalz | a |
| Schleswig-Holstein | b |
| Saarland | c |
| Bavaria II | d |
| Lower Saxony II | e |

The **location identifier** (e.g. OK 10) can assume one of 99 different possibilities. The actual value is determined by each individual state.

The field for the **vehicle number** (e.g. 4213) can contain one of 9999 combinations. The individual call signs are assigned by each specific service.

The **status** field contains the actual information. A maximum of 16 different messages may be transmitted. A distinction between messages from vehicle to control or control to vehicle must be made. For example a mobile-to-control message containing the digit ”0” may trigger an emergency call. The same message in the opposite direction i.e. control to vehicle, may imply a status request.

The last field (**special use**) is mapped to 4 bits in the telegram and serves to communicate the equipment state, directional and abbreviated tactical information.

# GMDSS/DSC-HF AND VHF

## GMDSS/DSC-HF

| | |
|---|---|
| Frequency range | HF |
| System | SELCAL digital |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Shift | 170 Hz |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF, HF or IF |

| | | | |
|---|---|---|---|
| GMDSS/DSC-HF | | | |
| Analysis | Demodulator | Options | 100.00 Baud |
| ASCII | | | |

## GMDSS/DSC-VHF

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | SELCAL digital |
| Baudrate | 1200 bit/s |
| Shift | 600 Hz |
| Center | 1500 Hz |
| Modulation | INDIRECT FM |
| Receiver settings | FM 12.0 KHz narrow |
| Signal sources | IF (only) |

| | | | |
|---|---|---|---|
| GMDSS/DSC-VHF | | | |
| Analysis | Demodulator | Options | 1200.00 Baud |
| ASCII | | | |

GMDSS means Global Maritime Distress and Safety System and is a worldwide system for handling maritime emergency and safety transmissions. Part of the whole system is the DSC (Digital Selective Calling). Each user of the GMDSS gets 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 HF the system is working with 100 baud and a shift of 170 Hz. On VHF the speed is 1200 baud and the tones are located at 1300 Hz and 2100 Hz (center 1700 Hz).

The complex structures of the DSC are described in detail in the ITU-Rec. 493-4.

# GOLAY

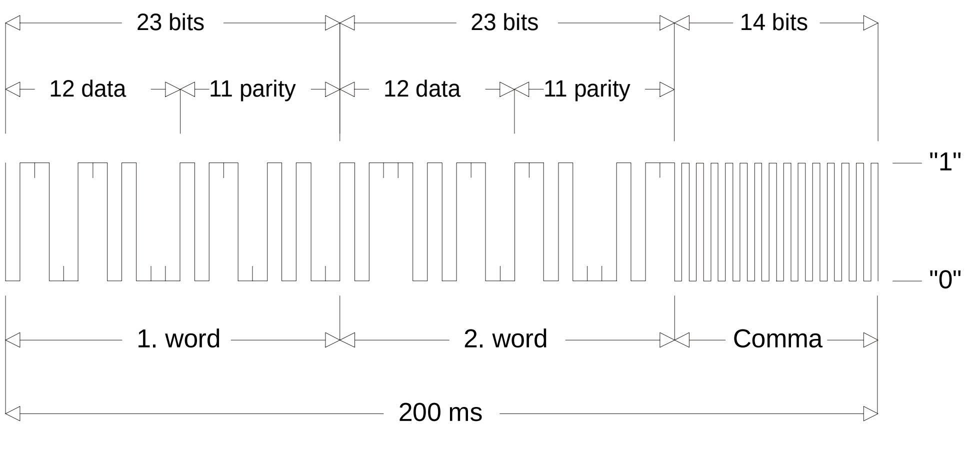
| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PAGER |
| Baudrate | 300/600 bit/s adaptive |
| Modulation | DIRECT FM |
| Receiver setting | FM 15.0 KHz narrow |
| Signal source | IF (only) |

## GOLAY OPERATING MENU

| GOLAY | | | |
|---|---|---|---|
| Signal Analysis | Demodulator | Options | 300/600 Baud |

The GOLAY pager system originates in the USA and is based on the binary code of Marcel Golay. GOLAY has been in use since 1973 and the first standard defined only tone calling and could handle a maximum of 400'000 addresses. Since 1982 the system allows for alphanumeric transmissions and up to 4 million addresses may be selected via a coded preamble.

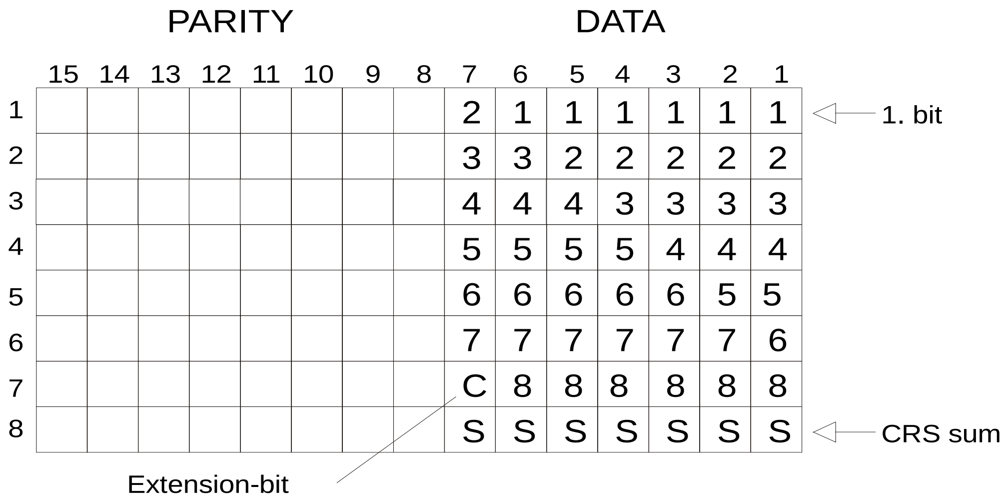
## GOLAY ADDRESSING FORMAT




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 15:7 BCH 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 15:7 BCH codeword. The bits within a block are interleaved during transmission which allows the correction of a 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 optimising 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, 10.7 MHz or 21.4 MHz)

# G-TOR

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100.0, 200.0 and 300.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# G-TOR OPERATING MENU

| G-TOR | | | |
|---|---|---|---|
| Analysis | Auto | Auto Sync | 100 Baud |
| 200 Baud | 300 Baud | Demodulator | Option |
| US-ASCII | | | |

G-TOR operates at a radio channel rate of 100, 200 or 300 Baud. The quality of the radio channel determines the actual adjustment baud rate.

By clicking the “Auto” menu field the demodulator will automatically adjust to the actual shift and centre frequency followed by phasing with automatic baud rate and signal polarity detection.

“Auto Sync” exclusively starts re-phasing to the signal. This is necessary if during transmission disturbances a change of baud rate takes place and receiver signal synchronism is lost.

With some skill the actual baud rate of G-TOR may be easily recognized. The baud rates "100 Baud", "200 Baud" 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 adoptions as is the case in “Auto” or “Auto Sync” 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 the 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).

# HC—ARQ

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 240.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## HC-ARQ OPERATING MENU

| HC-ARQ | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 240.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | |

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) are not fixed have no fixed timing frame.

Synchronisation is achieved by a long 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 viz. 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 transmission start.

HC-ARQ was originally intended for use in telephone line based data transmission, but it is also found on short-wave.

# HNG—FEC

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 100.05 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# HNG–FEC OPERATING MENU

| | | | |
|---|---|---|---|
| HNG-FEC | | | |
| Analysis | Auto | Demodulator | Options |
| 100.05 Baud | 96.0 Baud Var | ECC is on | Force LTRS-FIGS |
| Nor. Polarity | | | |

HNG-FEC operates at a speed of 100.05 Baud on the radio link.

HNG-FEC uses with a 15 bit code, the first 5 bits corresponding to the ITA-2 alphabet. The first and last bit 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 matches closest 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 synchronises 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 ”Auto” or by selecting a baud rate. By toggling the ”ECC is on/off” field the error correction may be enabled or disabled.

# ADDITIONAL FUNCTIONS

# ANALYSIS SOFTWARE

The WAVECOM analysis software may be used for :

- Spectrum display with Real-Time-FFT
- Spectrum display with Real-Time-Waterfall
- Spectrum display with Real-Time-Sonagram
- Determination of frequency shifts of FSK, F7B or MFSK signals (Signal Analysis)
- High precision determination of the signal baud rate (Signal Analysis)
- Automatic detection of operating mode (Code Analysis)
- Determination of periodicity (Signal Analysis)
- Analysis of bit patterns and determination of the alphabet in use (Bit Analysis)
- Determination of code spread (Bit Analysis)
- Determination of the bit length distribution (Bit Length)
- Determination of asynchronous bit length (Raw V1 data)

The W4100DSP analysis tools are all available from the "Analysis-HF" and "Analysis-VHF" menus.

## MENU ANALISIS-HF

| Analysis-HF | | | |
|---|---|---|---|
| FSK Analysis | Code Analysis | Real-Time-FFT | Waterfall |
| MFSK Analysis | Autocorrelation | Oscilloscope | Bit Analysis |
| Bit Analys. F7B | Bit Length | Raw FSK-Data | Phase Analysis |

## MENU ANALYSIS-VHF

| ANALYSIS-DIRECT | | | |
|---|---|---|---|
| FSK Analysis | Code Check | Real-Time-FFT | Waterfall |
| Autocorrelation | Oscilloscope | Bit Analysis | |

All analysis functions have been divided into two groups: One for HF modes and one for VHF/UHF modes. This is enables optimising for parameters like baudrate and shift which are very different for the various frequency ranges. In addition to the two analysis modes already mentioned, a ”SIGNAL ANALYSIS” menu is available in all modes. The HF or VHF/UHF option is then depending on the last active mode.

# MENU SIGNAL-ANALYSIS OF HF MODES

| ANALYSIS-DIRECT | | | |
|---|---|---|---|
| FSK Analysis | Code Check | Real-Time-FFT | Waterfall |
| Autocorrelation | Oscilloscope | Bit Analysis | |
| | | | |

## MENU SIGNAL-ANALYSIS OF VHF/UHF MODES

| ANAYLSIS-IND | | | |
|---|---|---|---|
| FSK Analysis | Code Check | Real-Time-FFT | Waterfall |
| SELCAL Analysis | Autocorrelation | Oscilloscope | Bit Analysis |
| | | | |

# FSK ANALYSIS HF

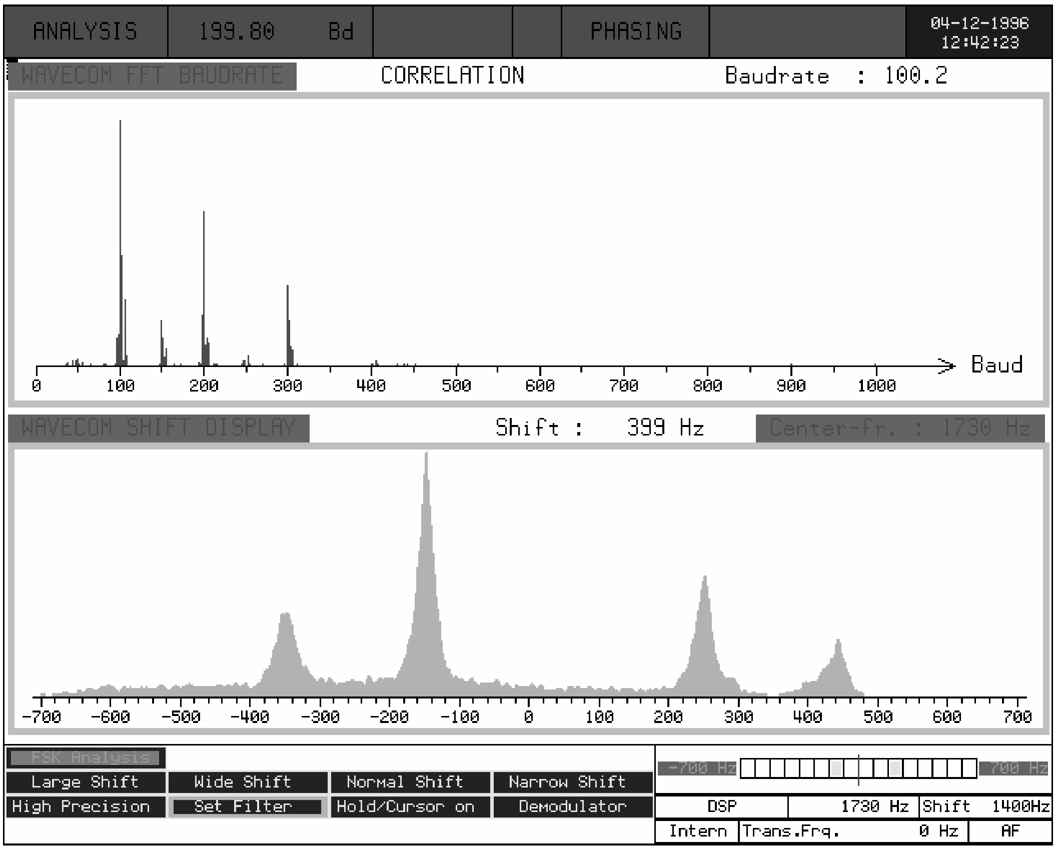
## MODE MENU FSK ANALYSIS

| FSK Analysis | | | |
|---|---|---|---|
| Large Shift | Wide Shift | Normal Shift | Narrow Shift |
| High Precision | Set Filter | Hold/Cursor on | Demodulator |
| | | | |

The "FSK Analysis" mode is a tool for measuring baud rate and frequency shift properties of a monitored signal. The baud rate measurement is based on a novel method of autocorrelation and subsequent FFT calculation. Using this tool the properties of most HF modes may be measured with a high degree of accuracy. In addition signal analysis is an excellent tuning aid especially for MFSK and F7B transmissions.

The user should note that non-integral 7.5 bit signals will produce a doubling of the apparent baudrate caused by the half stop bit. The graphic display serves to confirm the measured baud rate.

# TWINPLEX SIGNAL WITH 200-400-200 Hz SHIFT AND 100 BAUD




Signal Analysis is started by selecting either the "Large Shift", "Wide Shift", "Normal Shift" or "Narrow-Shift" menu fields. The respective shift ranges are 3500 Hz, 1400 Hz, 600 Hz and 200 Hz.

If the shift of a signal is unknown, analysis may be started using "Wide Shift". This will ensure that wide shift signals are not missed. If the measured shift is smaller than wide ”Normal Shift" or "Narrow Shift" may be selected.

To measure the frequency shift manually use the cursors of the shift display. By clicking the "Hold/Cursor on" menu a submenu is displayed. If the cursors are activated using the "Move Cursor #1" and "Move Cursor #2" functions, signal acquisition is stopped. Use the trackball to move the two cursors. The absolute and difference values to which the cursors point are displayed.

The "High Precision" mode is used for the exact determination of shifts. A series of measurements are averaged and displayed. The "High Precision" mode can also be used for shift determination of very weak signals.

In case of poor signal quality and for simplex modes the "Set Filter" function can be used. By pre-selection of the baudrate a low pass filter in the DSP demodulator is switched in to improve signal quality.

The "Center Freq." value is valid for all HF modes.

# DIRECT FSK-ANALYSIS VHF/UHF

## MENU FSK-ANALYSIS

| | | | |
|---|---|---|---|
| FSK Direct | | | |
| Large Shift | Wide Shift | Normal Shift | Narrow Shift |
| Set Filter | Hold/Cursor on | Demodulator | |
| | | | |

For technical reasons the signal analysis tools for the VHF/UHF range had to be differently designed for DIRECT and INDIRECT modulation methods. The INDIRECT methods, also known as "subcarrier modulation" require the output of the FM or AM demodulator of the receiver. In contrast the measurement of a DIRECT modulation method can only be done using the receiver IF signal. POCSAG(FFSK), INFO-CALL(FFSK), PACKET-9600(GFSK), GOLAY(FFSK), ERMES(4FSK) and MODACOM(4FSK) belong to the direct modulation methods.

The baudrate measurement is based on a new method of an autocorrelation and subsequent FFT calculation. With this method most VHF-UHF modes may be measured with high degree of precision. The graphical display is used for the control of the measured values.

The frequency shift is also graphically displayed. This allows FSK, FFSK, GFSK and 4FSK modulation procedures to be easily recognized and analyzed.

Signal Analysis is started by selecting either the "Large Shift", "Wide Shift", "Normal Shift" or "Narrow Shift" menu fields. The respective maximum shift ranges are 22,000 Hz, 10,000 Hz, 4,000 Hz and 1,000 Hz.

If the shift of a signal is unknown, analysis may be started using "Large Shift". An initial measurement of the signal is now possible and should it be required, a changeover to "Wide Shift", "Normal Shift" or "Narrow Shift" can be done.

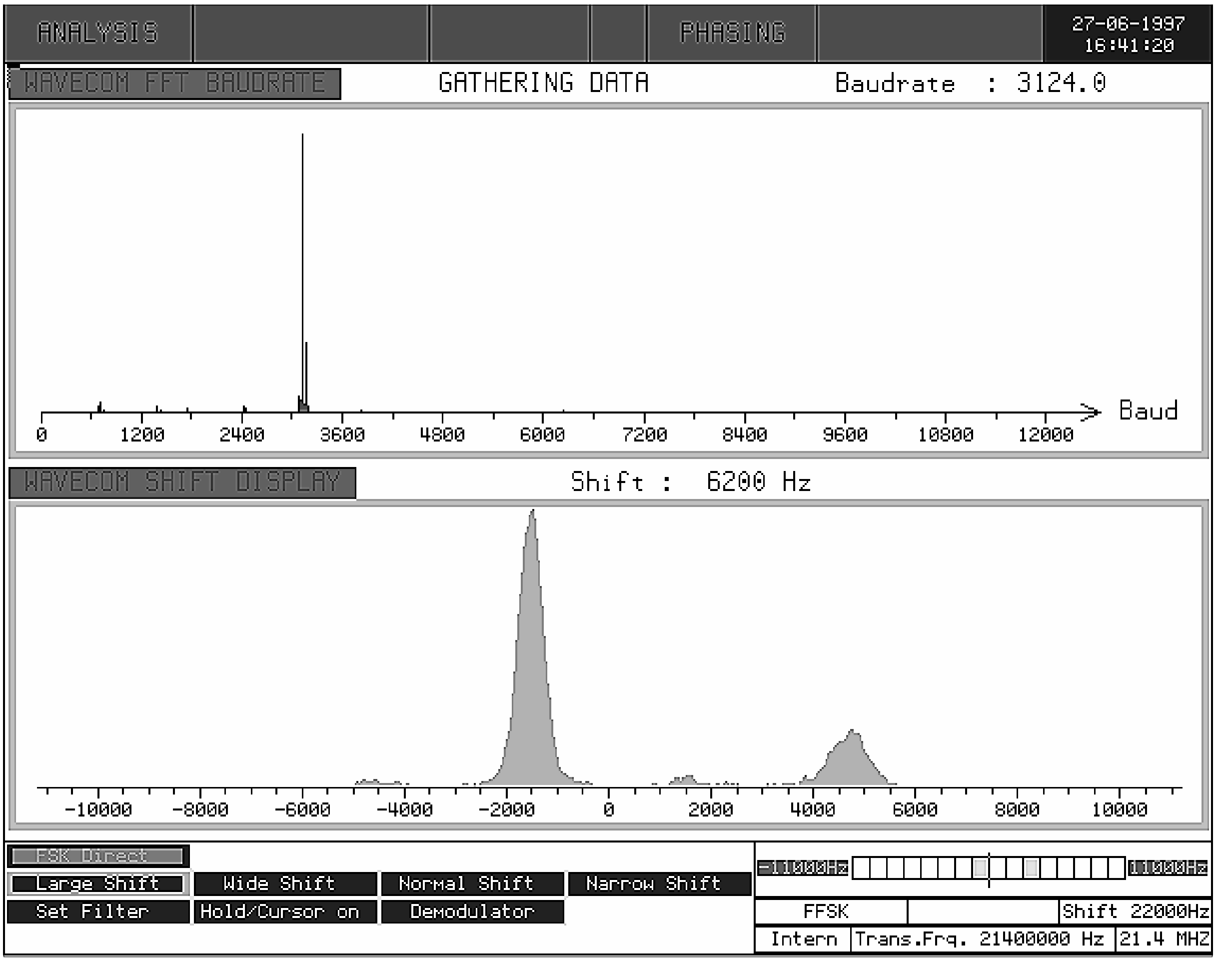
After selecting the menu field "Hold/Cursor on" a submenu with the fields "Move Cursor #1" and "Move Cursor #2" will appear. Signal sampling is stopped.

Using the trackball two cursors may be moved. The software displays both the difference (shift) and the relative value of the cursor positions to the translation frequency in the "WAVECOM SHIFT DISPLAY" field on the screen. This function allows the easy determination of shifts in FSK and 4FSK transmissions.

The center frequency used during "Signal Analysis" can be set in the "Demodulator\Translation Frq." menu field. The setting of the translation frequency is always identical to the signal center at DIRECT procedures.

The measurement of the baudrate has a typical inaccuracy of less than 1 % even at GFSK with 9600 bit/s. With several comparative

# MODACOM SIGNAL WITH 4FSK, 4800 BIT/S AND 1 KHz SHIFT




measurements the effective baudrate can be very precisely determined. Signal measurements of VHF/UHF modes require an exact adjustment to the signal center. This is very important. Deviations of transmitters of more than 1000 Hz occur quite often and have to be corrected by adjusting the receiver or using the translation frequency option.

At measurements of the signal shift up to 1200 Bit/s deviations of up to 5 % have to be expected. All FFSK modes are characterized by having a very high bitrate (keying frequency). The stable keying conditions thus become very short and may often for FFSK be as short as two sinusoidal periods per bit.

This produces an increase in the measured shift with increased baudrate. On the other hand the determination of the effective signal centre frequency is improved.

# INDIRECT FSK-ANALYSIS VHF/UHF

## INDIRECT FSK-ANALYSIS MENU

| FSK Indirect | | | |
|---|---|---|---|
| Large Shift | Wide Shift | Normal Shift | Narrow Shift |
| Set Filter | Hold/Cursor on | Demodulator | |
| | | | |

Decoding of the INDIRECT modulation methods, also known as "subcarrier modulation", requires the output from a FM or AM demodulator of the receiver. Processing of an indirectly modulated signal can only be done with the AF signal. ACARS, PACKET-1200, MPT1327/1343 belong to the INDIRECTly modulated modes as do number of digital selective call systems.

The baudrate measurement is bases on a new method of autocorrelation and subsequent FFT calculation. With this method most VHF modes can be measured with a high degree of precision. The graphical display is used for control of the measured values. The frequency shift is also graphically displayed .

Signal Analysis is started by selecting either the "Large Shift", "Wide Shift", "Normal Shift" or "Narrow Shift" menu fields. The respective maximum shift ranges are 3,500 Hz, 1,400 Hz, 600 Hz and 200 Hz.

If the shift of a signal is unknown, analysis may be started using "Large Shift". An initial measurement of the signal is now possible and if required, "Wide Shift", "Normal Shift" or "Narrow Shift" may be selected.

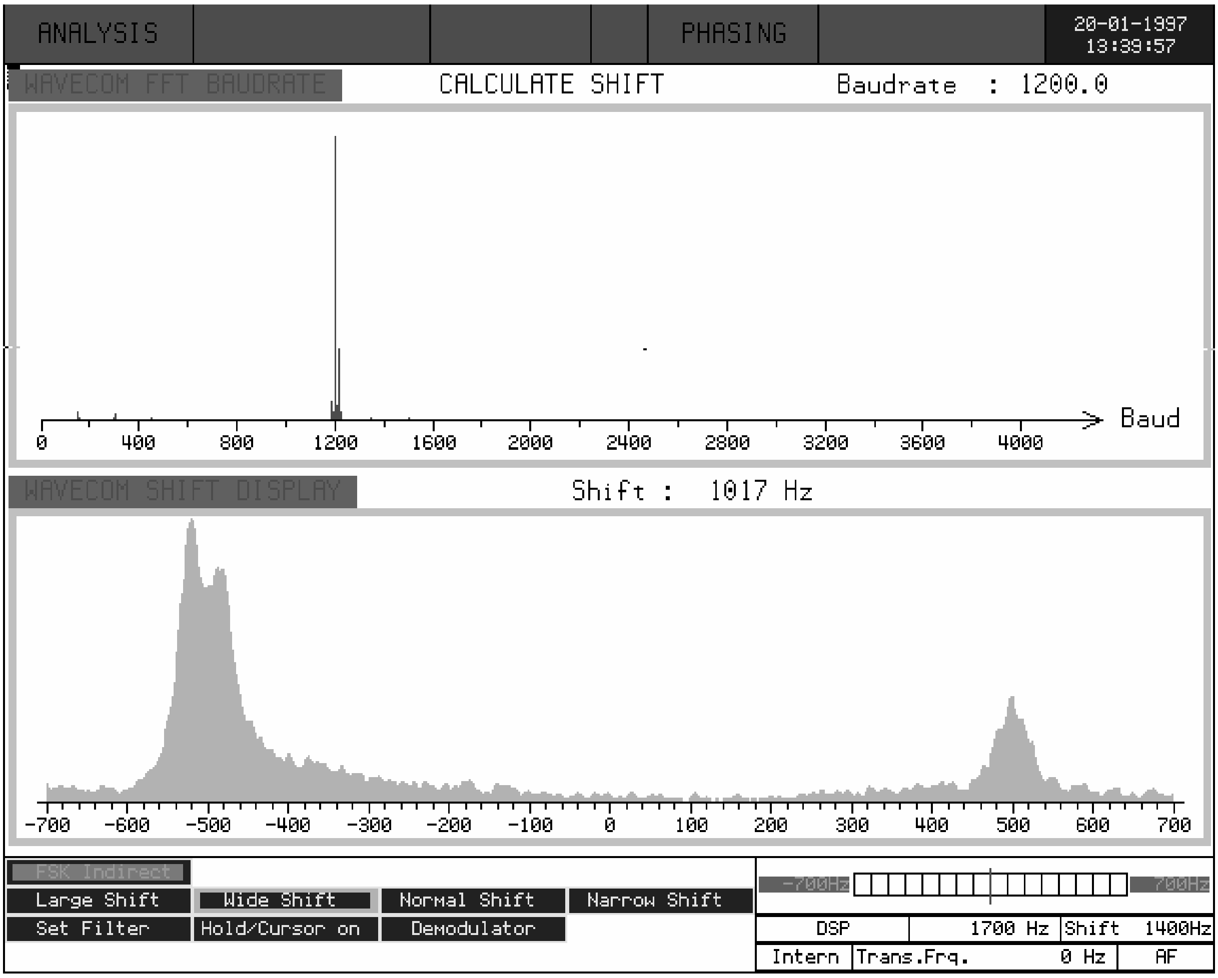
After selecting the "Hold/Cursor on" field a submenu with the fields "Move Cursor #1" and "Move Cursor #2" will appear. Signal sampling is stopped.

Using the trackball two cursors may be moved. The software displays both the difference (shift) and the relative value of the cursor positions to the translation frequency in the "WAVECOM SHIFT DISPLAY" field on the screen. This function allows the easy determination of shifts in FSK and 4FSK transmissions.

The center frequency used during "Signal Analysis" can be set in the "Demodulator\Center Frq." menu field. The setting of the translation frequency is always equal to the signal center frequency for direct modulation methods.

The measurement of the baudrate has a typical inaccuracy of less than 1 % for 2400 bit/s. With several consecutive measurements the effective baudrate can be determined very precisely. Signal measurements of VHF/UHF modes require an exact adjustment to the signal center frequency. This is very important. Transmitter frequency offset of more than 1000 Hz occur quite often and must to be cor-

# PACKET-1200 SIGNAL WITH 1200.0 BAUD AND 1000 Hz SHIFT




rected by adjusting the receiver or by using the translation frequency option.

When measuring of the signal shift at up to 1200 Bit/s deviations of up to 5 % have to be expected.

Often the modulation method of a given signal is unknown. However, using DIRECT analysis on a FM modulated INDIRECT signal will produce a harmonic frequency (double, triple or quadruple) of the the effective baudrate.

As an example the MPT1327 mode has easily recognized baudrate spectrum peaks at 2400 and 3600 Bauds.

If a comparison measurement using INDIRECT analysis tools is then applied to the signal this will produce valuable indications to the actual modulation method in use.

# PSK SYMBOL RATE MEASUREMENT AND PSK PHASE PLANE

## PHASE ANALYSIS MENU

| Phase Analysis | | | |
|---|---|---|---|
| Start | Center: 1800 | Demodulator | Hold Time: 20 |
| SYNC Mode | Symb: 100.0 | PSK Rate Anal | FFT |
| | | | |

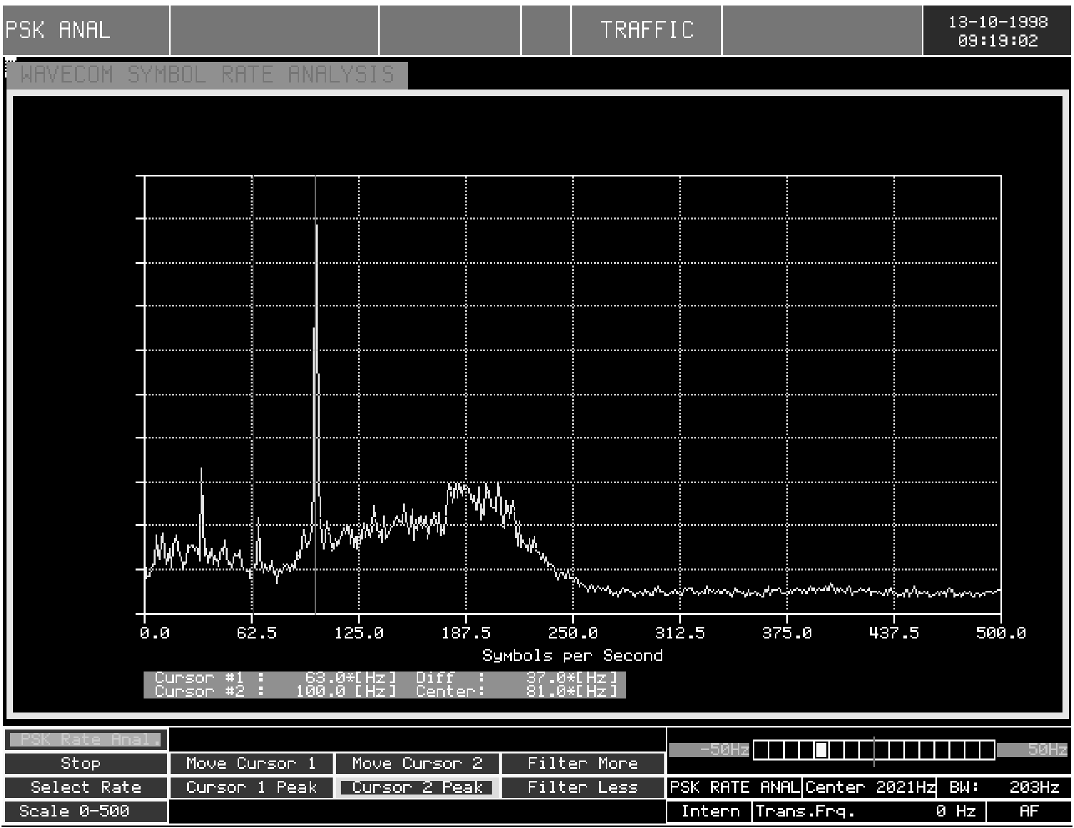
The Phase Analysis tool is used for analyzing the characteristics of phase modulated signals (BPSK, QPSK, M-ary DPSK), and to a limited extent, M-ary PAM signals. The Phase Analysis tools really consists of three tools. These are Asynchronous mode phase plane, Synchronous mode phase plane, and phase modulation symbol rate tool.

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.

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

(1) Use the **Real-time FFT** tool to characterize the signal. Use the cursors to configure a

## SYMBOL RATE MEASUREMENT OF A 100 BAUD 8-DPSK SIGNAL



filter to the estimate of the center frequency and bandwidth.

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

(3) 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.

(4) 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.

The Real-time FFT is used for determining an estimate of the signal center frequency, and signal bandwidth. This must be done with setting of the measurement cursors. Starting the phase analysis tools takes the information from the measurement cursors, and uses this information to configure the center frequency and bandwidth. This sets up a pre-filter, allowing the tools to be used on signals where there is out-of-band interference, or when there are more than one simultaneous channels.

To start the FFT measurement in "Phase Analysis" select **"FFT", Hold/Measurem."**and select a bandwidth. Now, configure the steep flanked bandpass filter by using the cursors and then save the values by selecting "**Set Filter"**. The menu now switches back to **"FFT"**.

Phase modulated transmissions may be multi level, e.g. 16-DPSK. Thus a phase change value may represent more than one logical symbol, hence the term symbol rate. An example is 16-DPSK PACTOR-II at a symbol rate of 100 Baud, but with an effective bit rate of 400 bps. To determine the symbol rate, the **PSK Symbol Rate** analysis tool is provided. This tool provides a spectrum display (with 3 zoom levels) and allows you to measure the symbol rate using **"Cursor 1"** and **"Cursor 2"**. A PSK signal will normally produce multiple peaks. Normally (but not always) the symbol (or baud rate) will be the obvious peak at the highest frequency. The other peaks are normally some fraction of the true symbol rate.

To automatically find the two highest peaks click **"Cursor 1 Peak"** and **"Cursor 2 Peak".** If a peak function is enabled a **"*"** removed from the measurement indication. If both **"*"** are removed the difference between peak 1 and peak 2 is also displayed.

For signals with low symbol rates, select a different resolution using **"Scale"**. The range options are "0-500", "0-100" and "0-4000" Baud. Note that the lower scales have a higher precision, but at the expense of a lower display rate.

The **"Filter More"** and **"Filter Less"** adjust the filtering on display. Depending on the signal data content, it may be found that more filtering is required to see the peaks clearly.

Once you are satisfied you have the correct symbol rate, determined with the measurement cursor 1 or 2 or the difference between 1 and 2, click **"Select Rate".** This will transfer the value and start the PSK Phase Plane analysis tool.

There are two modes for the PSK Phase Plane Analysis:

1. **Sync**hronous mode, and
2. **Async**hronous mode.

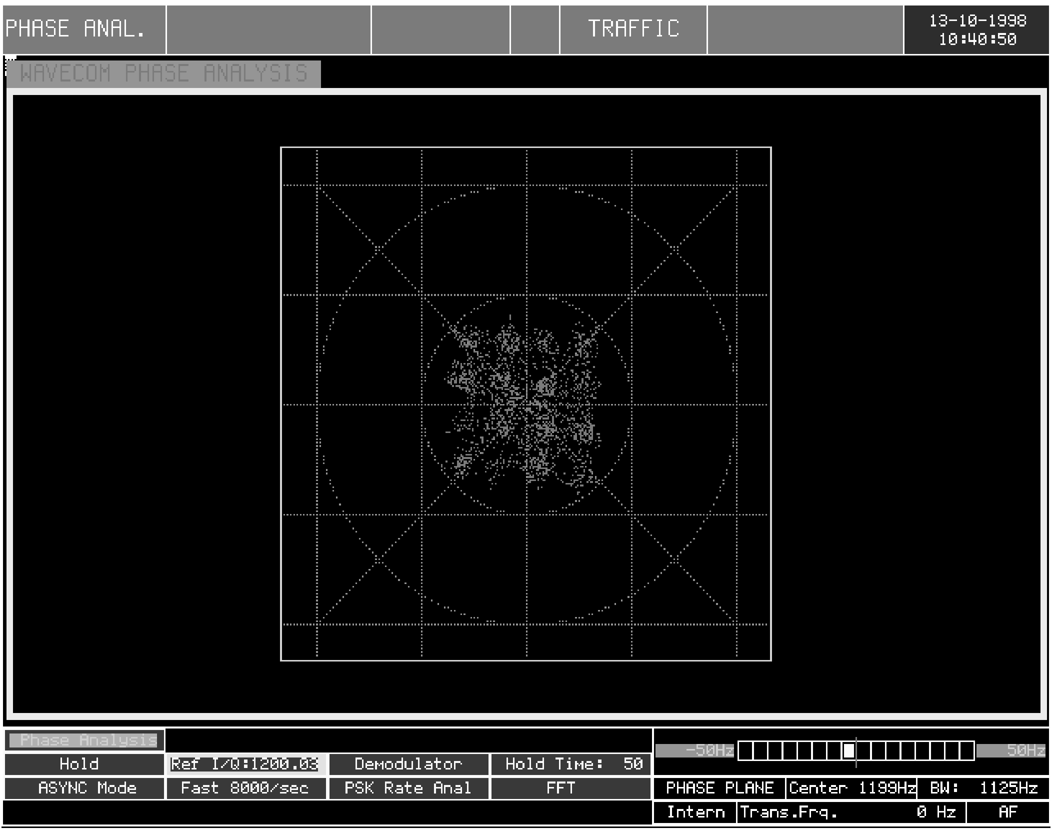
Back to the PSK Phase Rate analysis menu, the **"Center: xxx"** allows the center frequency for the demodulator transferred from the previous FFT measurement to be adjusted. An error in the center frequency normally results in a phase plane that is rotated by an amount proportional to the frequency error.

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 **ASYNC** mode, the signal is not demodulated at all. Instead, the phase of the signal is visually 'compared' with an internal high stability 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 display points will trace the path taken as the signal phases change. At the nominal signal mapping points, there is normally an accumulation of data points, providing a visual clue to the total signal mapping.

The frequency of the reference signal is set using the **"Ref I/Q: xxx"** 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 have immediate effect, and resulting change in the phase display is

## PHASE PLANE IN ASYNC MODE AND A 16-DPSK SIGNAL



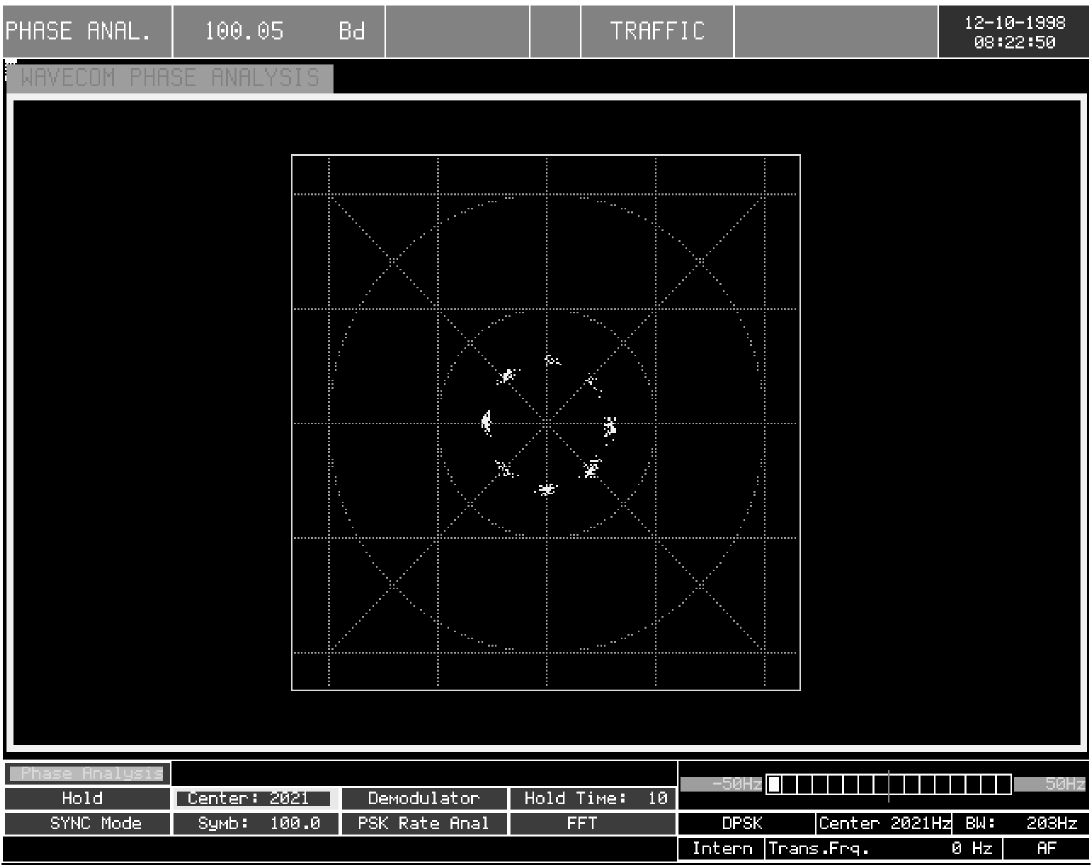
immediately visible on the display.

For **ASYNC**hronous mode, the symbol rate measurement is not required. The sampling rate is independent of symbol rate. Using **"Norm 4000/sec"** three sampling rates are selectable, "Slow", "Norm" and "Fast". For low baud rate signals, better results are obtained with a lower sampling rate. The **"Select Mode"** menu item is disabled in the **"Demodulator"** menu.

**SYNC**hronous 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 and indication of what level of phase modulation is used, e.g. 2-PSK to 16-PSK. For Synchronous mode, the symbol rate is the same as the baud rate of the signal, and needs to be known to configure the demodulator. The demodulator is selected in **"Demodulator\Select Mode"**. **"Symb: xxx"** is used to enter the signal symbol rate, either manually or transferred from PSK Symbol Rate Analysis. The center frequency is entered using **"Center: xxx"**.

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.

## Phase Plane in SYNC Mode and a 8-DPSK Signal



# HF CODE ANALYSIS

## OPERATING MENU CODE ANALYSIS

| Code Check | | | |
|---|---|---|---|
| Signal Analysis | Full Auto Mode | Manual Baudrate | Full Scan |
| IAS is on | Demodulator | | |
| | | | |

The purpose of the "Code Analysis" is to determine the mode of transmission, baud rate, shift and centre frequency. The software allows the fully automatic determination of operating mode. Presently the Wavecom software includes more than fifty operating modes. To quickly identify an operating mode then becomes increasingly difficult to even the trained user. Often known systems apparently without reason change baud rate e.g. ARQ-E3 from 48 to 50 or ARQ-E to 75 Baud. The baud rate itself is therefore a limited indicator of the transmission in use.

"Code Analysis" is started in full automatic mode by selecting the "Full Auto Mode" menu field. In the case of FEC and DUPLEX systems the baud rate, shift and centre frequency is normally very reliably determined. In case of SIMPLEX systems the presence of noise in the block intervals may lead to false measurements.

Therefore "Code Analysis" also offers an option to start the analysis manually in the "Manual Baudrate" menu field. The "Centre Frequency" and "Shift" values may be set using the trackball or cursor keys. After a baud rate value has been entered, the code check starts with the programmes values. The manual start is advantageous when a measurement has to be repeated or when the baudrate is already known.

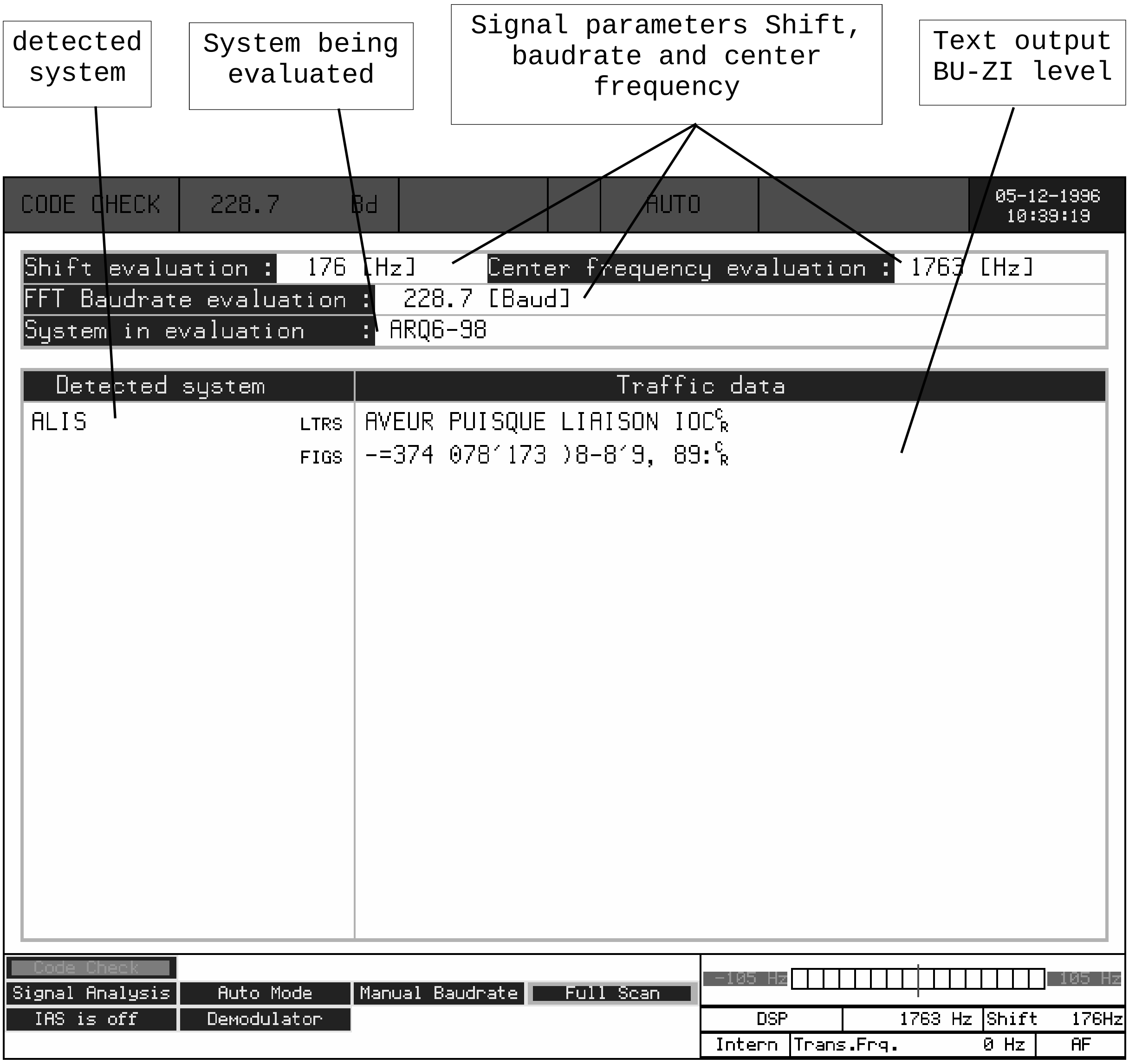
As a new feature the "Fast Scan" or "Full Scan" functions are available. The extremely fast determination in "Fast Scan” mode is due to an additional evaluation of the measured baud rate. Using "Fast Scan" only those systems are evaluated, which are known to use the measured baud rate. In "Full Scan" all operating modes are evaluated independent of the baud rate.

If "Code Analysis" does not recognize a mode the code check should be repeated using "Full Scan". The measurement may be restarted without a previous baud rate determination in case of heavy fading or disturbances by selecting the "Manual Baudrate" menu field.

If an operating mode is uniquely identified, the software will change into the actual operating mode and decoding is initiated with the measured values of mode, baud rate, shift and centre frequency.

If two or more different systems are identified or if too many transmission errors occur no automatic change-over takes place.

# HF CODE ANALYSIS VIDEO DISPLAY




After activation of the "Full Auto Mode", the screen changes to display the fields "Shift evaluation", "Centre frequency evaluation", "FFT Baudrate evaluation", "System in evaluation" and a split field with "Detected System" and "Traffic Data".

The Wavecom software initially determines the frequency shift, centre frequency and the baud rate. These values are displayed in the appropriate fields after the measurement has taken place.

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 "System detected" field. The decoded text is simultaneously displayed in letters and figures case in

the "Traffic Data" field.
Some telegraphy modes are very difficult to distinguish, especially when the system is in IDLE mode. The decoded text together with the readable special characters IDLE a, IDLE b and RQ are additional important classification aids in determining the correct mode.

In case of the ITA-2 alphabet, the two cases LTRS (letters) and FIGS (figures) are displayed. The LTRS and FIGS shift characters are displayed as special characters, but is otherwise ignored by the software.

In case of ITA-5 (ASCII) systems only one data line is displayed as the ITA-5 alphabet has no LTRS-FIGS shift.

Received characters in error are displayed in red. If typical parameters of another system are detected in the identified mode all characters are displayed in red. Thus in addition some modes as e.g. SITOR-FEC and POL-ARQ may be distinguished and automatically displayed.

The test for asynchronous Baudot transmissions with possible stop bits of half a bit length duration, is performed using a special process. The software tests the decoded binary data against valid start-stop bit patterns.

The sampling of data and the continuous test for known systems is done simultaneously (multitasking). An exception is only made in the case of test for a valid Baudot start-stop pattern as data is only sampled during the on-going test.

Code analysis is a sequential process. In case of strong disturbances during signal sampling, the operating mode will not be readily recognized correctly. Repeated execution of "Code Analysis" increases the probability of correct system recognition even under severe signal disturbances.

"Code Check" may be remotely controlled via the serial interface (Remote Control). Thus automatic data recording is possible.

# DIRECT CODE ANALYSIS VHF/UHF

## OPERATING MENU DIRECT CODE ANALYSIS OPERATING MENU

| Code-Check-Dir | | | |
|---|---|---|---|
| Signal Analysis | Auto Mode | Manual Baudrate | Demodulator |

For technical reasons the signal analysis tools for the VHF/UHF range had to be differently designed for DIRECT and INDIRECT modulation methods. The INDIRECT methods also known as sub-carrier modulation require the output of the receiver FM or AM demodulator. In contrast the measurement of a DIRECT modulation method can only be done using the receiver IF signal.

The following modes use INDIRECT modulation methods:

ACARS
ATIS
FMS/BOS
MPT1327/1343
PACKET-1200
ZVEI-VDEW

The purpose of **”Code Analysis”** is to determine the mode of transmission, baudrate, shift and center frequency. If a mode is uniquely identified, the software will change into the actual monitored mode using the measured values of mode, baudrate and shift.

The POCSAG mode is started using **”Auto Speed”.** This will enable the monitoring of radio nets using continuously changing baudrates.

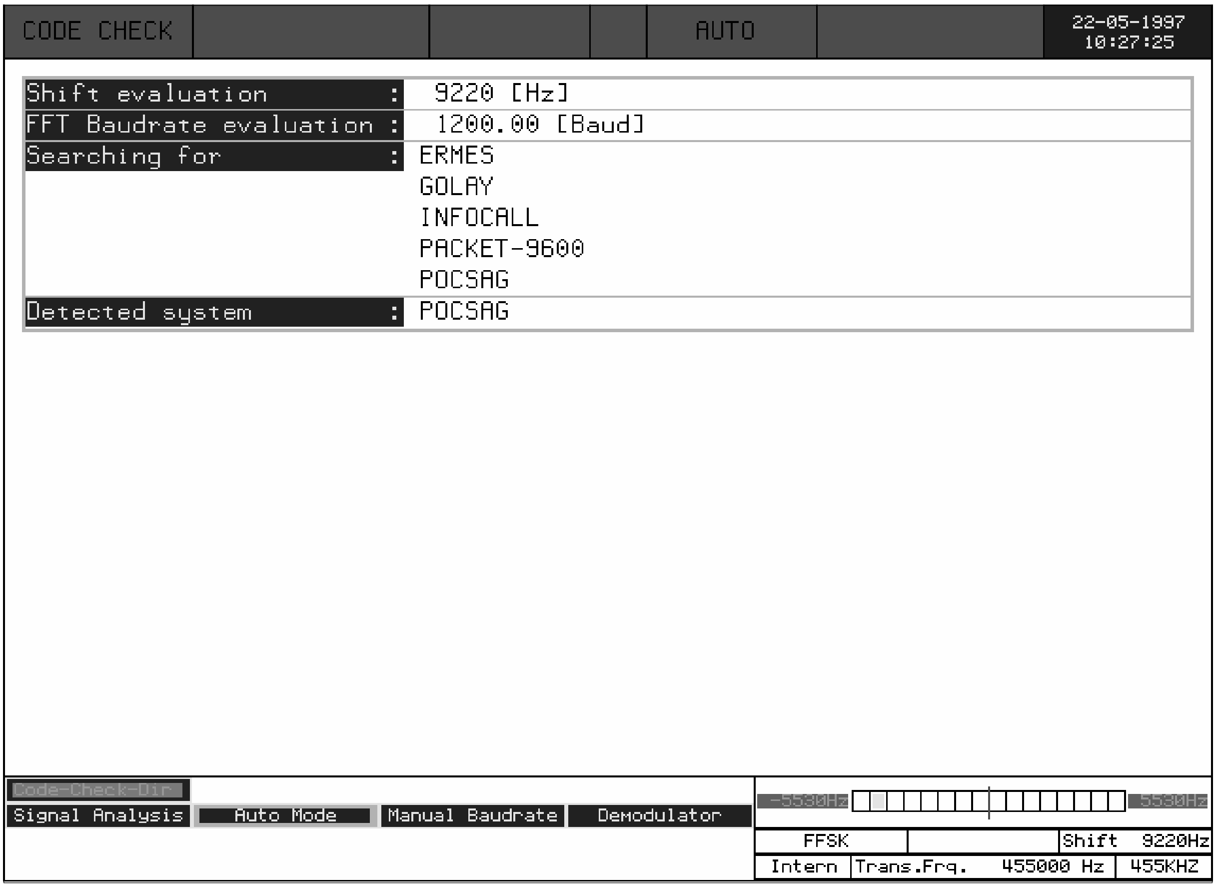
# HOW DOES CODE ANALYSIS WORK

When DIRECT code analysis is started shift and baudrate are at first extracted from the radio signal. VHF/UHF modes are often characterized by transmitting data in bursts, and thus a noise gate is required to ensure that the analysis tools only process valid signals. Otherwise the parameters would exhibit false values depending on the noise in the channel.

After shift and baudrate have been determined the value of these parameters are transferred to the demodulator. The actual mode must now be determined. I order to do this the incoming bit stream is sampled with an interrupt of five times the measured baudrate. Each of the five samples are shifted through separate shift registers and are compared to the synch sequence for every mode.

Ideally if a synch sequence is detected all five sampled bit sequences should be exactly identical to the sync codeword. In reality three consecutive and identical comparisons are deemed sufficient to recognize a mode as valid.

# VIDEO DISPLAY OF THE DIRECT CODE ANALYSIS OPERATING MENU




# SPECTRUM CORRELATION

This method utilizes a direct spectrum comparison between the actual spectrum and a reference spectrum. The reference is equal to the sequence of a typical signal.

Due to the restrictions imposed by the very heavy computational demands a spectrum cannot be compared to all possible spectrums in real time. Thus a reference must be created from the incoming signal. A very hard noise gate determines which spectra belong to the reference spectrum searching for stable frequencies. It is assumed that a valid signal is present when a frequency has a certain duration, as is the case for FSK. Using this method a reference spectrum is solely constructed by averaged valid spectra.

To construct a useable reference spectrum approximately 50 valid spectra are required. When this is the case direct spectrum comparison is activated and determines whether the incoming signal is valid or not. The data to be compared are averaged once again and a small hysteric is added. The resulting flag has direct influence on the frequency data written to the analysis buffer.

Good results have been obtained when the method was tested with these receivers:

IC R-9000
IC R-8500
IC R-7000
AEG E-1900/3

The noise gate requires some time to work. Even when fully functional a 80 - 100 ms delay is experienced. The delay is not compensated for.

# INDIRECT CODE ANALYSIS VHF/UHF

## INDIRECT CODE ANALYSIS MENU

| Code-Check-Ind | | | |
|---|---|---|---|
| Signal Analysis | Auto Mode | Manual Baudrate | Demodulator |

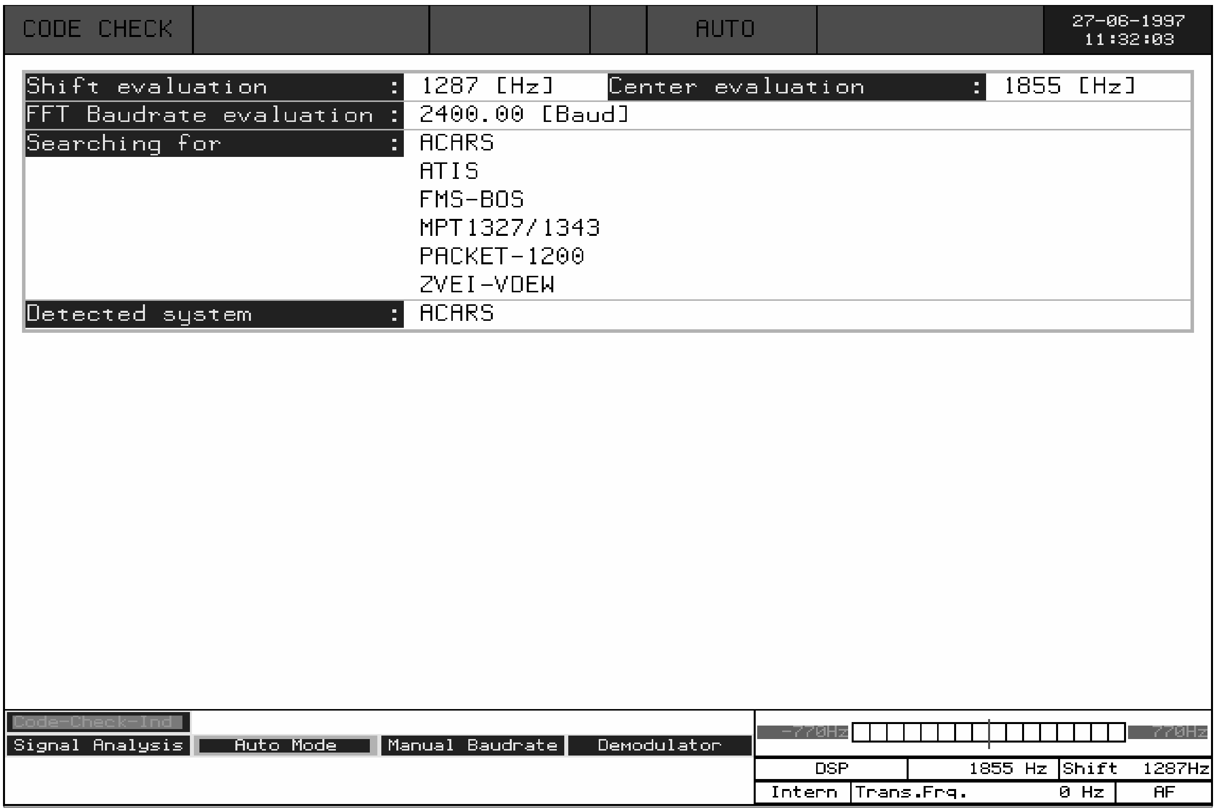
For technical reasons the signal analysis tools for the VHF/UHF range had to be differently designed for DIRECT and INDIRECT modulation methods. The INDIRECT methods also known as sub-carrier modulation require the output of the receiver FM or AM demodulator. In contrast the measurement of a DIRECT modulation method can only be done using the receiver IF signal.

The following modes use INDIRECT modulation methods:

ACARS
ATIS
FMS/BOS
MPT1327/1343
PACKET-1200
ZVEI-VDEW

The purpose of **”Code Analysis”** is to determine the mode of transmission, baudrate, shift and center frequency. **Video display of the INDIRECT Code Analysis**

## VIDEO DISPLAY OF THE INDIRECT CODE ANALYSIS OPERATING MENU



# SPECTRUM CORRELATION

This method utilizes a direct spectrum comparison between the actual spectrum and a reference spectrum. The reference is equal to the sequence of a typical signal.

Due to the restrictions imposed by the very heavy computational demands a spectrum cannot be compared to all possible spectrums in real time. Thus a reference must be created from the incoming signal. A very hard noise gate determines which spectra belong to the reference spectrum searching for stable frequencies. It is assumed that a valid signal is present when a frequency has a certain duration, as is the case for FSK. Using this method a reference spectrum is solely constructed by averaged valid spectra.

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The noise gate requires some time to work. Even when fully functional a 80 - 100 ms delay is experienced. The delay is not compensated for.

The data to be compared are averaged once again and a small hysterics is added. The resulting flag has direct influence on the frequency data written to the analysis buffer.

IC R-9000
IC R-8500
IC R-7000
AEG E-1900/3

The noise gate requires some time to work. Even when fully functional a 80 - 100 ms delay is experienced. The delay is not compensated for.

# VHF/UHF 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 tone call systems.

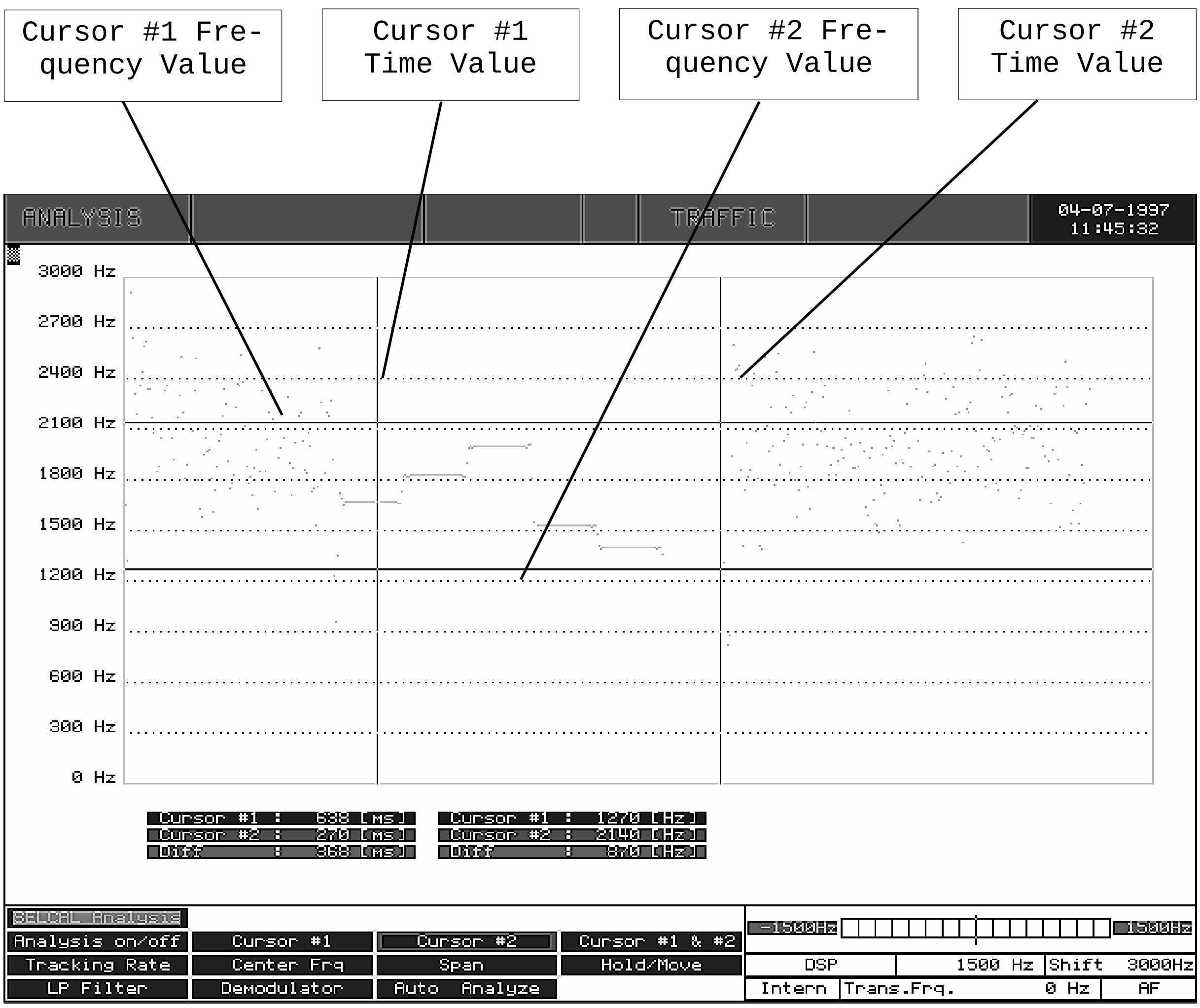
After clicking **"SELCAL Analysis"** analysis is started. The detected frequency values are displayed as pixels.

A monitored analogue tone call is easily recognized as stable lines. To stop the horizontally scrolling display click **"Hold/Move"**. The display may be searched to the maximum extent of 2750 measured values using the trackball.

**"Analysis on/off"** restarts monitoring.

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

## ANALOG0S ZVEI-2 SELECTIVE CALL



Clicking **”LP 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 baudrate. 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 (analogue selcal systems), 1,500, 600 and 300 Hz.

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

**”Cursor #1”** and **”Cursor #2”** are used for measurement of the monitored data. Both cursors may be moved in x and y directions for the frequency and time axis. The instantaneous values are continuously displayed below the analysis display field.

Clicking **”Cursor #1 & #2”** will change the position of both cursors symmetrically to each other. This function is useful for the comparison of frequency distances.

Clicking **”Auto Analyse”** 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.

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

# HF MFSK ANALYSIS

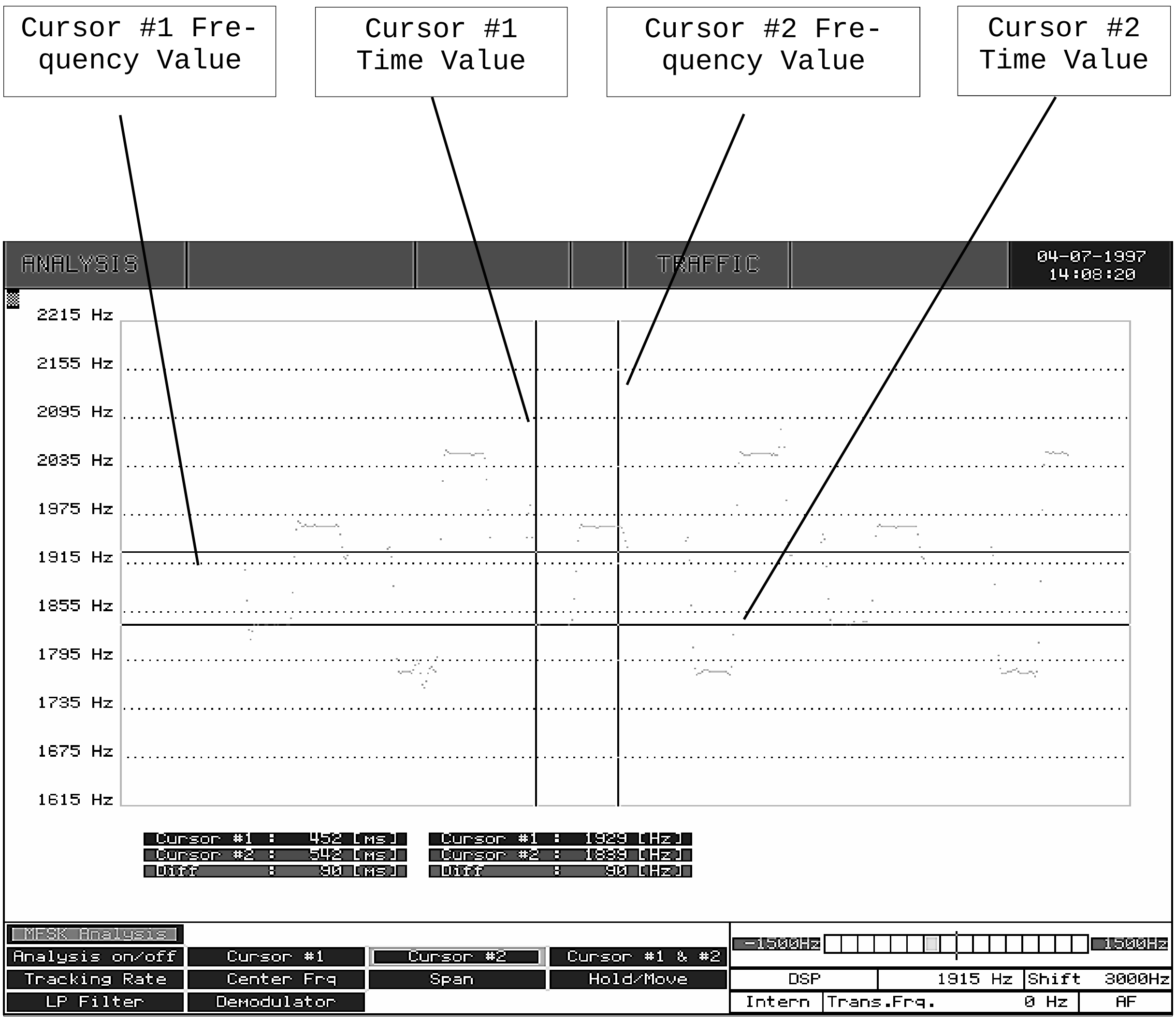
The MFSK analysis for the HF range employs a graphical display in two dimensions, frequency (y axis). Both values may be preset. This tool was originally developed for the analysis of analogue tone call systems, but is equally suitable for evaluation of FSK and MFSK systems. In particular the frequency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

After clicking **"MFSK Analysis"** analysis is started. 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 **"Hold/Move"**. The display may be searched to the maximum extent of 2750 measured values using the trackball.

**"Analysis on/off"** restarts monitoring.

## COQUELET-13 MFSK-ANALYSIS



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

Clicking **”LP 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 baudrate. 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 (analogue selcal systems), 1,500, 600 and 300 Hz.

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

**”Cursor #1”** and **”Cusor #2”** are used for measurement of the monitored data. Both cursors may be moved in x and y directions for the frequency and time axis. The instantaneous values are continuously displayed below the analysis display field.

Clicking **”Cursor #1 & #2”** will change the position of both cursors symmetrically to each other. This function is useful for the comparison of MFSK frequency distances to find symmetry.

# REAL-TIME-FFT

The real time signal analysis is an important function and is now also available in the W4100DSP. The spectrum analysis is based on Fast Fourier Analysis (FFT) in real time and has a 4096 pixel resolution. Briefly explained the signal is digitalized, 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 is considerably higher with the 16-Bit converter used, but the configured display resolution has proved better in practical use. The frame refreshment frequency is more than 20 pictures per second, allowing fast signal changes to be displayed as well.

## REAL-TIME-FFT WITH AN HF-SIGNAL

After clicking on "**Hold/ Cursor On**" the frequency spectrum can be measured. The absolute and the difference values of the cursor positions are continuously displayed .

When the cursors are set to the desired positions they may be moved simultaneously by clicking "**Move #1 & #2**". The measurement of MFSK and FDM transmissions is thus considerably easier.

Using the center of both cursor positions, the center frequency is determined. Selecting the "Cent Freq=C1-C2" function, the calculated center frequency is set to the new value.

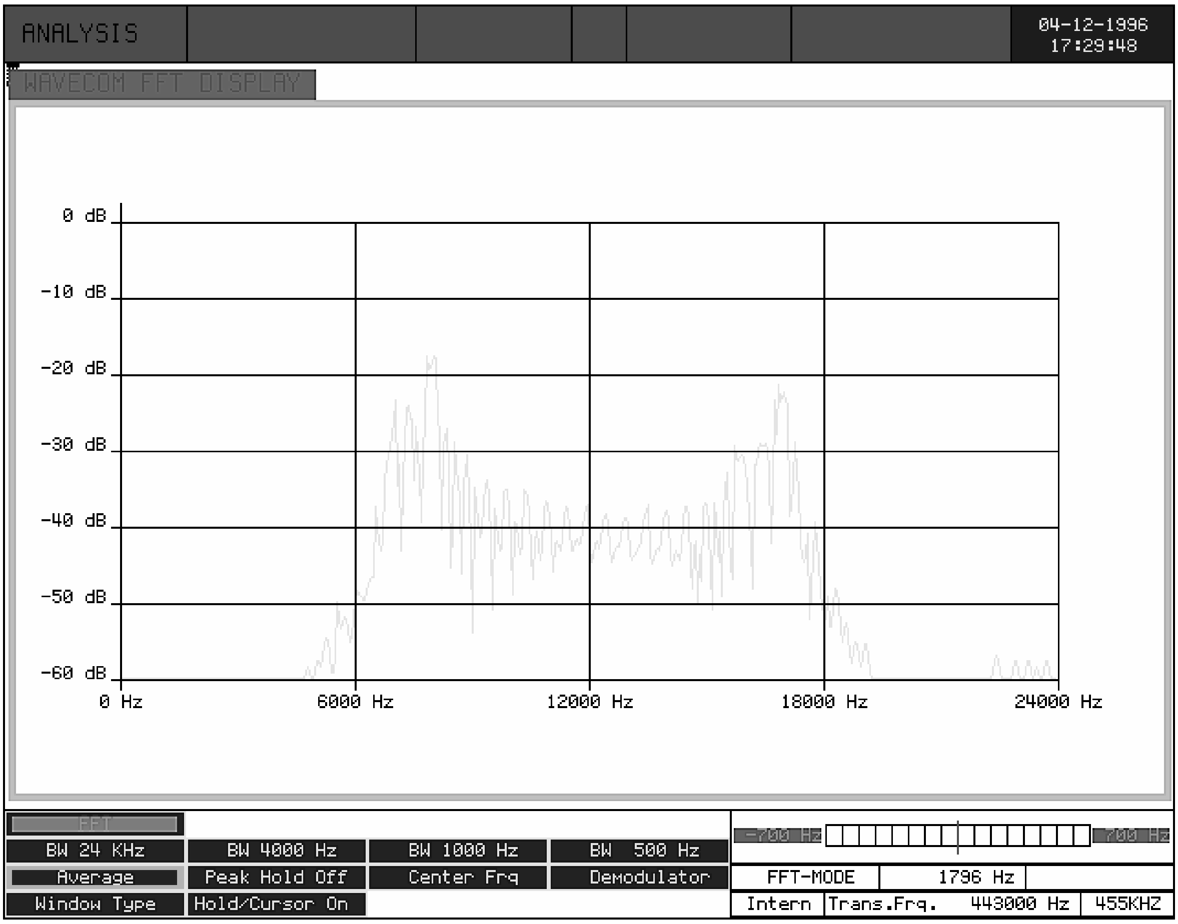
After choosing **"Average"** up to 64 measurements can be displayed as an average value. A value of 1 turns averaging off. The centerred display of several measurements is very helpful when observing FDM transmissions or during heavy fading.

The **"Peak Hold On/Off"** function freezes the instantaneous peak value of all measurements. The peak values are displayed in blue. The continuous display of the received signal peaks enables more precise measurements of burst transmissions.

By clicking on **"Center Frq"** the preset center frequency is displayed as a green line. Each change of the center frequency is continuous displayed.

In the **"Window Type"** menu field

# POCSAG OUTPUT WITH IF INPUT AND 8000 Hz SHIFT



the four window functions "Rectangle", "Hamming", "Hanning" and "Blackman" may be selected. The different window types influence 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.

One has to be aware that for the FFT measurements changes in the received signal can cause the display of spurious spectral lines or a liasing ("false" frequency display).

# 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 as e. g. POCSAG or ERMES must be adjusted to the effective center frequency of the signal, f.e. 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 half of the bandwidth. The translation frequency adjustment is calculated as the IF output frequency. **(455 kHz)**- half of the adjusted FFT bandwidth **(12 KHz)** = Translation **(443 KHz).** The measurement range now is 443 KHz to 467 KHz.

For a 455 KHz receiver IF output of a short wave receiver (e.g. HF-1000) the translation frequency is first adjusted to 453.3 KHz to obtain the standard center frequency of 1700 Hz. Thus it is not necessary to change the translation frequency for the FFT measurements. Neither is a change necessary when **INDIRECT-FSK** (AF) is received.

# REAL-TIME-WATERFALL

The waterfall analysis gives 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 gives a display also in the time domain.

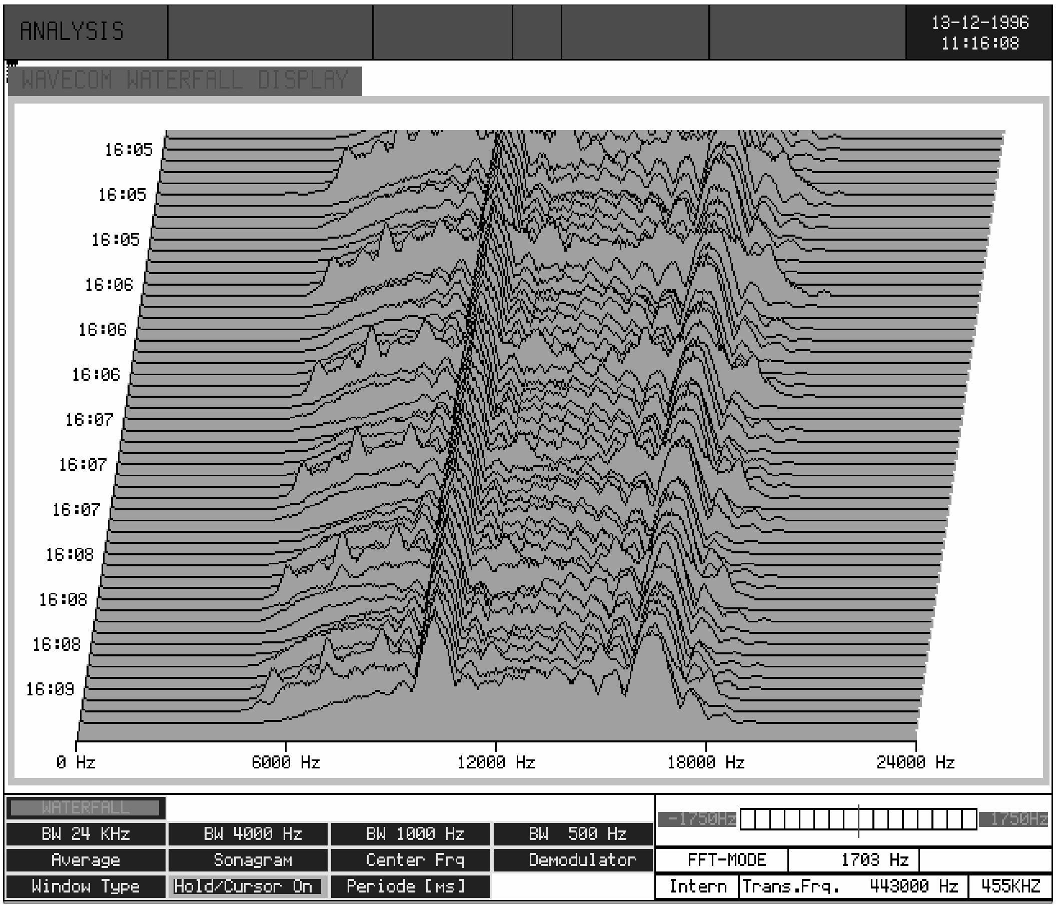
Waterfall analysis is started by clicking on a desired bandwidth **"BW 500 Hz"**, **"BW 1000 Hz"**, **"BW 4000 Hz"** or **"BW 24 KHz"**.

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

The functions **"Average"**, **"Center Frq."**, **"Window Type"** and **"Hold/ Cursor on"** are identical to the same real-time-FFT functions.

In the **"Period (ms)"** menu field 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 10'000ms a measurement is done once every 10 seconds giving a total time span of more than 400 seconds.

## REAL-TIME-WATERFALL OF AN ERMES TRANSMISSION



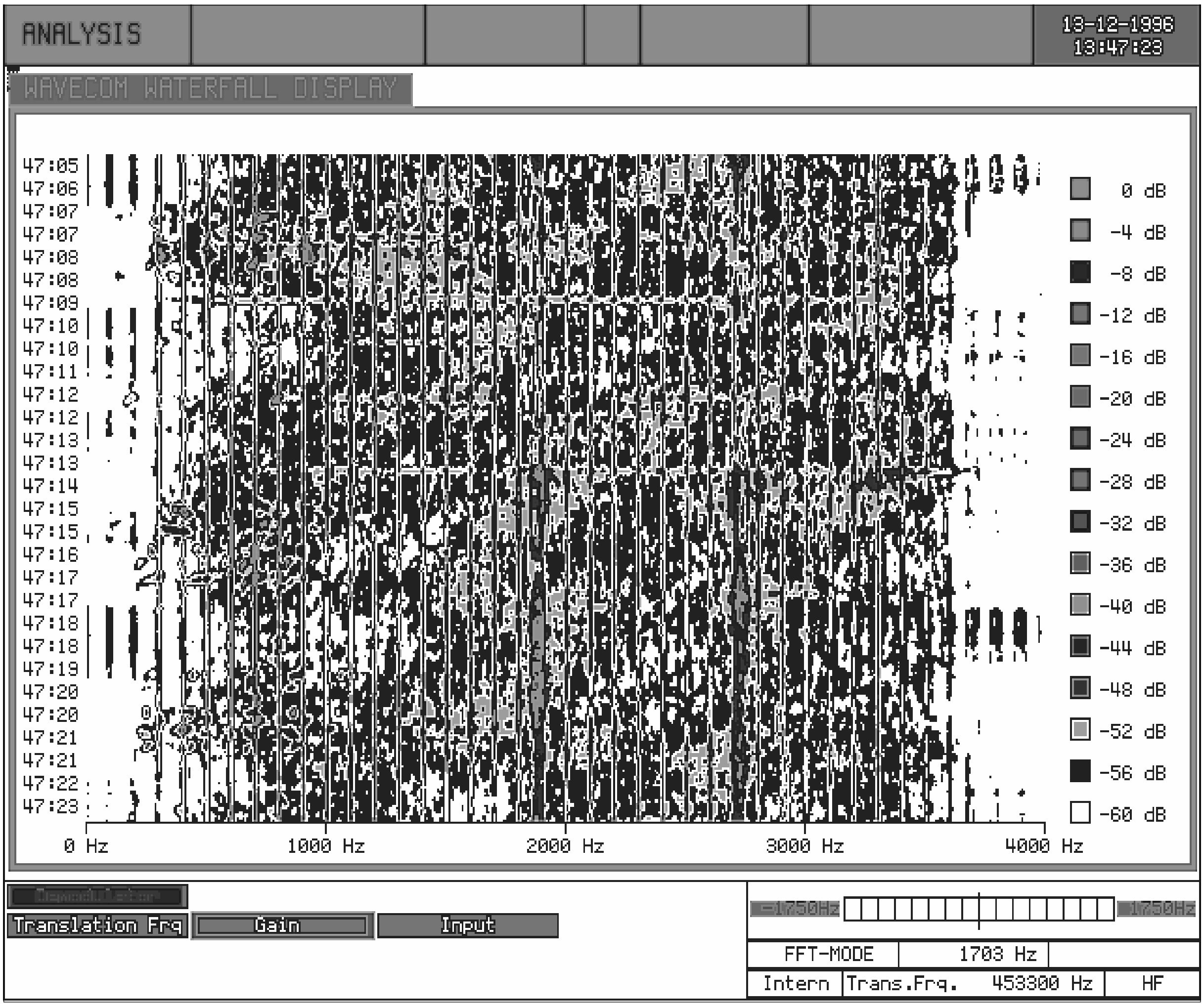
# REAL-TIME-SONAGRAM

A second widespread method for FFT display is the SONAGRAM which also displays the frequency, amplitude and time domain parameters of the signal. A sonogram is a graphical display of an acoustical structure. In the sonogram the signal amplitude is displayed in colour coded 4.0 db steps.

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

The sonogram analysis is started by clicking on the "Sonogram" menu field while the real-time-FFT is active. The operation is identical to the waterfall analysis.

## SONOGRAM OF A FDM TRANSMISSION ON HF



# REAL-TIME-OSCILLOSCOPE

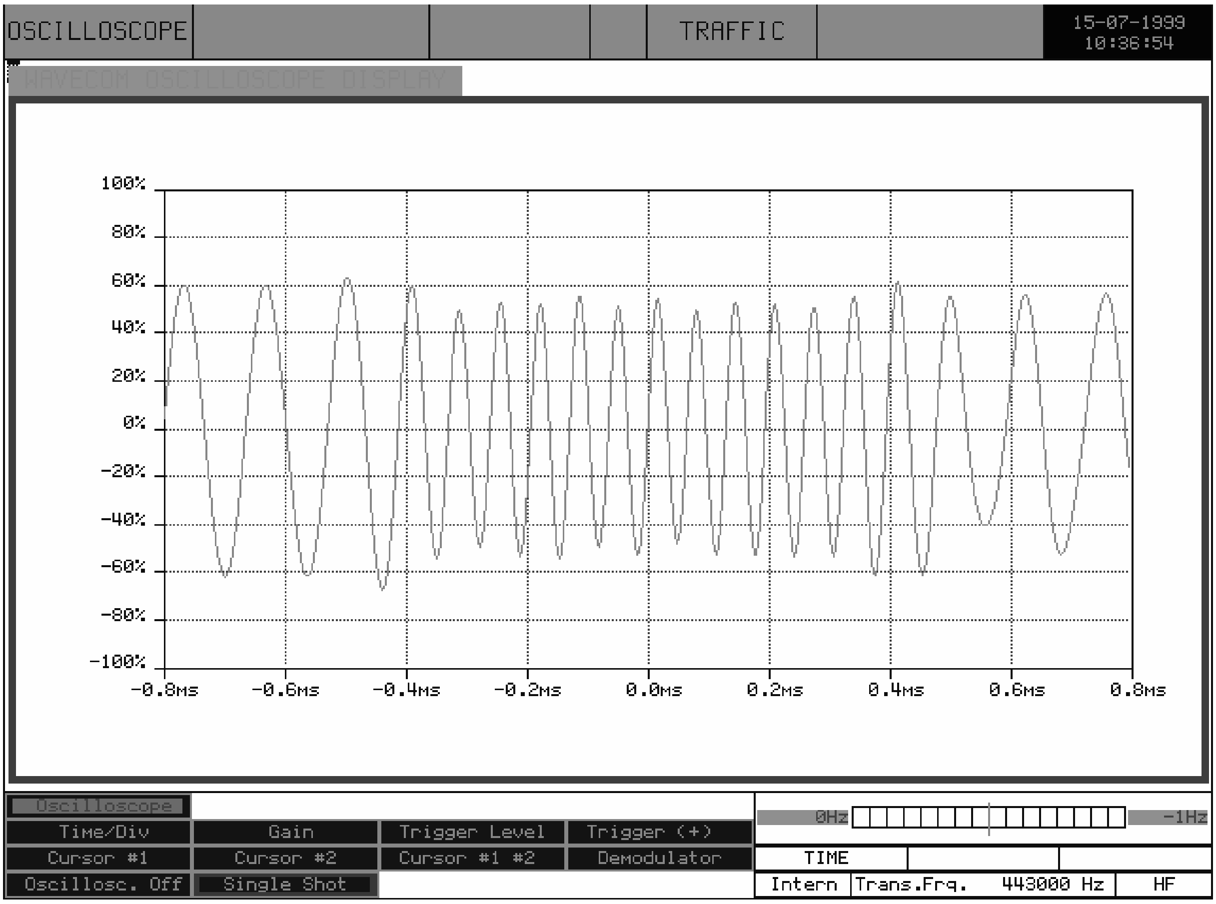
## OSCILLOSCOPE MENU

| Oscilloscope | | | |
|---|---|---|---|
| Time/Div | Gain | Trigger Level | Trigger (+) |
| Cursor #1 | Cursor #2 | Cursor #1 #2 | Demodulator |
| Oscillosc. Off | Single Shot | | |

The "Oscilloscope" functions are similar to the ones found in a ordinary digital oscilloscopes. The more important functions are "Time/Div" (time) and "Gain" (amplitude).

The horizontal sweep time per screen division may be set in **"Time/Div"** from 200 us/div to 100 ms/div. The fastest line sweep thus is 1.6 ms, which is sufficient for all modes. It should be noted that both the HF and IF inputs may be used for high resolution displays. At 10.7 MHz this equals a device operating at 150 M samples/sec.

## OSCILLOSCOPE DISPLAY OF A 1200 BIS/S FFSK SIGNAL



Using **"Gain"** the gain should be adjusted to 2/3 of the display height.

In order to achieve a stationary display use **"Trigger"**. This function will start the display at a defined signal level, e.g. at a sinus zero crossing or a preset level.

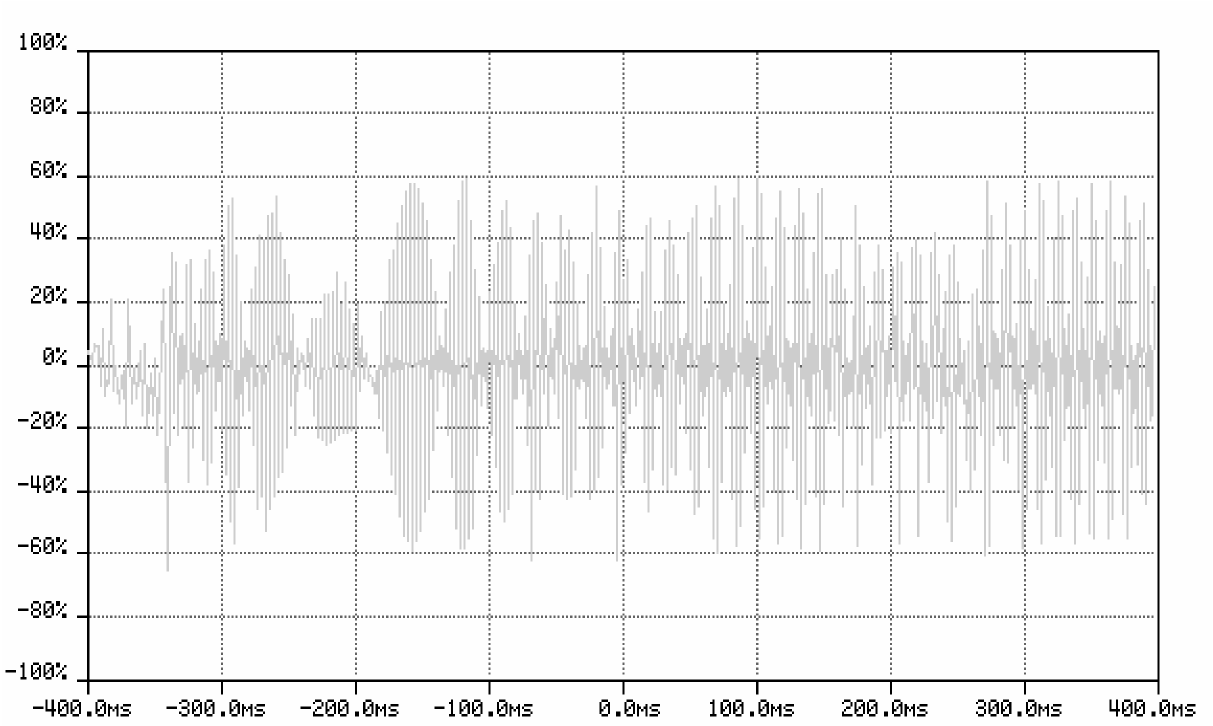
The **"Trigger Level"** determines the minimum signal level for display start. If the level value is adjusted to e.g. 50 the display will only be triggered when the signal amplitude reaches 50 % of the selected scale. If the signal fades below this value the display will not be erased and the noise will not generate a new display.

The **"Trigger (+)"** function is only necessary as an exception. **"Trigger Off"**, **"Trigger (-)"** are adjustable and **"Trigger (+)"** has a standard value. "Trigger Off" will display the input signal without locking to it (no trigger). "Trigger (-)" will start the display 180 degrees later.

The **"Cursor #1"** and **"Cursor #2"** are used for signal measurements. In the lower display area the actual cursor values are continuously displayed. Using **"Cursor #1 & #2"** the cursor movements are locked together.

To stop the display use **"Oscilloscope Off"**. The latest measurement remains displayed and may be measured using the cursors. To start an one-time measurement use **"Single Shot"**.

# MEASUREMENT OF AN AM VOICE SIGNAL



# AUTOCORRELATION

## AUTOCORRELATION OPERATING MENU

| | | | |
|---|---|---|---|
| Autocorrelation | | | |
| Signal Analysis | 96.0 Baud Var | Stop Tracking | Stop Autocorr. |
| Zoom | Demodulator | | |
| | | | |

Autocorrelation is used for determing the periodicity of bit patterns. Periodicity implies a constant repetition of a specific bit pattern. If a station f. e. transmits the IDLE pattern 0010011011 0010011011 etc., the periodicity is said to be 10 bits. HNG-FEC and RUM-FEC have a periodicity of 15 and 16 bits respectively. The periodicity can f. e. 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, Signal Analysis 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 is on” setting in the “Demodulator” menu field. Autocorrelation is then initiated by selecting and programming the baud rate menu field. After a while the very accurate measured baud rate will be displayed in the upper system status field, next to the heading “AutoCorr.”. If the baud rate deviates by more than 0.5 Baud, bit slip may occur and therefore the autocorrelation must be restarted with the exact baud rate.

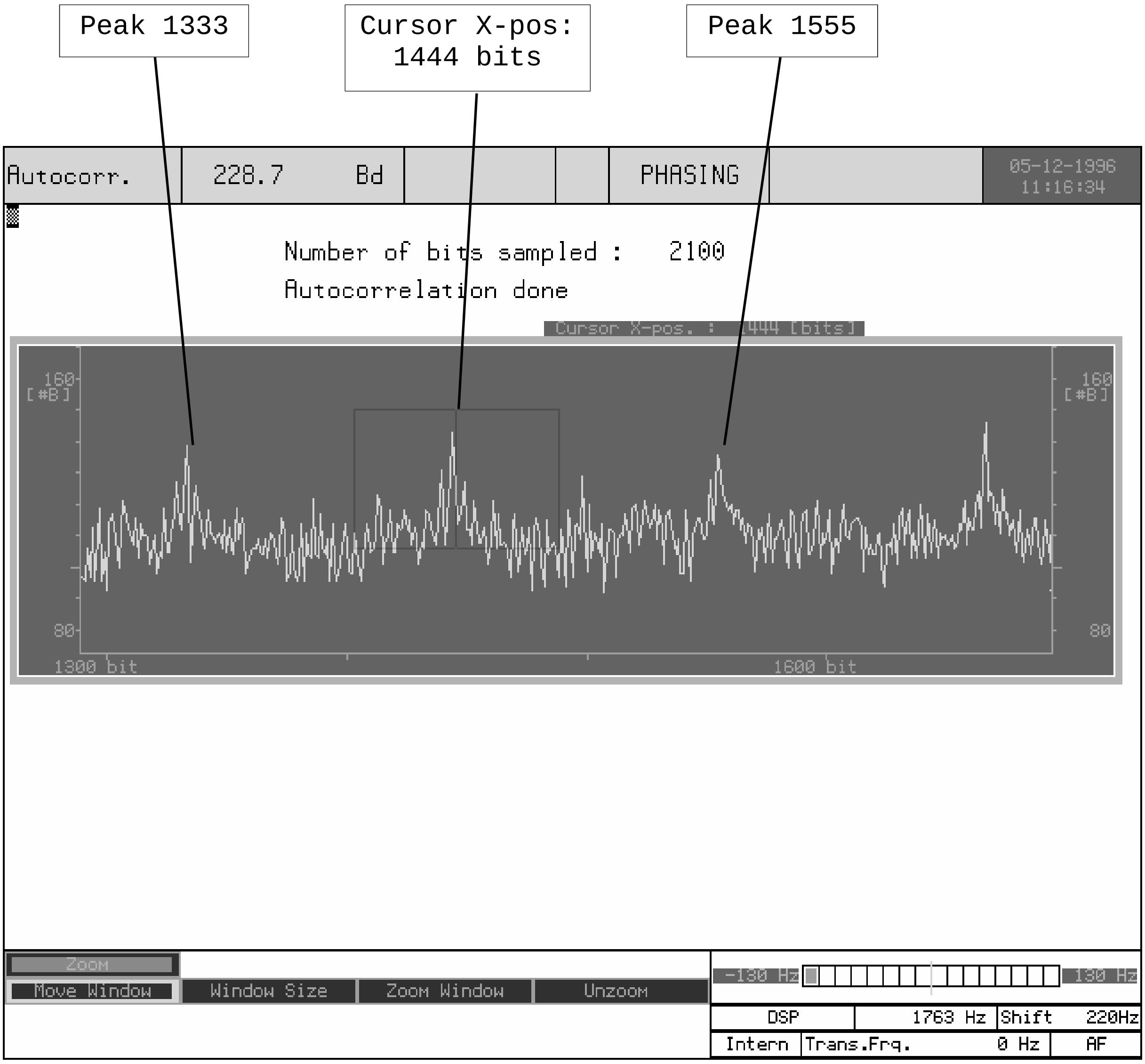
To start the sampling process (Start Tracking) the menu field depicted in this case as “96.0 Baud Var” is selected. A field appears which allows the manual entry of the baud rate. After data entry has been completed, signal sampling is started. The number of sampled bits is displayed continuously. The autocorrelation can currently process up to 200 000 bits, but a minimum of 2000 samples is required.

By selecting the menu field “Stop Tracking”, the actual computation of the autocorrelation is started. Results are displayed graphically on the video monitor. If a large number of bits were sampled and the graph indicates a low periodicity the
computation may be stopped by selecting the menu field “Stop Autocorr.” Periodicity is indicated by distinct peaks in the graphic display which may show 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 no distinct periodicity is 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 can not be determined without the Zoom function. Such measurements indicate the fact that the system is transmitting data (TRAFFIC). 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

# SIMPLEX SYSTEM WITH A CORRELATION OF 111 BIT




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 result in very different displays. Often it is possible to determine a periodicity with the zoom function (Enlargement). The later explained function "Bit Analyse" allows a control or fine determination of the periodicity.

By clicking on the "Window Size" field a purple under laid field appears. By turning the trackball (or by the up-down-left-right keys), this field can be enlarged or reduced horizontal and vertical.

The field should be sized in such a way that the peaks fill out the zoom field optimally. With the function "Move Window" the field can be moved in all directions.

After the zoom field has been sized, the zoom function can be activated. An enlarged section of the autocorrelation track is displayed. Then the function "Move Window" is

# ZOOM MENU

| | | | |
|---|---|---|---|
| Zoom | | | |
| Move Window | Window Size | Zoom Window | Unzoom |
| | | | |

opened. In the upper right part the center position of the zoom field is shown as "Cursor X-pos: xx (Bits)".

By turning the trackball the field is moved downwards and that value changes. The determination of the different subsequent peaks give the periodicity. With the function "Unzoom" the full screen display is displayed again.

# HF BIT ANALYSIS

## BITANALYSIS OPERATING MENU

| | | | |
|---|---|---|---|
| Bit Analysis | | | |
| Signal Analysis | 96.0 Baud Var | 56 Bit Block | Start/Stop |
| Extract Bits | Demodulator | Nor. Polarity | |
| | | | |

## BITANALYSIS F7B OPERATING MENU

| | | | |
|---|---|---|---|
| Bit Analys. F7B | | | |
| Signal Analysis | 100.0 Baud | 96.0 Baud Var | 90 Bit Block |
| Start/Stop | F7B Fixed Shift | F7B Var. Shift | Extract Bits |
| Demodulator | | | |

Bit Analysis is used to determine the bit pattern of a telegraphy system (IDLE, TRAFFIC and REQUEST bit patterns) as well as the alphabet being used.

As described previously the frequency shift and exact baud rate must first be determined. The number of desired horizontal bits is programmed with the field "56 Bit Block". This value is determined with autocorrelation and the number of bits per horizontal line should correspond to the periodicity (or a multiple thereof). In the case of simplex systems, the setting should include the entire system cycle e.g. the SITOR-ARQ mode consists of 210 ms traffic and a 240 ms pause which adds up to a 45 bit block.

By selecting the "96.0 Baud var" field and subsequent setting of the exact baud rate, the bit analysis process is started. In the upper third section of the screen display horizontal lines are now drawn. The colour BLUE corresponds to the Y V1-data and YELLOW to B V1-data. If the periodicity corresponds to the block length a bit pattern with periodic repetition now becomes visible. If the setting of the block length is correct, repetitive bit patterns or data blocks are displayed symmetrical underneath each other. Thus by setting the block length the previously determined periodicity may be verified.

Phase errors or state transitions within a data bit are displayed in RED. Such phase errors may occur when weak signals are received or during the transmission pause of simplex systems.

With the field "Nor. Polarity" the display of the signal polarity may be changed. This allows transmissions with differing polarities to be displayed in the same way. This feature is advantageous for data comparisons using the "Extract Bits" function.

Activation of the menu field "Start/Stop" controls the capturing of data bits which may be further analysed with the "Extract Bits" function.
The analysis of F7B systems (using the "**Bit Analyse**. F7B" option) is done in exactly the same way as described above. The correct settings of the demodulator may be obtained from the description in the section on the TWINPLEX operating mode. The graphic representation is spread over two screen lines corresponding to the V1 and V2 channels respectively.

# ADDITIONAL MENU "EXTRACT BITS" IN BITANALYSIS

| Extract Bits | | | |
|---|---|---|---|
| Frame Size 5 | ITA-2 5 Bits | Move by Frame | Move by Bit |
| Move by Block | Block Size 5 | Bit Spread 0 | Normal Spread |
| Norm. Bit Order | Show Frames | Restore Screen | Printer is off |

# ADDITIONAL MENU "EXTRACT BITS" IN BITANALYSIS F7B

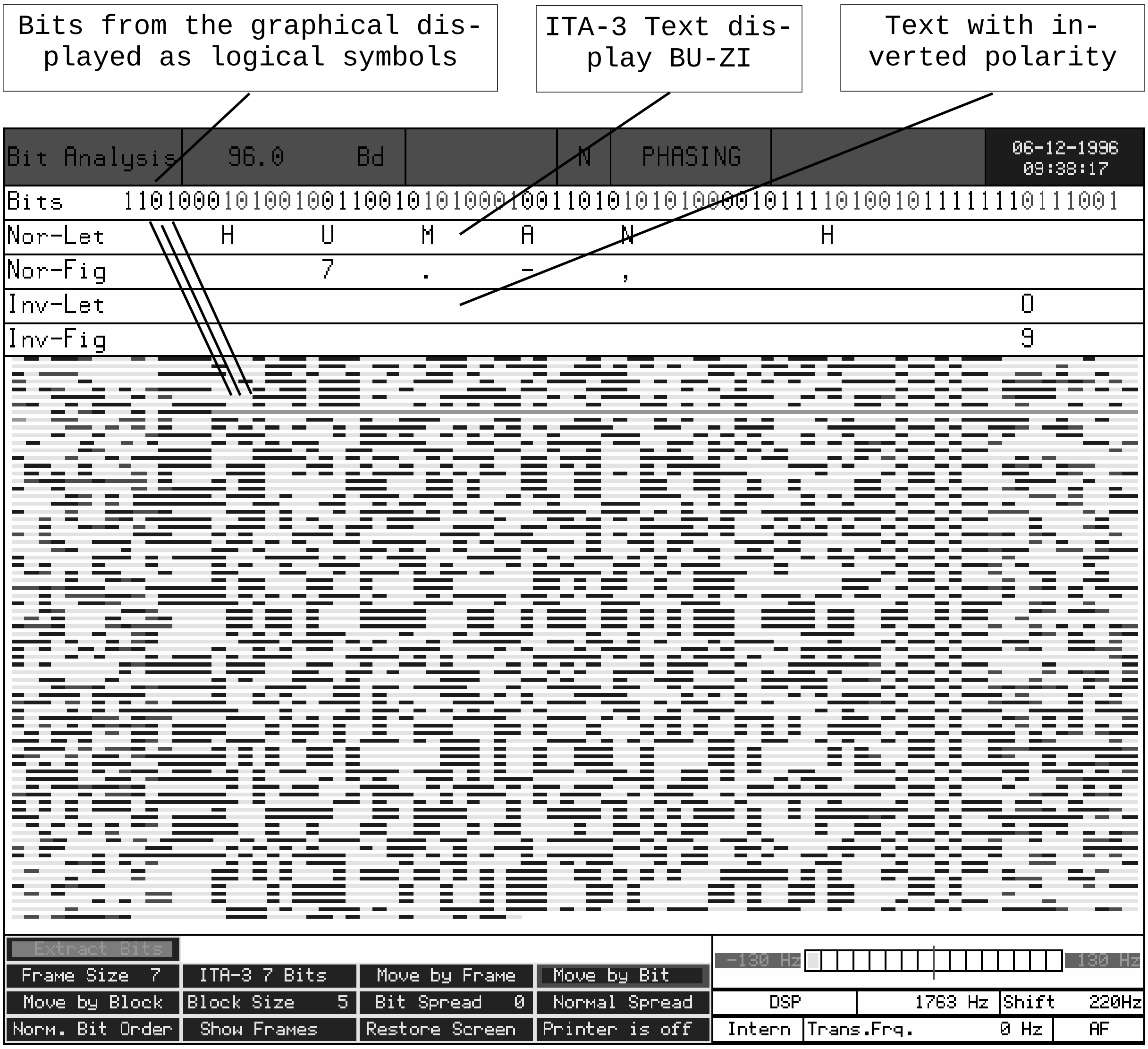
| Extract Bits | | | |
|---|---|---|---|
| Field Size 5 | Block Size 45 | ITA-2 5 Bits | Move by Block |
| Move by Field | Move by Bit | Bit Spread 0 | Norm. Bit Order |
| Y-BV1 Channel | Y-BV2 Channel | | |

Bit Analysis may be seen as a representation of a synchronous bit stream. Data is represented graphically on the screen using coloured lines.

The colours blue, yellow, red, green and grey are utilised - blue and yellow representing B and Y (mark and space) and red a data bit error. With the functions “**Move by Bit**” or “Move by Frame” a cursor may be moved freely over the graphic area. The cursor is green when the data line was yellow or alternatively brown if the data line was either blue or red.

More important however is the representation of the bit stream with the binary values zero (0) and one (1). The displayed bit sequence corresponds to the cursor line in the graphic display area.

# BINARY BIT DISPLAY FUNCTION



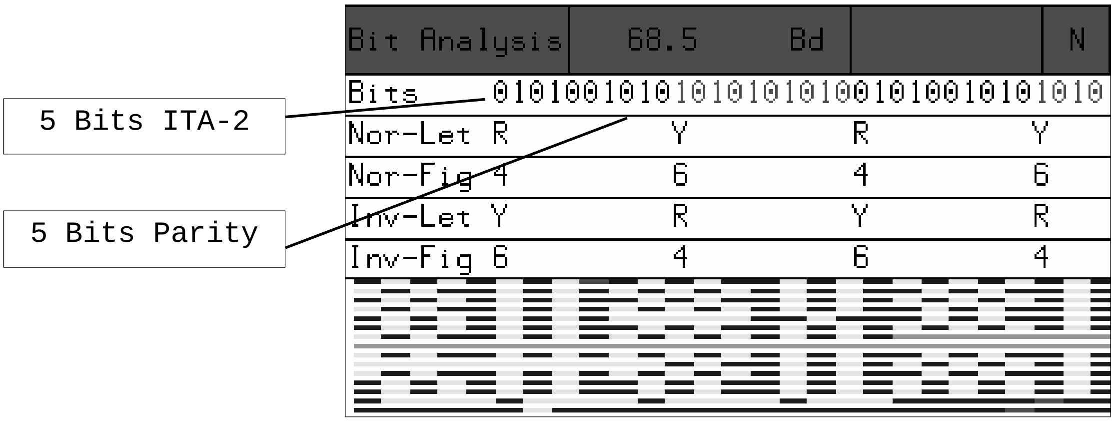

The example is preset with the "**ITA-3 7 bits**" alphabet. In the "**Bits**" field groups of 7 bits are alternately displayed in red and white. If the alphabet be changed to e.g. ITA-3 7 bits for example, the bit stream will be grouped in segments of 7 bits each.

In the fields below the data characters are displayed. The "Nor-Let" field contains letters with normal polarity, "Nor-Fig" figures with normal polarity, "Inv-Let" letters with inverse polarity and "Inv-Fig" figures with inverse polarity.

Depending on the transmitting system the bit sequence convention may be least significant bit (LSB) first or most significant bit (MSB) first. The menu fields "**Norm. Bit Order**" or "**Rev. Bit Order**" are used to set the desired mode. Most known telegraphy systems use the MSB system or "Norm. Bit Order" setting.

With these displays the bit stream may be checked to see if it contains valid and useful information. All display fields are updated as the track ball is moved to reposition the data cursor.

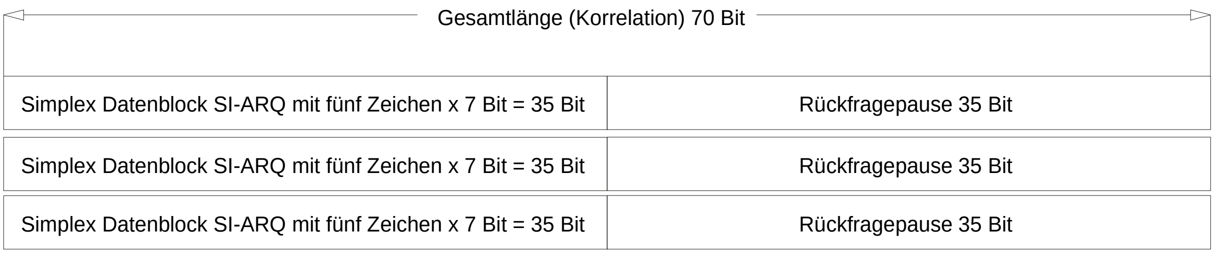
# EXAMPLE: "FRAME SIZE" FUNCTION




Various systems improve data transmission integrity by adding parity or check bits which are appended to a data block. This example shows the setting “ITA-2 5 bits” and “**Frame Size 7**”. The five parity bits are ignored and each character is displayed with 10 bit intervals. The Bauer alphabet used in the AUTOSPEC system uses 10 bit characters. The first five represent the ITA-2 character and the following five bits are transmitted in normal or inverse polarity depending on the parity.

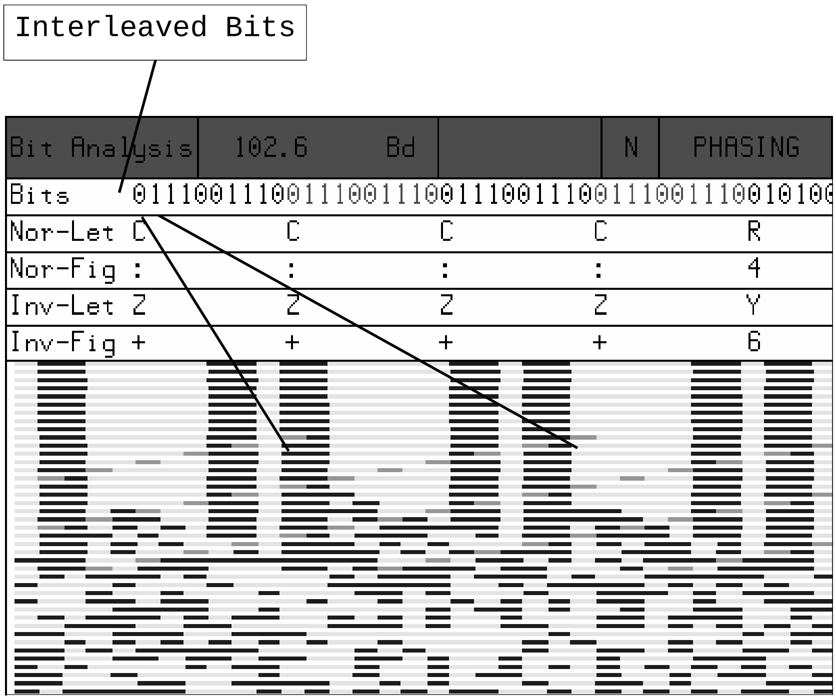
In all cases the correct bit synchronization must be obtained. This may be done by moving the cursor with the “**Move by Bit**” function. Subsequent cursor movements are best done with the “**Move by Frame**” function so that cursor steps are done in increments as set up in the “Frame Size” field.

# EXAMPLE: "MOVE BY BLOCK" FUNCTION




The function “Block size x” and “Move by Block” are an aid for cursor movements. The example shows a SI-ARQ transmission frame. If the start of the block is found with the “Move by Bit” function, a step size equal to the entire frame is a good choice. This is set up by “Block size 70 Bit” and performing cursor movement via the “Move by Block” function. By now moving the trackball, the cursor moves from the start of one frame to the start of the next frame. This function can also be applied with good results in cases of analysing various functional bits. The setting “Block Size x” has no effect on the binary bit display and is a pure cursor related function.

# EXAMPLE: "BIT SPREAD" FUNCTION




Modern FEC techniques often make use of code spread or interleaving. The individual bits are interleaved with other bits to improve the transmission’s immunity to burst errors. Typical systems using spreads are SPREAD51, HNG-FEC or RUM-FEC.

This simplex example shows a code spread of 1. The ITA-2 alphabet is read from every second bit with the remaining bits being ignored. This setting is done with the field “Bit Spread 1” and the field “Normal Spread”. This particular spread is symmetric i.e. the software always displays the next bit according to the programmed spread parameter.

More complex code spreads are also known e.g. the GOLAY system. These spreads are asymmetrical. The menu fields “Spread by Frame” and “Spread by Block” in the menu field "Normal Spread" offer additional functionality in such cases. The spread then refers to the preprogrammed values of the fields “Frame Size x” and “Block Size x”.

As a further aid the software can display a count of recognised data blocks. If both the data block length (e.g. RUM-FEC is 16 bit) and spread length are known, this function permits character synchronisation to be made. The number of frames found must be smaller than the possible combinations in the alphabet (ITA-2 has 32 combinations).

By selecting the “Show Frames” menu field all recognised bit combinations are displayed in hexadecimal format. The original screen contents may be restored by selecting the “Restore Screen” menu field.

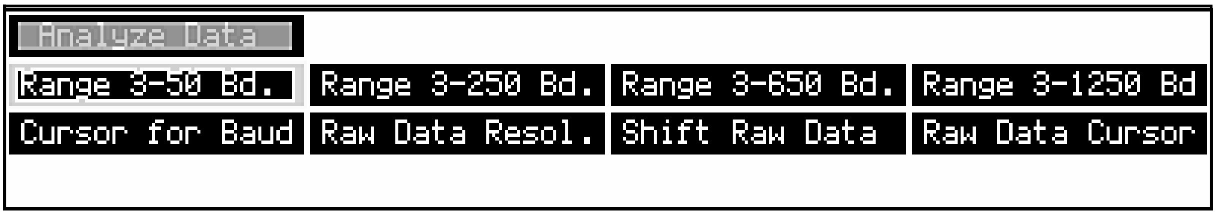
# BIT LENGTH ANALYSIS HF

## BIT LENGTH ANALYSIS OPERATING MENU


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

The resolution offered by the SAMPLER option is 10 us (100 000 samples per second). After the demodulator has been set up correctly, sampling is initiated by selecting the “Start Tracking” menu field. To stop sampling, the menu field “Stop Tracking” is selected. Captured data may then be analysed further via the “Analyze Data” sub-menu.

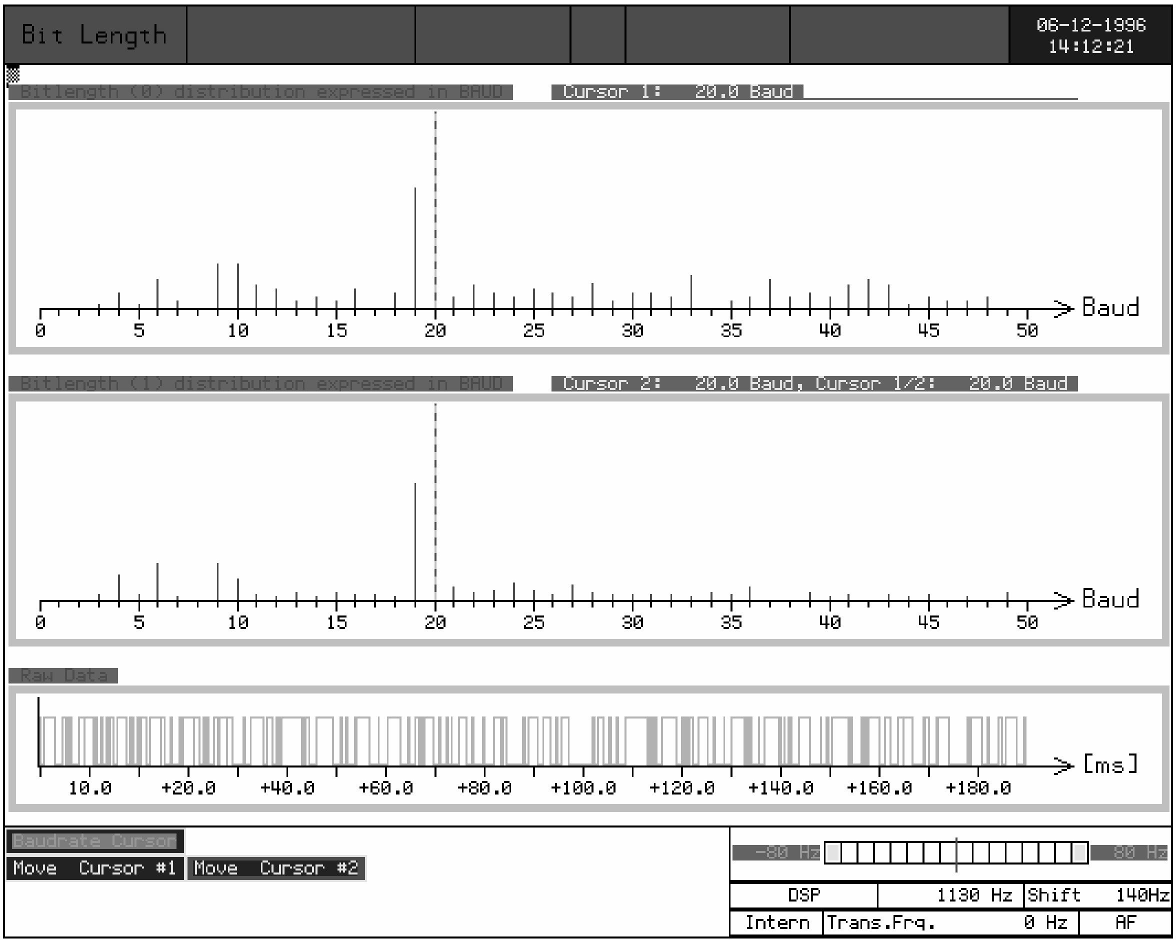
## MENU "ANALYZE DATA"




After proceeding to the “Analyze Data” menu , further evaluation is started by specifying one of three baud rate ranges : “Range 3-250 Bd.”, “Range 3-650 Bd.” or “Range 3-1250 Bd.”. The resolution of the graphic display is determined by the selected range.

The actual computation lasts between 1 and 10 seconds , depending on the amount of captured data. A screen with 3 graphs is then constructed. The following example shows a typical “Bit length” display screen.

# REPRESENTATION OF BIT LENGTH DISTRIBUTION (PICCOLO-MK6)



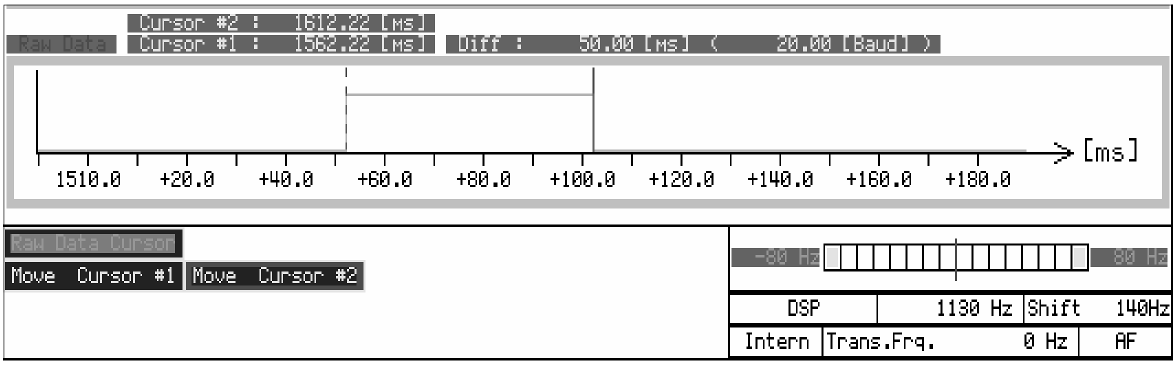

The bit length analysis screen consists of the two functions Bit length distribution binary 0 “Bit length (0) distribution expressed in BAUD” and Bit length distribution binary 1 “Bit length (1) distribution expressed in BAUD” as well as a graph of the raw binary data “Raw data”.

The two fields “Bit length (0)” and “Bit length (1)” show the distribution of bit lengths as computed from the sampled data. The following example shows the bit length distribution for a PICCOLO-MK6 signal. The measured values at 20 Baud (50 ms), 10 Baud (100 ms) and 5 Baud (200 ms) may easily be seen. They correspond to the data transitions 1, 2 and 3. Using this display any type of transmission may be analysed in terms of baud rates or tone duration.

By selecting the menu field “Cursor for Baud” a graphic cursor may be used to move over the graph to allow measurement of data. The field “Cursor : 19.9 Baud” shows the current value at the cursor position.

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

# DISPLAY OF BINARY BIT PATTERN (PICCOLO-MK6)




In the “Raw data” field of the display a graphic representation of the binary data “0” and “1” is performed. The resolution may be set in the range between 10 us (0.00001 s) to 100 000 us (0.1 s) via the “Raw data Resol.” field. Practical values are between 1000 us and 10 000 us. In general the resolution is governed by the smallest parameter to be measured. In MFSK cases this corresponds to tone changes and with RTTY to data transitions (bits).

Using the menu field “Shift Raw Data” the binary bit pattern may be moved left or right without break. This allows the location of the bit or tone duration which needs to be measured.

The example shows the lower section of the screen display after selection of the “Raw data Cursor” menu field. With the fields “Move Cursor #1” and “Move Cursor #2” the two cursors may be moved across the bit pattern. The individual positions of cursor #1 and #2 as well as the difference between the two cursors is displayed continuously in ms.

A direct conversion to baudrate is therefore possible.

When measuring binary 0 or 1 (mark /space) it should be noted that the two states may be subject to severe distortions depending on the quality of the received signal. Using the average over a number of measurements improves the accuracy of results. Some transmission types are also known where mark or space may be modulated in terms of bit length.

# RAW V1-DATA ANALYSIS HF

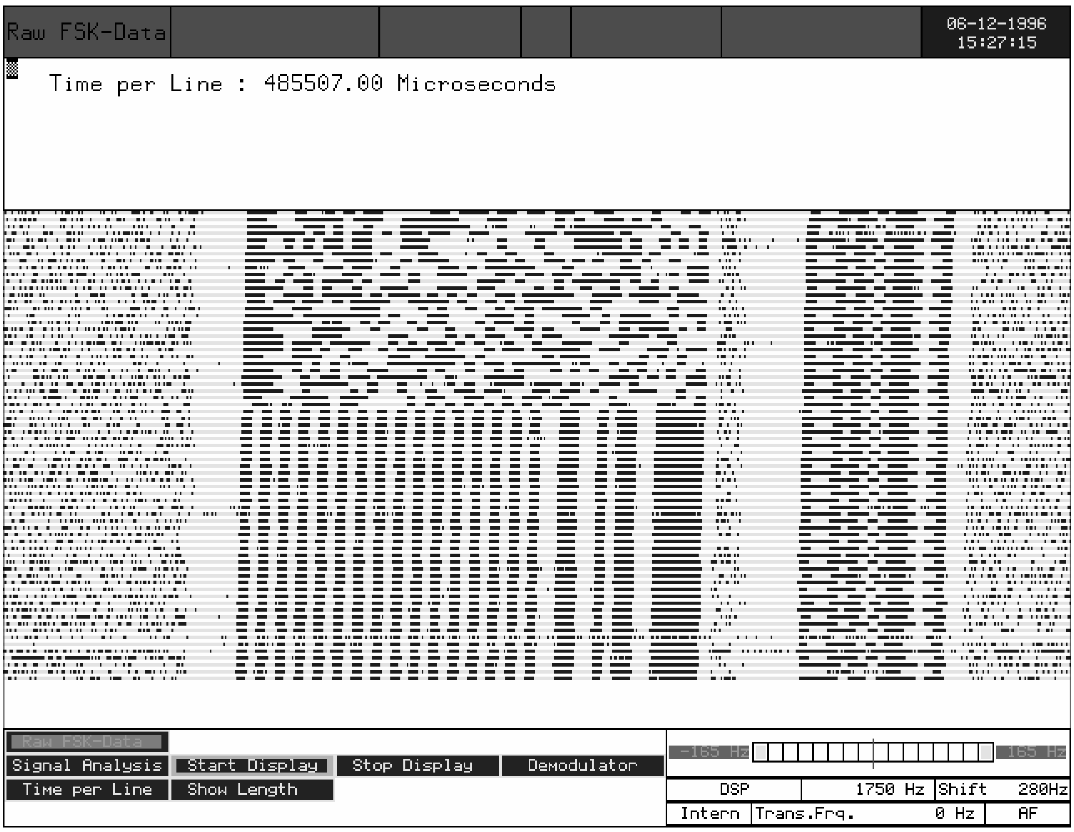
## RAW V1-DATA OPERATION MENU

| | | | |
|---|---|---|---|
| Raw V1-Data | | | |
| Signal Analysis | Start Display | Stop Display | Demodulator |
| Time per Line | Show Length | | |

The "Raw V1-Data" and "Bit Length" analysis tools serve the measurement of bit length. The "Bit Length" analysis relies on a statistical evaluation of many individual measurements, whereas the "Raw V1-Data" function displays the V1 data graphically.

The data of the "Raw V1-Data" is purely sampled and displayed with respect to time. Thus pulse and tone duration lengths as well as bit bias may be measured. The "Raw V1-Data" analysis also allows the accurate determination of baud rates in the case of asynchronous systems with bit errors and propagation dependent distortions.

## RAW V1-DATA WITH 228.66 BAUD AND 111 BIT CORRELATION



The time duration of a video line and thus the display resolution is set in the menu field “Time per Line”. The range is 20.000 us (0.02 s) to 650.000 us (0.65 s) per graphical line and sampling takes place in steps of 10 us. One graphical display line corresponds to the preset time.

Selecting the “Start Display” and “Stop Display” controls the effective data sampling.

By selecting the “Show Length” menu field a red cursor is displayed. Using the trackball the cursor may be freely positioned in all directions.

The value of the positioned segment is continuously displayed in the time unit “ms” and the baud rate unit “Bd” with the graphical cursor. The graphical representation of V1 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 the “Raw V1-Data”. The setting of time unit per line in “Time per Line” is together with the baud rate the preset values for the correlation.

The example shows a correlation of 111 bits. The baudrate is 228.66 baud. The calculation of the total system cycle length thus is (1/228.66) x 111 = 0,4854369 s.

# CODE STATISTIC HF

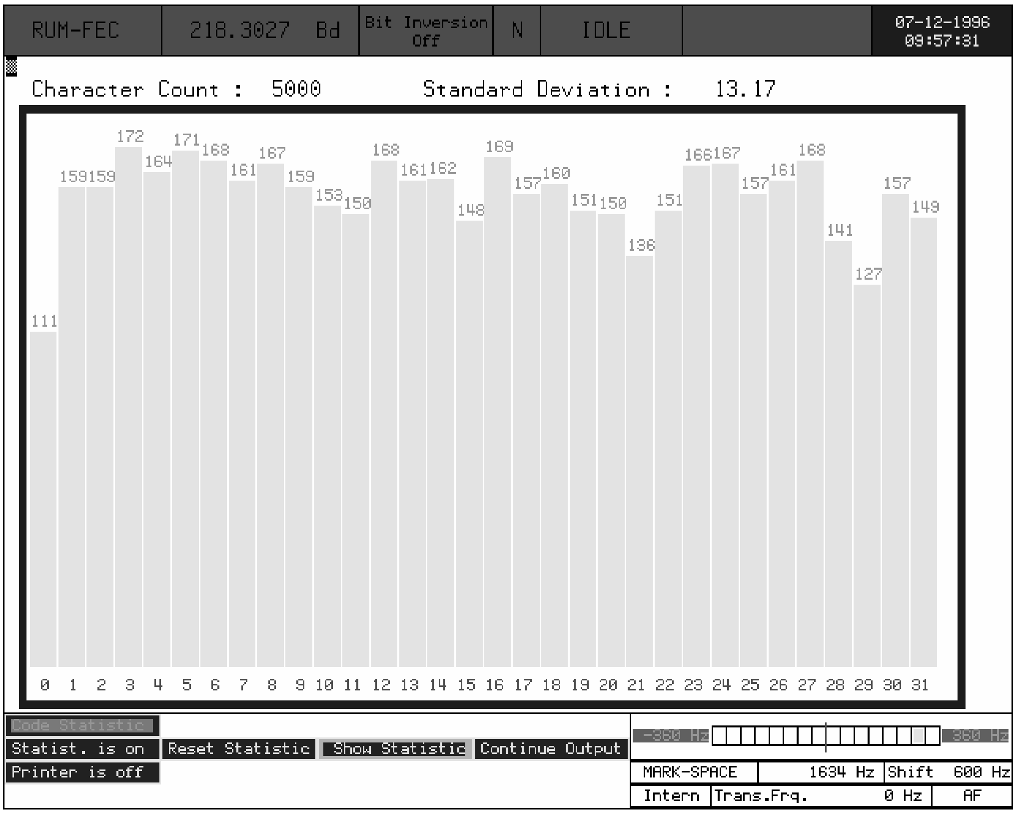
## CODE STATISTIC MENU

| | | | |
|---|---|---|---|
| Code Statistik | | | |
| Statist. is on | Reset statistic | Show statistic | Continue output |
| Printer is off | | | |

The "Code Analysis" display enables a reliable evaluation of a whether monitored Baudot based transmission is encrypted or not. A properly encrypted data stream will have an even distribution of character frequencies and thus no deductions as to the language used can be made.

Transmissions in clear will exhibit an uneven distribution of character frequencies depending on the language used. For long texts this frequency distribution will approach the specific distribution for the language.

## CODE STATISTIC WITH SCRAMBLED DATA



In the **Options** menu field the **Code Statistic** analysis can be activated in some modes.

Clicking the "**Statistik is off**" menu field the code statistic is started, but the text output is not interrupted.

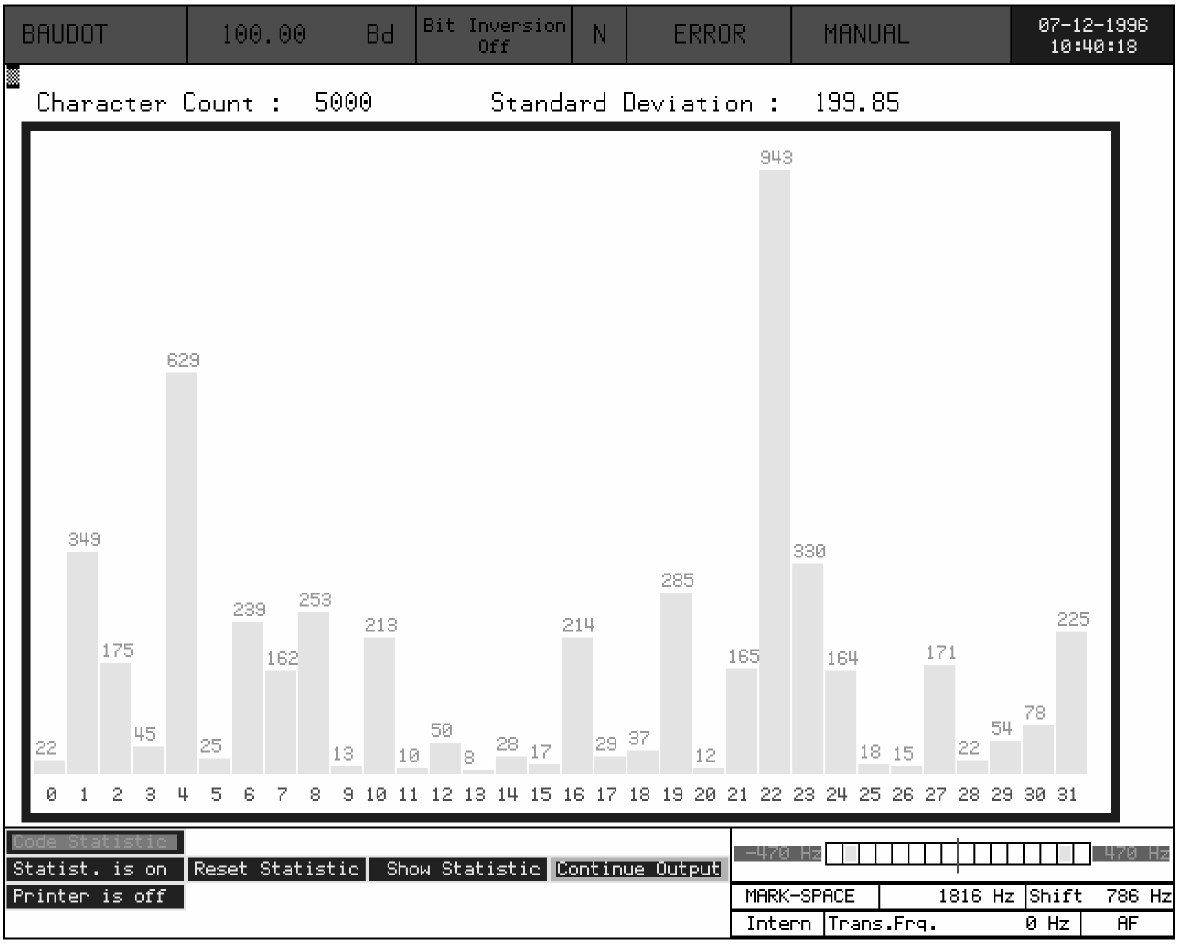
A background counter is maintained for each of the 32 bit pattern combinations.

By clicking on the "**Show Statistik**" field a bar chart is displayed. The bit patterns are listed horizontally and their frequency is displayed vertically.

By clicking on the "**Reset Statistik**" field all counters are reset to zero.

Normal text output is reactivated by clicking “**Continue Output**”.

# CODE STATISTIC WITH WEATHER NEWS



# SETUP FUNCTIONS

## SETUP FUNCTIONS OPERATION MENU

| Setup Functions | | | |
|---|---|---|---|
| Set Time+ Date | Gain Control | Test Screen | Printer |
| Serial # 1 | Remote Control | Test Ser. Ports | Global Settings |
| Test DIG Inp. | | | |

All parameters relating to “Setup Functions” are saved in battery backed up memory and remain intact without mains supply.

**NOTE:** When installing a new software version for the first time all settings may me changed to a default value. All parameters must then be re-entered by the user.

The function **“Set Time + Date”** is used to set the built-in real-time clock. Programming of the clock is done using an easily understandable dialogue.

The **“Gain Control”** menu field allows to adjust gain between 0 and 100 (linear scale) for each input independently.

The **“Test Screen”** function displays a circle with 16 different colours and a bar with 16 grey levels. This function allows the control and adjustment of the monitor.

The **“Printer”** menu contains the “Printer on/off” and “Printer Type” functions. Printer activation starts by selecting the appropriate menu field. This is equivalent to utilizing the PRINT ON-OFF key on the front panel. The “Printer Type” menu displays all supported printer types. By moving the trackball a printer may be selected and activated by clicking the left trackball button. After leaving the menu through a click of the right button, the selected printer is installed.

A hardcopy of the screen display (PRINT SCREEN is only available from the front panel) is possible for the colour printers HP PaintJet, HP DeskJet 500C, HP DeskJet 550C, HP Deskjet 560C, HP Deskjet 660C and HP DeskJet 850C. Later printer models from HP mostly can be used with one of the available printer drivers.

The two **“Serial #1”** and **“Serial #2”** menus enable the configuration of the two serial RS232 interfaces 1 and 2.

Serial interface 2 is reserved for remote control of the W4100DSP. Decoded data is output on the first serial interface. The data are identical to the data output on the parallel Centronics interface. Output on serial interface #1 is always enabled.

Programming of the serial interface configuration is done via a user friendly menu. The parameters “Baud Rate”, “Data Length”, “Parity Bit” and “Stop Bit” can be set.

| | |
|---|---|
| Baud rate: | 300, 600, 1200, 2400,4800, 9600 and 19200 Baud |
| Data length: | 7 bits<br>8 bits |
| Parity bit: | No parity<br>even parity<br>odd parity |
| Stop bit: | 1 stop bit<br>2 stop bits |

The **REMOTE INTERFACE** can only be used up to 9600 Baud.

The settings of the serial interface must always match the configuration of the controlling computer (e.g. PC with terminal programme).

The **“Test Ser. Ports”** function is required for testing the serial interfaces normally done by the manufacturer. This requires a 9 pin D-SUB connector where PIN 2 (TxD) is connected to PIN 3 (RxD), PIN 4 (DTR) to PIN 6 (DSR) and PIN 7 (RTS) to PIN 8 (CTS). The software tests all connections after activation of this function and reports the results in the lower half of the screen display.

In the **Global Settings** menu the globally valid defaults for "Preload Center Frequency", "Timestamp" and "Trackball Type" may be set.

The centre frequency value in **"Pre-load Centre Frequency"** field is the pre-set value for the AUTO MODE of a short wave mode.

With the active function **"Timestamp"** date and time are shown before each data block in all VHF/UHF modes. The data are read from the internal W4100DSP clock (real-time-clock).

With the pre-setting **"Print Screen" = BMP (Remote)** the "Print Screen" function outputs a BMP (bit map file) to the REMOTE-CONTROL (Serial #2) interface. The output occurs in HEX0-code and can be read by any TERMINAL programme (e.g. "Terminal.exe" of WINDOWS). The BMP-file must then be converted to binary format (command h2b test.txt text.bmp) with the DOS conversion programme "h2b.exe" . The BMP-file can now be read by a graphics program (e.g. Corel Photo-Paint). H2B.EXE is included in all W4100DSP software updates starting with release 2.0.01.

The function **"Preset BATTERY MEMORY"** completely resets the built-in parameter memory. All parameters are set to default values. This function should only be used after a battery replacement or if the settings have been completely lost or changed.

The **“Test Dig. Input”** is normally used for factory testing of the digital input.

# REMOTE CONTROL W4100DSP

# INTRODUCTION

**REMOTE INTERFACE**

The W 4100DSP may be remotely controlled using the serial RS232 interface #2 (Remote Control).

The configuration of the serial RS232 interface #2 and the presetting of the device address may be done in the "\SETUP\REMOTE CONTROL" menu.

The data communication is based on the use of printable characters - binary data is not used. Data flow cannot be controlled neither by hardware handshake nor by XON/XOFF protocol. XON/OFF has been discontinued to enable complete transparency of the serial interfaces. To control data flow it is recommended to await the acknowledgement and prompt character (">") from the W4100DSP before sending the next command. Overwriting of the command buffer is then avoided.

**COMMAND TRANSMISSION**

The software of the W 4100DSP does not echo characters to the host. When a terminal or a terminal emulator (e.g. installed in a PC) is used the latter must be configured to *AUTO-ECHO*. The translation of a single CR (Carriage Return) character into a CR + LF (Carriage Return + Line Feed) combination should be ensured.

If a keying error is corrected using the backspace character, the character in error and the backspace character are transmitted. However, the W 4100DSP display will display the corrected text, but the command is ignored because of the correction.

After receiving the string REMOTExx=ON<<CR>> or after pressing the front panel "REMOTE ON-OFF" key the W 4100DSP changes into the remote mode. The expression "xx" represents the device address within a range "00" to "99".

**KEYPAD AND DISPLAY**

With the exception of the REMOTE ON-OFF and LOAD-RESET keys, all other keys as well as the trackball become inactive. The menu display area on the screen is cleared and the message "Remote messages at local address #xx" is displayed. All subsequent data traffic between the host and the W 4100DSP is displayed in the menu field.

The REMOTE ON LED indicates the operating mode of the W 4100DSP. In remote mode the LED is on and in local mode it is off.

**REMOTE AND LOCAL OPERATION**

After receiving the string "REMOTExx=OFF" the software returns to the menu of the last active mode. The last active mode remains active also after switching off remote mode and can normally be handled with the keypad or trackball. After receiving the command "REMOTExx=ON" or after the REMOTE ON-OFF key has been pressed the W 4100DSP changes into remote mode. The active mode stays active and may be controlled by remote control.

**COMMANDS**

All global, valid commands are listed in the table "global re-

mote commands“ found later in this chapter. Commands belonging to a particular mode are listed in the following paragraphs.
The “PORTxx=OFF<<CR>>“ command causes the W 4100DSP to reject further commands from the serial interface, the remote mode stays active, however. Only after receiving the "PORTxx=ON<<CR>>" command the software will accept commands again. This allows a number of devices to be connected to the same RS232 interface or to use a host interface for more than one device.

Every command from the host to the W 4100DSP must be terminated with a ‘Carriage Return’ (shown here as “CR“). The W 4100DSP interpreters the command string, executes the appropriate function(s) and returns a “>“ character to the host as an acknowledgement and ready prompt (the apostrophes are not transmitted).

If the command is undefined or incorrect, the W 4100DSP returns a “?“ character and the “>“ prompt. The software is not case sensitive.

By appending a question mark at the end of a command, the host can interrogate all settings of the W 4100DSP. The W 4100DSP responds after an inquiry has been made with a parameter string terminated with a “CR“ and the prompt “>“. The software returns an “UNDEF “CR“ “>“ message in response to an undefined command. An undefined condition message is displayed if after switching the W 4100DSP on no mode is selected.

If appending the parameter “/ AUTO“ to the “MODE=xxxxx“ command the mode is started in AUTO MODE with automatic determination of frequency shift, center frequency and baud rate. If requesting data during automatic measurements the message “AUTO“ “CR“ “>“ will be displayed. After automatic measurements have been completed a STATUS request will not release an AUTO message.

**DATA INTERFACES**

The output of the teletype data can additionally be switched on and off to the serial interface SERIAL #1 and the centronics interface via the REMOTE CONTROL interface with DATA=ON or DATA=OFF. The host PC terminal protocol must take care of the distinction between W 4100DSP command responses and decoded data at the remote interface. A possible solution is to disable data output before issuing any remote commands.

**COMMAND “DATA“**

The command “DATA=ON“ enables the output of the decoded data to the Remote Control interface. The following points should however be noted:

- When the system state changes to or from "REMOTE“ mode, “DATA“ is internally set to “OFF“.
- After a “PORTxx=OFF“ command has been received the data output is stopped.
- When a transition from “PORTxx=OFF“ to “PORTxx=ON“ occurs, the data output will resume if "DATA ON“ has been previously received.

**TRANSPARENT DATA**

The output of the transparent data is always routed to the serial interface #1 and the remote port (if opened by a "DATA=ON" command). No output is sent to the Centronics interface.

# REMOTE-CONTROL EXAMPLES

Every command and response is terminated with a “CR“. The W 4100DSP uses the prompt character “>“ when acknowledging all defined and correct commands, and as a termination character after responses and other data output.

Requests are formed by appending a question mark “?“ and “CR“ to the appropriate command. The W4100DSP answers with "Value/Condition", "CR" and ">".

All invalid commands or requests are responded to by question mark “?“ and “>“.

A request for an undefined status will give the response "UNDEF“ “CR“ and “>“.

As long as AUTO MODE is active a status request will result in the response “AUTO“ “CR“ “>“.

The examples below always are presented with the active generation “CR“ -> “CR“ “LF“ at transmission and receipt.

| PC/MASTER SENDS | W4100DSP ANSWERS | REMARKS |
|---|---|---|
| Remote00=on | > | |
| Mode? | UNDEF | no mode active |
| | > | |
| | | |
| Mode=POCSAG | > | |
| Mode? | POCSAG | mode active |
| | > | |
| Status? | PHASING | |
| | > | |
| Shift? | 9000 | Shift |
| | > | |
| Translation? | 455000 | Center frequency |
| | > | |
| Mess-typee-o | auto | Pocsag message type |
| | > | |
| | | |
| Mode=ARQ-E/AUTO | > | |
| Mode? | ARQ-E/AUTO | Auto Mode selected |
| | > | |
| Shift? | AUTO | Auto Mode active |
| | > | |
| Center? | AUTO | Auto Mode active |
| | > | |
| Status? | AUTO | Auto Mode active |
| | > | |
| Status? | IDLE | Auto Mode finished |
| | > | |
| Shift? | 170 | Auto Mode measurement |
| | > | |
| Baudrate? | 96.00 | |
| | > | Auto Mode measurement |
| Signal-Source=HF | > | active Input |

| PC/MASTER SENDS | W4100DSP ANSWERS | REMARKS |
|---|---|---|
| Signal-Source? | HF | |
| | > | |
| Translation=12500 | > | to the active input |
| Translation? | 12500 | |
| | > | |
| Gain=65 | > | Gain always refers |
| | 65 | to the active input |
| Signal-Source | 455KHZ | active input |
| | > | |
| Signal-Source? | 455KHZ | |
| | > | |
| Translation=455000 | > | to the active input |
| Translation? | 455000 | |
| | > | |
| Alphabet=BAGDAD-80 | > | |
| Alphabet? | BAGDAD-80 | |
| | > | |
| Date=15-06-96 | > | 00 means 2000 |
| Date? | 15-06-96 | |
| | > | |
| Mode=Twinplex | > | |
| Mode? | TWINPLEX | Mode active |
| | > | |
| Baudrate=100.0 | > | |
| Baudrate? | 100.00 | |
| | > | |
| Shift | 200-400-200 | Shift |
| | > | |
| Shift? | 200-400-200 | |
| | > | |
| Twinplex-V1 | Y-Y-B-B | Combination V1 Channel |
| | > | |
| Twinplex-V2 | B-Y-B-Y | Combination V2 Channel |
| | > | |
| Mode=Analysis-dir | > | VHF/UHF direct FSK |
| Data=ON | > | |
| | SHIFT = 8950 | |
| | BAUDRATE = 1199.5 | |
| | > | |
| | SHIFT = 102 | no baudrate measurable |
| | > | |
| Mode=CODECHECK-HF/AUTO | > | |
| Data=ON | > | |
| | SHIFT = 452 | |
| | CENTER = 1705 | |
| | BAUDRATE = 99.8 | |
| | MODE = SITOR-ARQ | Result code |
| | CODECHECK-FINISHED | |
| | > | |

# GLOBAL REMOTE COMMANDS

The following REMOTE-CONTROL commands are global control- or request able. Presupposition is, that any HF or VHF/UHF mode is set active. The global valid commands are not mentioned in the command list of the modes.

| REMOTE COMMAND | COMMAND LIMITING VALUES | REMARKS |
|---|---|---|
| REMOTExx= | ON<br>OFF | xx is the units' address<br>from 00 - 99 |
| PORTxx= | ON<br>OFF | xx is the units' address<br>from 00 - 99 |
| PRINT | ON<br>OFF | Centronics printer<br>interface |
| STATUS? | UNDEF<br>AUTO<br>SYNC<br>PHASING<br>TRAFFIC<br>IDLE<br>RQ<br>ERROR | only request ? |
| DATA | ON<br>OFF | REMOTE CONTROL Serial RS232 |
| SIGNAL-SOURCE | AF<br>HF<br>455KHZ<br>10.7MHZ<br>21.4MHZ<br>DIG-3791<br>PCM | <br><br><br><br><br>no translation possible<br>no translation possible |
| TRANSLATION | 0 - 16000<br>16000 - 1500000<br>440000 - 470000<br>10685000 - 10715000<br>21385000 - 21415000 | active input AF<br>active input HF<br>active input 455KHz<br>active input 10.7MHz<br>active input 21.4MHz |
| GAIN | 0 - 100 | valid for the active input |
| LEVEL? | -65 to +10 | only request ? |
| DATE | 18-06-96 | day, month, year |
| TIME | 11:05:00 | hours, minutes, seconds |
| TIMESTAMP | ON<br>OFF | Timestamp from RTC<br>on/off |

| REMOTE COMMAND | COMMAND LIMITING VALUES | REMARKS |
|---|---|---|
| VIDEO | ON<br>OFF | Screen display on/off |
| MSI | ON<br>OFF | multiple line feed on/off |
| ECC | ON<br>OFF | error correction on/off |
| TRIGGER | INTERN<br>EXTERN<br>STROBE | V1/V2 Data input |
| LTRS-FIGS | NORMAL<br>LTRS-ONLY<br>FIGS-ONLY<br>UOS | BU-ZI Mode |
| COM1BAUD | 300<br>600<br>2400<br>4800<br>9600<br>19200 | SERIAL#1 Baudrate<br>1200 |
| COM1LENGTH | 7<br>8 | SERIAL#1 Character length |
| COM1PARITY | NO<br>ODD<br>EVEN | SERIAL#1 Parity |
| COM1STOP | 1<br>2 | SERIAL#1 Stopp bits |
| VERSION? | VERSION : 2.0.00 | only request ?<br>Software version |

# SHORT COMMANDS

The first two character of the remote control commands are also valid as short commands. For some commands special sequences were implemented.

| | | | | | |
|---|---|---|---|---|---|
| Baudrate | BA | MSI | MS | Status | ST |
| Center | CE | Mess-Type-O | ME | Trigger | TG |
| Data | DA | Mode | MO | Time | TI |
| **Date** | **DT** | Polarity | PO | **Timestamp** | **TS** |
| Demodulator | DE | Print | PR | Tone-Duration | TO |
| ECC | EC | Repetition | RE | Translation | TR |
| Gain | GA | RPM | RP | Twinplex-Shift | TW |
| IOC | IO | Signal-Source | SI | **Twinplex-V1** | **V1** |
| Language | LA | Shift | SH | **Twinplex-V2** | **V2** |
| Level | LE | Slength | SL | Version | VE |
| LTRS-FIGS | LT | Span | SP | Video | VI |

# REMOTE COMMANDS MODES

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| ANALYSIS-HF | MODE | ANALYSIS-HF |
| | SPAN | NARROW |
| | | NORMAL |
| | | WIDE |
| | | LARGE |
| | CENTER | 600 - 3500 |
| ANALYSIS-DIR | MODE | ANALYSIS-DIR |
| | SPAN | NARROW |
| | | NORMAL |
| | | WIDE |
| | | LARGE |
| ANALYSIS-IND | MODE | ANALYSIS-IND |
| | SPAN | NARROW |
| | | NORMAL |
| | | WIDE |
| | | LARGE |
| CODECHECK-HF | MODE | CODECHECK-HF/AUTO |
| | | CODECHECK-HF |
| | SHIFT | 50 - 3500 |
| | CENTER | 600 - 3500 |
| | BAUDRATE | 30.0 - 1200.0 |
| CODECHECK-DIR | MODE | CODECHECK-DIR/AUTO |
| | | CODECHECK-DIR |
| | SHIFT | 50 - 16000 |
| | BAUDRATE | 30.0 - 9600.0 |
| CODECHECK-IND | MODE | CODECHECK-IND/AUTO |
| | | CODECHECK-IND |
| | SHIFT | 50 - 3500 |
| | CENTER | 600 - 3500 |
| | BAUDRATE | 30.0 - 3000 |
| ACARS | MODE | ACARS |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | FRAMES | ALL |
| | | ERROR-FREE |
| ALIS | MODE | ALIS |
| | | ALIS/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK-SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| ARQ-E | MODE | ARQ-E |
| | | ARQ-E/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |

# MODE REMOTE COMMAND COMMAND LIMITING VALUE

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| ARQ-E3 | MODE | ARQ-E3 |
| | | ARQ-E3/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| ARQ-N | MODE | ARQ-N |
| | | ARQ-N/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | REPETITION | FOUR |
| | | EIGHT |
| ARQ-M2-242 | MODE | ARQ-M2-242 |
| | | ARQ-M2-242/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ARQ-M2-342 | MODE | ARQ-M2-342 |
| | | ARQ-M2-342/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ARQ-M4-242 | MODE | ARQ-M4-242 |
| | | ARQ-M4-242/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ARQ-M4-342 | MODE | ARQ-M4-342 |
| | | ARQ-M4-342/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ARQ6-90 | MODE | ARQ6-90 |
| | | ARQ6-90/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ARQ6-98 | MODE | ARQ6-98 |
| | | ARQ6-98/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| ASCII | MODE | ASCII |
| | | ASCII/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | US-ASCII |
| | | GERMAN |
| | | TRANSPARENT |
| ATIS | MODE | ATIS |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| AUTOSPEC | MODE | AUTOSPEC |
| | | AUTOSPEC/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| BAUDOT | MODE | BAUDOT |
| | | BAUDOT/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| | | ITA-1 |
| | | ITA-2-BULGARIAN |
| CCIR | MODE | CCIR |
| CCITT | MODE | CCITT |
| CTCSS | MODE | CTCSS |
| CIS-11 | MODE | CIS-11 |

# MODE REMOTE COMMAND COMMAND LIMITING VALUE

| | | | |
|---|---|---|---|
| | | CIS-11/AUTO | |
| | SHIFT | 50-3500 | |
| | CENTER | 600-3500 | |
| | BAUDRATE | 30.0-1200.0 | |
| | DEMODULATOR | DSP | |
| | | MARK/SPACE | |
| | LANGUAGE | ITA-2 | |
| | | TRANSPARENT | |
| | | TASS-CYRILLIC | |
| | | ITA-2-CYRILLIC | |
| | | 3-SHIFT-CYRILLIC | |
| | | BAGDAD-70 | |
| | | 3-SHIFT-GREEK | |
| | | BAGDAD-80 | |
| CIS-14 | MODE | CIS-14 | |
| | | CIS-14/AUTO | |
| | SHIFT | 50-3500 | |
| | CENTER | 600-3500 | |
| | BAUDRATE | 30.0-1200.0 | |
| | DEMODULATOR | DSP | |
| | | MARK/SPACE | |
| COQUELET-8 | MODE | COQUELET-8 | |
| | CENTER | 600-3500 | |
| | TONE-DURATION (ms) | 37.5, 75 | |
| | DEMODULATOR | DSP | |
| | | MFSK | |
| COQUELET-13 | MODE | COQUELET-13 | |
| | CENTER | 600-3500 | |
| | TONE-DURATION (ms) | 75.0 | |
| | DEMODULATOR | DSP | |
| | | MFSK | |
| DTMF | MODE | DTMF | |
| CW-MORSE | MODE | CW-MORSE | |
| | | CW-MORSE/AUTO | (only SPEED) |
| | BANDWIDTH | 50-1200 | |
| | CENTER | 800-2000 | |
| | SPEED(bpm) | 20-400 | |
| DUP-ARQ | MODE | DUP-ARQ | |
| | | DUP-ARQ/AUTO | |
| | SHIFT | 50-3500 | |
| | CENTER | 600-3500 | |
| | BAUDRATE | 30.0-1200.0 | |
| | DEMODULATOR | DSP | |
| | | MARK/SPACE | |
| | POLARITY | NOR | |
| | | INV | |
| DUP-ARQ-2 | MODE | DUP-ARQ-2 | |
| | | DUP-ARQ-2/AUTO | |
| | SHIFT | 50-3500 | |
| | CENTER | 600-3500 | |
| | BAUDRATE | 30.0-1200.0 | |
| | DEMODULATOR | DSP | |
| | | MARK/SPACE | |
| DUP-FEC-2 | MODE | DUP-FEC-2 | |
| | | DUP-FEC-2/AUTO | |
| | SHIFT | 50-3500 | |
| | CENTER | 600-3500 | |
| | BAUDRATE | 30.0-1200.0 | |
| | DEMODULATOR | DSP | |

# MODE REMOTE COMMAND COMMAND LIMITING VALUE

| | | |
|---|---|---|
| | | MARK/SPACE |
| | POLARITY | NOR |
| | | INV |
| | LANGUAGE | US-ASCII |
| | | TRANSPARENT |
| | | SWEDISH |
| | | DANISH |
| EEA | MODE | EEA |
| EIA | MODE | EIA |
| EURO | MODE | EURO |
| | ALL-DATA | OFF |
| | | ON |
| FEC-A | MODE | FEC-A |
| | | FEC-A/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| | LENGTH | SREG72 |
| | | SREG128 |
| FELDHELL | REMOTE CONTTROL | NOT AVAILABLE |
| FMS-BOS | MODE | FMS-BOS |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| GOLAY | MODE | GOLAY |
| | SHIFT | 50-16000 |
| G-TOR | MODE | G-TOR |
| | | G-TOR/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | US-ASCII |
| | | TRANSPARENT |
| HC-ARQ | MODE | HC-ARQ |
| | | HC-ARQ/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| HNG-FEC | MODE | HNG-FEC |
| | | HNG-FEC/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |

# MODE REMOTE COMMAND COMMAND LIMITING VALUE

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | POLARITY | NOR |
| | | INV |
| INFOCALL | NOT CONTROLLABLE | |
| METEOSAT | NOT CONTROLLABLE | |
| MPT | MODE | MPT |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | STATION | FIXED |
| | | MOBILE |
| | DCW-DATA | ASCII |
| | | BINARY |
| NATEL | MODE | NATEL |
| | ALL-DATA | OFF |
| | | ON |
| NOAA-GEOSAT | NOT CONTROLLABLE | |
| PACTOR | MODE | PACTOR |
| | | PACTOR/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| PACKET-300 | MODE | PACKET-300 |
| | | PACKET-300/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 300, 600 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | FRAMES | ALL |
| | | I-FRAMES |
| PACKET-1200 | MODE | PACKET-1200 |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 1200, 600 |
| | FRAMES | ALL |
| | | I-FRAMES |
| PACKET-9600 | MODE | PACKET-9600 |
| | SHIFT | 50-16000 |
| | BAUDRATE | 9600, 2400, 4800 |
| | FRAMES | ALL |
| | | I-FRAMES |
| PCM-30 | NOT CONTROLLABLE | |
| PICCOLO-MK6 | MODE | PICCOLO-MK6 |
| | CENTER | 600-3500 |
| | TONE-DURATION (ms) | 25, 50 |
| | DEMODULATOR | DSP |
| | | MFSK |
| PICCOLO-MK12 | MODE | PICCOLO-MK12 |
| | CENTER | 600-3500 |
| | TONE-DURATION (ms) | 25, 50 |
| | DEMODULATOR | DSP |
| | | MFSK |

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| POCSAG | MODE | POCSAG |
| | SHIFT | 50-16000 |
| | BAUDRATE | 512.0, 1200.0, 2400.0 |
| | MESS-TYPE-O | BIN |
| | | ASCII |
| | | AUTO |
| | | TYPE3 |
| | LANGUAGE | US-ASCII |
| | | GERMAN |
| POL-ARQ | MODE | POL-ARQ |
| | | POL-ARQ/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| PRESS-FAX | NOT CONTROLLABLE | |
| RUM-FEC | MODE | RUM-FEC |
| | | RUM-FEC/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | NATIONAL |
| | POLARITY | NOR |
| | | INV |
| SI-AUTO | MODE | SI-AUTO |
| | | SI-AUTO/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SI-ARQ | MODE | SI-ARQ |
| | | SI-ARQ/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SI-FEC | MODE | SI-FEC |
| | | SI-FEC/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SITOR-AUTO | MODE | SITOR-AUTO |
| | | SITOR-AUTO/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| SITOR-ARQ | MODE | SITOR-ARQ |
| | | SITOR-ARQ/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| SITOR-FEC | MODE | SITOR-FEC |
| | | SITOR-FEC/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| SPREAD-11 | MODE | SPREAD-11 |
| | | SPREAD-11/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SPREAD-21 | MODE | SPREAD-21 |
| | | SPREAD-21/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SPREAD-51 | MODE | SPREAD-51 |
| | | SPREAD-51/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| SSTV | REMOTE CONTROL | NOT AVAILABLE |

# MODE REMOTE COMMAND COMMAND LIMITING VALUE

| MODE | REMOTE COMMAND | COMMAND LIMITING VALUE |
|---|---|---|
| SWED-ARQ | MODE | SWED-ARQ |
| | | SWED-ARQ/AUTO |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MARK/SPACE |
| TWINPLEX | MODE | TWINPLEX |
| | TWINPLEX-SHIFT | 50-50-50 up to |
| | | 800-800-800 |
| | CENTER | 600-3500 |
| | BAUDRATE | 30.0-1200.0 |
| | DEMODULATOR | DSP |
| | | MFSK |
| | LANGUAGE | ITA-2 |
| | | TRANSPARENT |
| | | TASS-CYRILLIC |
| | | ITA-2-CYRILLIC |
| | | 3-SHIFT-CYRILLIC |
| | | BAGDAD-70 |
| | | 3-SHIFT-GREEK |
| | | BAGDAD-80 |
| | TWINPLEX-V1 | Y-Y-B-B |
| | | Y-B-Y-B |
| | | B-Y-Y-B |
| | | B-Y-B-Y |
| | | Y-B-B-Y |
| | TWINPLEX-V2 | Y-B-Y-B |
| | | B-Y-Y-B |
| | | B-Y-B-Y |
| | | Y-B-B-Y |
| VDEW | MODE | VDEW |
| WEATHER-FAX | MODE | WEATHER-FAX |
| | | WEATHER-FAX/AUTO (only synchronisation) |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| | IOC | 288 |
| | | 352 |
| | | 576 |
| | RPM | 60 |
| | | 90 |
| | | 120 |
| | | 180 |
| | | 240 |
| ZVEI-VDEW | MODE | ZVEI-VDEW |
| | SHIFT | 50-3500 |
| | CENTER | 600-3500 |
| ZVEI-1 | MODE | ZVEI-1 |
| ZVEI-2 | MODE | ZVEI-2 |

# LOADING OF THE W4100DSP SOFTWARE VIA REMOTE-CONTROL

The new W4100DSP **BOOT-Software V4.2** enables software download via the serial REMOTE-CONTROL interface (Serial #2). Thus the W4100DSP can be centrally controlled or decent rally controlled from a host computer which may download the latest software version without interrupting normal operation.

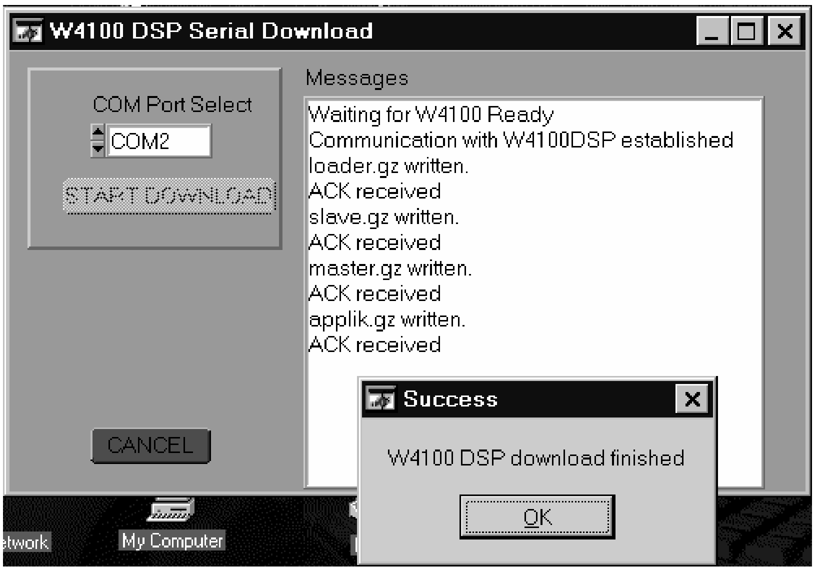
For interested users a complete WINDOWS95 application as well as source code for the driver are available. Loading of the compressed software takes place at a speed of 9600 bit/s.

The checksum of the compressed data offers a very high security against transmission errors. Error messages will alert the host operator to transmission errors and may be retransmitted as required. Approximately nine minutes are required for a complete download and unpacking of the software.

W4100DSP Program files BOOT V4.2

| | |
|---|---|
| - loader.gz | DSP loader File in GZ format |
| - slave.gz | DSP slave programme in GZ format |
| - master.gz | DSP master programme in GZ format |
| - applik.gz | TMS34010 programme file in GZ format |

# SOFTWARE DOWNLOAD IN WINDOWS95



| PROGRAM FLOW | COMMUNICATION |
|---|---|
| Remove W4100DSP programme floppy disk from the disk drive | |
| HOST switches W4100DSP **off**<br>HOST switches W4100DSP **on** | |
| Program HOST interface to (COM):<br>- 9600 Baud<br>- 8 Data bits<br>- 1 Stopp bit<br>- No Parity<br>- Handshake: none | |
| HOST sends ENQ and waits for response | ENQ |
| Timeout 2s | ENQ |
| W4100DSP searches the disk<br>Timeout after 25 seconds | ACK |
| HOST sends file<br>File length is binary 32 bit longword (4 Bytes) | @loader.gz:<br>32 bit longword of file length in bytes<br>packet file data |
| HOST waits for acknowledgement<br>or | > |
| Error message | 'error message> |
| HOST sends file<br>File length is binary 32 bit Longword (4 Bytes) | @slave.gz:<br>32 bit longword of file length in bytes<br>packet file data |
| HOST waits for acknowledgement<br>or | > |
| Error message | 'error message> |
| HOST repeats file transfer | @slave.gz:<br>32 bit longword of file length in bytes<br>packet file data |
| HOST waits for acknowledgement | > |
| HOST sends File | @master.gz:<br>32 bit longword of file length in bytes |

# PROGRAM FLOW COMMUNICATION

| | |
|---|---|
| | packet file data |
| HOST waits for acknowledgement | > |
| or | |
| Error message | 'error message> |
| HOST sends file | @applik.gz: |
| | 32 bit longword of file length in bytes |
| | packet file data |
| HOST waits for acknowledgement | > |
| or | |
| Error message | 'error message> |
| HOST sends start command | @start |
| HOST waits for 25 seconds and sends | REMOTE00=ON |
| Remote-ON confirmation W4100DSP | > |

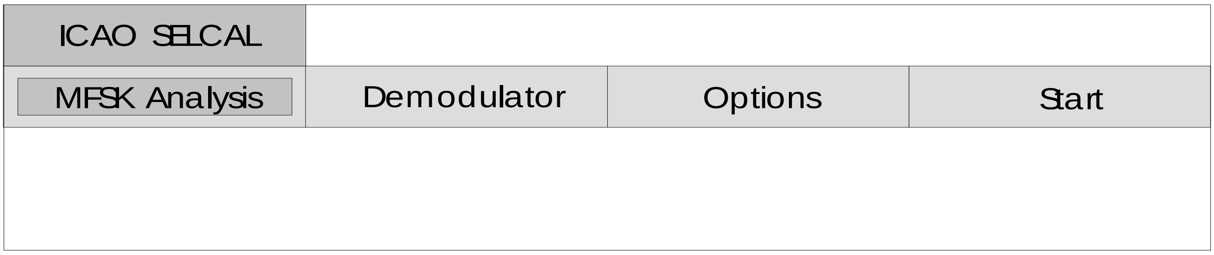
# ERROR MESSAGES

| | |
|---|---|
| run out of input data | Error in transmission |
| incomplete literal tree | Error in ZIP format |
| incomplete distance tree | Error in ZIP format |
| bad gzip magic numbers | Error in ZIP file |
| internal error, invalid method | Compression error |
| Input is encrypted | Unacceptable scrambling |
| Multi part input | Error in transmission |
| Input has invalid flags | Error in transmission |
| invalid compressed format | Error in ZIP file |
| out of memory | Too little memory |
| invalid compressed format | Compression error |
| crc error | Error in checksum |
| length error | Error in expanding |

# ICAO SELCAL

| | |
|---|---|
| Frequency range | HF |
| System | SELCAL analog |
| Tone duration | 1000 ms |
| Modulation | SSB |
| Receiver settings | CW, LSB or USB |
| Signal sources | AF, HF or IF |

## ICAO SELCAL OPERATING MENU




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 1000 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 |

# INFOCALL

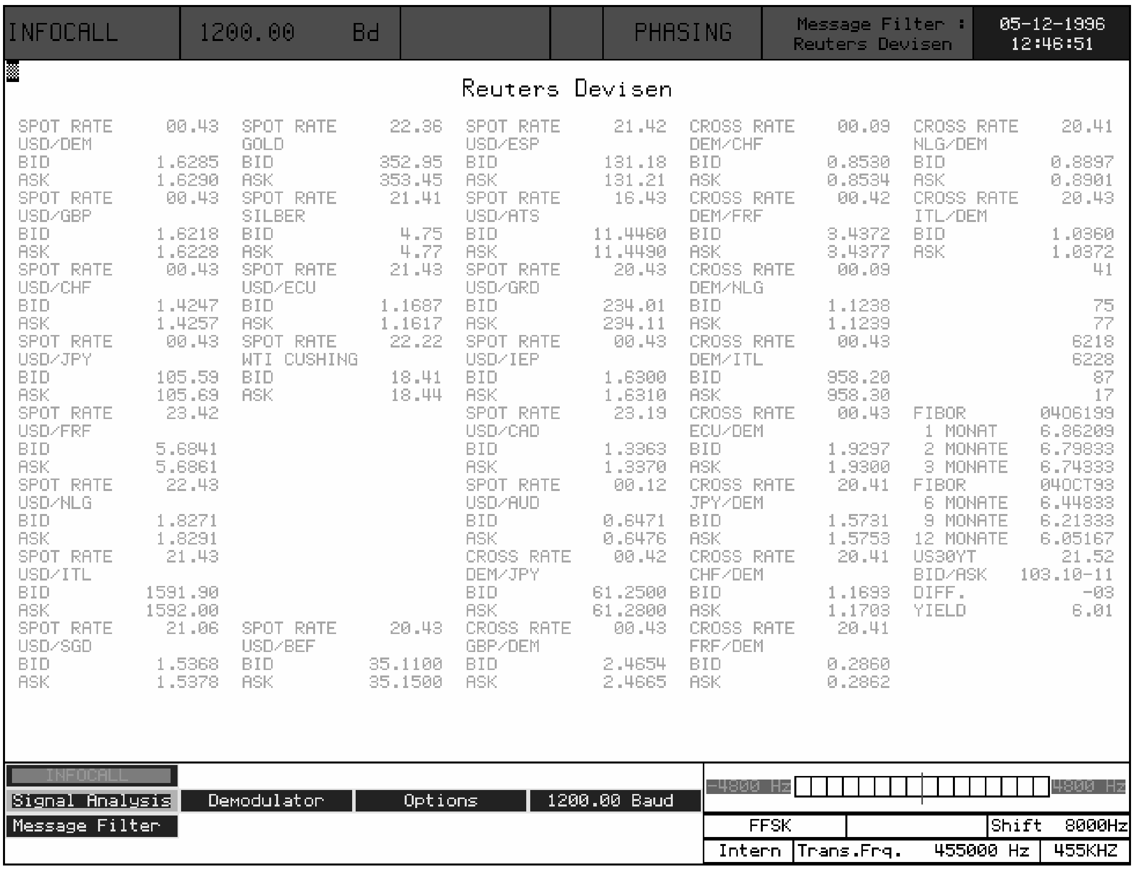
| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PAGER |
| Baudrate | 1200 Bit/s |
| Modulation | DIRECT FM |
| Receiver setting | FM 15 KHz, narrow |
| Signal source | IF (only) |

# INFOCALL OPERATING MENU

| | | | |
|---|---|---|---|
| INFOCALL | | | |
| Analysis | Demodulator | Options | 1200.00 Baud |
| Message Filter | | | |

The INFOCALL system permanently broad carts information on current stock exchange prices and market reports as well as up to date political and economic news.

# EXAMPLE OF A INFOCALL DATABASE




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SPOT RATE | 00.43 | SPOT RATE | 22.36 | SPOT RATE | 21.42 | CROSS RATE | 00.09 | CROSS RATE | 20.41 |
| USD/DEM | | GOLD | | USD/ESP | | DEM/CHF | | NLG/DEM | |
| BID | 1.6285 | BID | 352.95 | BID | 131.18 | BID | 0.8530 | BID | 0.8897 |
| ASK | 1.6290 | ASK | 353.45 | ASK | 131.21 | ASK | 0.8534 | ASK | 0.8901 |
| SPOT RATE | 00.43 | SPOT RATE | 21.41 | SPOT RATE | 16.43 | CROSS RATE | 00.42 | CROSS RATE | 20.43 |
| USD/GBP | | SILBER | | USD/ATS | | DEM/FRF | | ITL/DEM | |
| BID | 1.6218 | BID | 4.75 | BID | 11.4460 | BID | 3.4372 | BID | 1.0360 |
| ASK | 1.6228 | ASK | 4.77 | ASK | 11.4490 | ASK | 3.4377 | ASK | 1.0372 |
| SPOT RATE | 00.43 | SPOT RATE | 21.43 | SPOT RATE | 20.43 | CROSS RATE | 00.09 | | 41 |
| USD/CHF | | USD/ECU | | USD/GRD | | DEM/NLG | | | |
| BID | 1.4247 | BID | 1.1687 | BID | 234.01 | BID | 1.1238 | | 75 |
| ASK | 1.4257 | ASK | 1.1617 | ASK | 234.11 | ASK | 1.1239 | | 77 |
| SPOT RATE | 00.43 | SPOT RATE | 22.22 | SPOT RATE | 00.43 | CROSS RATE | 00.43 | | 6218 |
| USD/JPY | | WTI CUSHING | | USD/IEP | | DEM/ITL | | | 6228 |
| BID | 105.59 | BID | 18.41 | BID | 1.6300 | BID | 958.20 | | 87 |
| ASK | 105.69 | ASK | 18.44 | ASK | 1.6310 | ASK | 958.30 | | 17 |
| SPOT RATE | 23.42 | | | SPOT RATE | 23.19 | CROSS RATE | 00.43 | FIBOR | 0406199 |
| USD/FRF | | | | USD/CAD | | ECU/DEM | | 1 MONAT | 6.86209 |
| BID | 5.6841 | | | BID | 1.3363 | BID | 1.9297 | 2 MONATE | 6.79833 |
| ASK | 5.6861 | | | ASK | 1.3370 | ASK | 1.9300 | 3 MONATE | 6.74333 |
| SPOT RATE | 22.43 | | | SPOT RATE | 00.12 | CROSS RATE | 20.41 | FIBOR | 040CT93 |
| USD/NLG | | | | USD/AUD | | JPY/DEM | | 6 MONATE | 6.44833 |
| BID | 1.8271 | | | BID | 0.6471 | BID | 1.5731 | 9 MONATE | 6.21333 |
| ASK | 1.8291 | | | ASK | 0.6476 | ASK | 1.5753 | 12 MONATE | 6.05167 |
| SPOT RATE | 21.43 | | | CROSS RATE | 00.42 | CROSS RATE | 20.41 | US30YT | 21.52 |
| USD/ITL | | | | DEM/JPY | | CHF/DEM | | BID/ASK | 103.10-11 |
| BID | 1591.90 | | | BID | 61.2500 | BID | 1.1693 | DIFF. | -03 |
| ASK | 1592.00 | | | ASK | 61.2800 | ASK | 1.1703 | YIELD | 6.01 |
| SPOT RATE | 21.06 | SPOT RATE | 20.43 | CROSS RATE | 00.43 | CROSS RATE | 20.41 | | |
| USD/SGD | | USD/BEF | | GBP/DEM | | FRF/DEM | | | |
| BID | 1.5368 | BID | 35.1100 | BID | 2.4654 | BID | 0.2860 | | |
| ASK | 1.5378 | ASK | 35.1500 | ASK | 2.4665 | ASK | 0.2862 | | |

INFOCALL data is transmitted on different UHF frequencies. The entire available information is transmitted at midnight whereas only a specially designated subset of the information is transmitted during the day. The reception should therefore be set up for overnight operation.

INFOCALL consists of 16 databases of which four are currently in use. Three databases are managed by REUTERS and one by VWD. Information is either transmitted on a fixed cycle or whenever data changes have occurred.

The WAVECOM software provides a total of 9 different video pages which are designated as ”Reuters Devisen”, ”Reuters Aktien #1”, ”Reuters Aktien #2”, ”VWD Kurse #1”, ”VWD Kurse #2”, ”VWD Kurse #3”, ”VWD Kurse #4”, ”VWD News” and ”Reuters News” respectively. In addition, a menu field provides for summarised information with a scrolling function.

The most important exchange rates which have been transferred directly from the stock market, may be viewed in the different fields. In general, data is updated after 84 seconds at the latest.

The thirty share prices are based on the DAX (German share index) and are transmitted in real time from the Frankfurt Stock Exchange.

News messages consist of market reports and economic news.

Besides the current information on offer, additional news availability is possible in future. At the CeBIT 1992 exhibition the new RADIO-MAIL system was introduced. This allows larger amounts of data to be transferred to a notebook PC with an internal paging system. The MODACOM system will however most probably replace the RADIO-MAIL concept.

INFOCALL, consisting in some cases of very long ”0” and ”1” sequences, operates with direct frequency modulation. This requires demodulation from an IF signal source at either 455 KHz, 10.7 MHz or 21.4 MHz. The decoding from an audio frequency source which is offered by other manufacturers is unusable for INFOCALL services.

Most amateur radio sets require modification for this purpose. The 10.7 MHz IF output available on some equipment (ICOM) has too low an output voltage. In addition, the small bandwidth filters of 15 and 20 KHz are only available on the 455 KHz outputs of amateur equipment due to price considerations. For this reason the receiver should be fitted with a separate IF output of 455 KHz with an output level of between 10 mV and 1 V.

# METEOSAT

| | |
|---|---|
| Frequency range | SATELLITE-MODES |
| System | METEOSAT |
| Drum speed | 240 RPM |
| Resolution | IOC 288 |
| Modulation | INDIRECT AM |
| Receiver setting | AM 12 KHz, narrow |
| Signal source | AF (only) |

## METEOSAT OPERATING MENU

| METEOSAT | | | |
|---|---|---|---|
| Analysis | Auto | Manual | Demodulator |
| Options | Phase | Zoom | Fine Speed |

The METEOSAT software has been specifically tailored to the transmissions of meteorological satellites. Transmissions are always at 240 rpm using an IOC of 288. In contrast to shortwave stations which use frequency modulation, satellite weather images are transmitted using amplitude modulation. For this purpose the W4100DSP is fitted with a DSP AM demodulator with an integrated software lowpass filter.

The software is started in automatic mode by clicking the ”Auto” field or the ”Manual” field for manual mode. In manual mode the correct display of the image is controlled using the ”Phase” function. In the ”Demodulator” submenu the special function fields ”AM-Gain” and ”AM-Offset” are placed. Centerring 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.

Meteosat reception equipment even today costs just over DM 2200.-- including a parabolic reflector and receiver. The AF output of the receiver may be fed directly into the W4100DSP, which converts the W4100DSP into a weather image viewing station providing excellent image quality.

# MPT1327

| | |
|---|---|
| Frequency croup | VHF/UHF Modes |
| System croup | MPT1327 |
| Baudrate | 1200 Bit/s |
| Shift | 600 Hz |
| Center frequency | 1500 Hz |
| Modulation | INDIRECT-FM |
| Receiver settings | FM 15KHz, narrow |
| Signal source | AF (only) |

# MPT1327 OPERATING MENU

| MPT1327 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 1200.00 Baud |
| ECC is off | Fixed Stations | Output is on | DCW ASCII Data |

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 signalling procedures on a control channel. The W4100DSP 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.

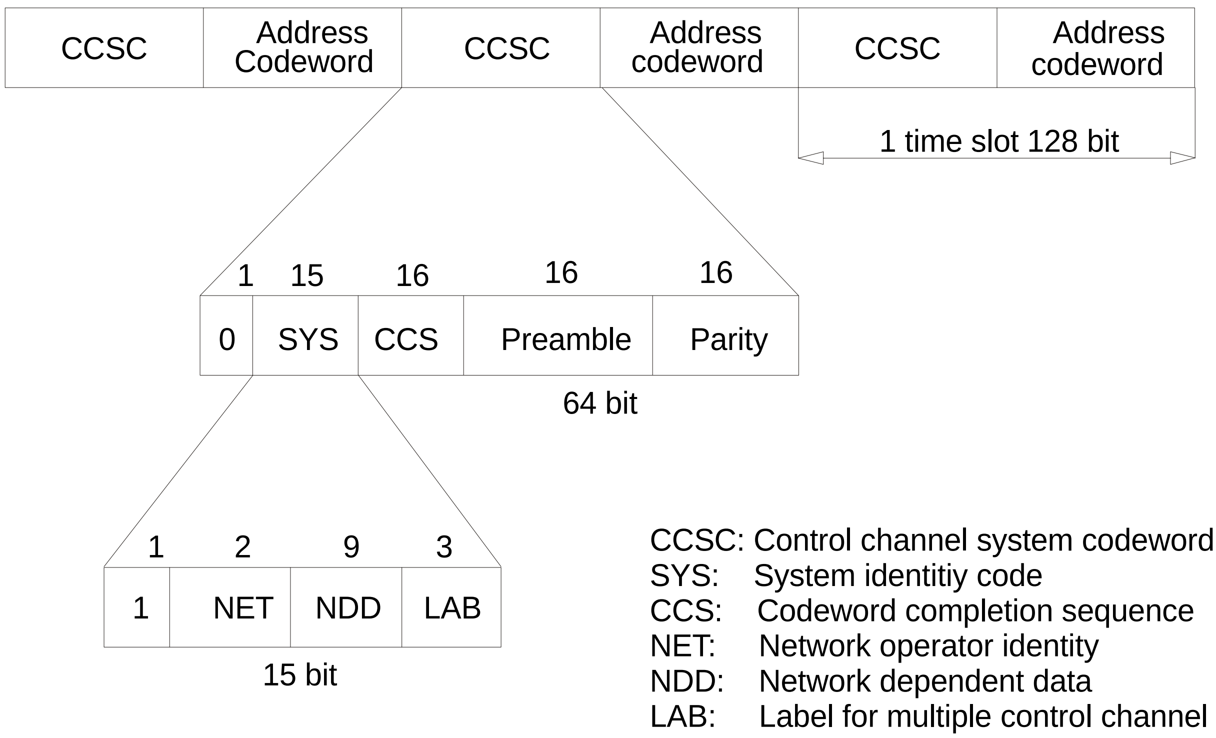
Trunked systems may carry voice or data signals. The mobile unit uses two-channel simplex and the base station full duplex.

The British MPT 1327 and MPT 1343 specifications for trunked private land mobile radio systems have won general an de-facto acceptance in Europe. MPT 1327 specifies the general signalling features whereas MPT 1343 specifies the actual system interface 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 (NMT) with national adaptations.

# GENERAL SPECIFICATIONS

| | |
|---|---|
| Frequency range | National allocations |
| Channel spacing | 12,5 kHz |
| Duplex spacing | 10 MHz |
| Data modulation | Indirect FFSK |
| Access method | Segmented ALOHA with dynamic frame length |
| Bit rate | 1200 bps |
| Logical ‘0’ | 1800 Hz |
| Logical ‘1’ | 1200 Hz |
| Data format | NZRI |

# SIGNALISATION STRUCTURE IN THE ORGANISATION CHANNEL




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 TSCs, which then access the channel in TDMA (time division multiple access).

The return control channel is randomly accessed by the mobiles in timeslots of 106.7 mS (128 bits).

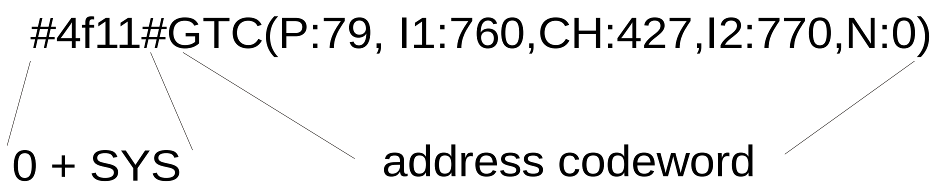
The forward control channel is divided into time slots each carrying two 64-bit code words:

- A Control Channel System Code-word (CCSC), which identifies the system to radio units and provides synchronisation 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.

# DATA OUTPUT FORMAT OF THE W4100DSP




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.

To start MPT1327/1343 monitoring, select “VHF-UHF MODES”/”MPT1327/1343” and then select “1200.00 Baud”.

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. In a separate part of the screen, the two latest AHL messages will be displayed in yellow and smaller typeface.

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 labelled 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 "OPTIONS" and using the mouse enable the timestamp function. 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 “OPTIONS” and using the mouse enable the timestamp 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** time slots **(N:0)**.A broadcast message:

**BCAST(SYSDEF:5,SYS:20265,CH:520,SPARE:0,RSVD:00,ADJ:2)**

Gives idle radio units an opportunity to use the next timeslot to assess signal strength **(SYSDEF:5)** on control channel **520 (CH:520)** of system **20265 (SYS:20265)** having local serial number **2 (ADJ:2)**.

# NOAA-GEOSAT

| | |
|---|---|
| Frequency range | SATELLITE-MODES |
| System | NOAA-GEOSAT |
| Drum speed | 120 RPM |
| Modulation | INDIRECT AM |
| Receiver setting | AM 12 KHz, narrow |
| Signal source | AF (only) |

# NOAA-GEOSAT OPERATING MENU

| NOAA-GEOSAT | | | |
|---|---|---|---|
| Analysis | Auto | Manual | Demodulator |
| Options | Phase | Zoom | Fine Speed |

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. For this purpose the W4100DSP is fitted with a DSP AM demodulator with an integrated FIR software low-pass filter.

The software is started in automatic mode by clicking the ”Auto” field or the ”Manual” field for manual mode. In manual mode the correct display of the image is controlled using the ”Phase” function.

In the ”Demodulator” submenu the special function fields ”AM-Gain” and ”AM-Offset” are placed. Centring 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 W4100DSP, which converts the W4100DSP to a weather image viewing station providing excellent image quality.

The ”Phase” function is very important for this mode. If the start synchronization is missed the video image may still be aligned and positioned without problems.

Polarization problems occur with orbiting satellites resulting in reception gaps of up to 2 minutes. An active antenna obtainable in Holland 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) capabilities.

# PACTOR

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100/200 adaptive |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# PACTOR OPERATING MENU

| PACTOR | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 100/200 Baud | | | |

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 distance 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 takes place 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 has been successfully used. In the evening, however, strong propagation distortion occurs which necessitates a reduction in the bit 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 Huffmann code has the disadvantage that compression synchronisation 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. For these applications the data protocol was changed. The WAVECOM software automatically detects and decodes versions 1 to 5.

Detailed descriptions of the PACTOR protocols can be obtained in the radio amateur literature. It must however be pointed out that real-world PACTOR implementation differs considerably from these descriptions.

# PACKET-300/600

| | |
|---|---|
| Frequency range | HF-MODES |
| System | STANDARD |
| Baudrate | 300 oder 600 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# PACKET-300 OPERATION MENU

| PACKET-300 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 300 Baud | 600 Baud | I/S/U-frames | Monitor ALL |
| Select Call | Remove Call | Display Frame | |

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.

By selecting either ”300 Baud” or ”600 Baud” the Packet Radio mode is started. The correct bandwidth must be set up via the ”Demodulator” menu as may be required.

The ”I/S/U frames” function gives the user the possibility to display either all packets or only packets with message contents. The function is useful to display call-signs and status information in addition to message-only packets. To toggle between display of I/S/U frames and I frames only, is achieved by simply clicking the left trackball button or the ENTER key on the front panel.

The ”Monitor ALL” function erases all call signs which may have been selected using the ”Select Call” field and all data packets are redisplayed.

The ”Select Call” field enables the selection of up to 10 received call signs. After selecting this field the list may be inspected by moving the trackball ball. To select a call sign click the left button. Call signs are stored in a FIFO (First in - first out) buffer. The ability to select call signs is useful when monitoring high activity channels. It should be noted that call signs which have been previously selected do not appear in the list.

To deselect stations use the "Remove Call" field. However, the call sign will not be erased.

Clicking the ”Display Frames” field causes it to change to ”Display Text”. In ”Display Frames” mode all call signs and the entire packet contents are displayed, whereas the ”Display Text” mode limits the display to text packets only. The use of the latter mode is sufficient in most cases since all call signs and the system state are dis-

played in any case on the status line. For longer decoding sessions however, the call signs should form part of the output.
The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Through the effort of American radio amateurs (TAPR) low cost equipment has become easily available and packet radio has become very popular. Packet radio is a synchronous system, and data is ASCII characters. Information is transferred in blocks (frames).

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 addresses are most common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types : I, S and U frames. Actual data transfer takes place using the I (information) frame and very seldom the U frame. The S and U frames are used for transmission control.

The data field can contain up to 256 characters in packet radio. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

When the ”Display Frames” mode is active the status field contains additional connection status information in addition to call signs.

Frame types are indicated I, S or U.

Possible 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 number is displayed. This number ranges from r0 to r7 or alternately 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

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PACKET-1200 |
| Baudrate | 1200 Bit/s |
| Modulation | INDIRECT FM |
| Receiver setting | FM 12 KHz, narrow |
| Signal source | AF (only) |

# PACKET-1200 OPERATION MENU

| PACKET-1200 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 600 Baud |
| 1200 Baud | I/S/U-frames | Monitor ALL | Select Call |
| Remove Call | Display Frame | | |

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 may be set in the ”Demodulator” menu. The software of the W4100DSP allows for automatic presetting of a standard shift of 3500 Hz. This value will not be changed by any other mode.

The ”I/S/U frames” function gives the user the possibility to display either all packets or only packets with message contents. The function is useful to display call-signs and status information in addition to message-only packets. To toggle between display of I/S/U frames and I frames only, is achieved by simply clicking the left trackball button or the ENTER key on the front panel.

The ”Monitor ALL” function erases all call signs which may have been selected using the ”Select Call” field and all data packets are redisplayed.

The ”Select Call” field enables the selection of up to 10 received call signs. After selecting this field the list may be inspected by moving the trackball ball. To select a call sign click the left button. Call signs are stored in a FIFO (First in - first out) buffer. The ability to select call signs is useful when monitoring high activity channels. It should be noted that call signs which have been previously selected do not appear in the list.

To deselect stations use the "Remove Call" field. However, the call sign will not be erased.

Clicking the ”Display Frames” field causes it to change to ”Display Text”. In ”Display Frames” mode all call signs and the entire packet contents are displayed, whereas the ”Display Text” mode limits the display to text packets only. The use of the latter mode is sufficient in most cases since all call signs and the system state are displayed in any case on the status line. For longer decoding sessions however, the call signs should form part of the output.

The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Through the effort of American radio amateurs (TAPR) low cost equipment has become easily available and packet radio has become very popular. Packet radio is a synchronous system, and data is ASCII characters. Information is transferred in blocks (frames).

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 addresses are most common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types : I, S and U frames. Actual data transfer takes place using the I (information) frame and very seldom the U frame. The S and U frames are used for transmission control.

The data field can contain up to 256 characters in packet radio. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

When the ”Display Frames” mode is active the status field contains additional connection status information in addition to call signs.

Frame types are indicated I, S or U.

Possible 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 number is displayed. This number ranges from r0 to r7 or alternately 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

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PACKET-9600 |
| Baudrate | 2400, 4800 und 9600 Bit/s |
| Modulation | DIRECT FM |
| Receiver setting | FM 15 KHz, narrow |
| Signal source | IF (only) |

# PACKET-RADIO OPERATION MENU

| PACKET-9600 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 2400 Baud |
| 4800 Baud | 9600 Baud | I/S/U-frames | Monitor ALL |
| Select Call | Remove Call | Display Frame | |

PACKET-9600 can be monitored in the amateur UHF and SHF bands. The transmissions sounds like as noise. 2400 Baud transmissions are more rare. Some digipeaters work with two modes, PACKET-1200 and PACKET-9600.

To start PACKET-9600 select "9600 Baud" or "2400 Baud". The correct shift may be set in the ”Demodulator” menu. The software of the W4100DSP allows for automatic presetting of a standard shift of 3500 Hz. This value will not be changed by any other mode.

As PACKET-9600 uses direct FM 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 ”I/S/U frames” function gives the user the possibility to display either all packets or only packets with message contents. The function is useful to display call-signs and status information in addition to message-only packets. To toggle between display of I/S/U frames and I frames only, is achieved by simply clicking the left trackball button or the ENTER key on the front panel.

The ”Monitor ALL” function erases all call signs which may have been selected using the ”Select Call” field and all data packets are redisplayed.

The ”Select Call” field enables the selection of up to 10 received call signs. After selecting this field the list may be inspected by moving the trackball ball. To select a call sign click the left button. Call signs are stored in a FIFO (First in - first out) buffer. The ability to select call signs is useful when monitoring high activity channels. It should be noted that call signs which have been previously selected do not appear in the list.

To deselect stations use the "Remove Call" field. However, the call sign will not be erased.

Clicking the ”Display Frames” field causes it to change to ”Display Text”. In ”Display Frames” mode all call signs and the entire packet contents are displayed, whereas the ”Display Text” mode limits the display to text packets only. The use of the latter mode is sufficient in most cases since all call signs and the system state are displayed in any case on the status line. For longer decoding sessions however, the call signs should form part of the output.

The packet radio protocol is a derivative of the X.25 and HDLC computer network protocols. Through the effort of American radio amateurs (TAPR) low cost equipment has become easily available and packet radio has become very popular. Packet radio is a synchronous system, and data is ASCII characters. Information is transferred in blocks (frames).

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 addresses are most common when using direct connections or a single repeater.

The packet protocol distinguishes between three frame types : I, S and U frames. Actual data transfer takes place using the I (information) frame and very seldom the U frame. The S and U frames are used for transmission control.

The data field can contain up to 256 characters in packet radio. All characters and character combinations are permitted since transmission is transparent. A checksum is sent in the FCS field.

When the ”Display Frames” mode is active the status field contains additional connection status information in addition to call signs.

Frame types are indicated I, S or U.

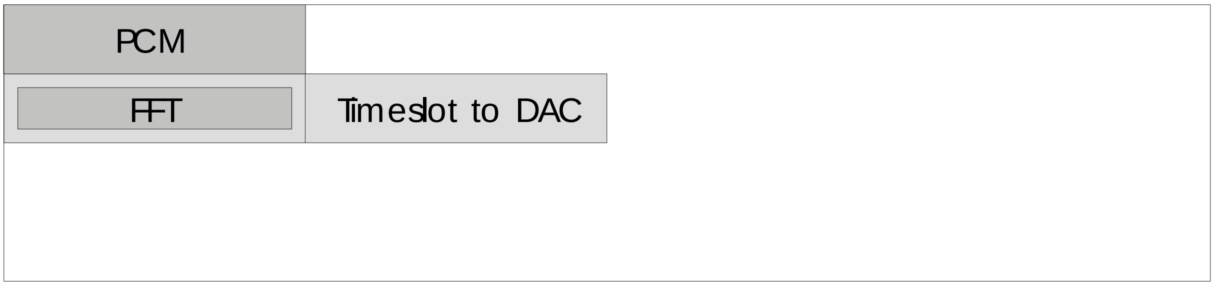
Possible S-frame status messages, e.g. Receiver Ready (RR), Receiver Not Ready (RNR) or Reject (REJ) are displayed.

In the third field the transmit and receive sequence number is displayed. This number ranges from r0 to r7 or alternately 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.

# PCM-30

| | |
|---|---|
| Frequency range | SATELLITE-MODES |
| System | PCM-30 |
| Baudrate | 2.048 MBit/s |
| Modulation | QPSK |
| Signal source | HDB-3 |

## OPERATION MENU PCM




The W4100DSP has a separate input for standard CCITT G.703 2.048 Mb/s PCM data HDB3 coded. This standard is used for land lines, satellite links and ISDN.

The system has 32 sub channels each of 64 KBit/s. Thirty sub channels (time slots 1 - 15 and 17 - 31) can contain any type of information: Digital ISDN or modem data as well as digitised voice, modem or fax transmissions. Sub channel 0 is used for synchronization and sub channel 16 for signalling.

The functions in the “PCM” menu enable solution and control of any sub channels 1 to 31.

Using the function "FFT" the real time FFT analysis is activated.

The W4100DSP has an audio output fed form a DAC (Digital-Analogue Converter). The signal processor converts a selected digital sub channel into an analogous signal. By selecting the menu item "Timeslot to DAC" the converting is started.

An AF amplifier can be connected to the audio output to make the contents of the sub channel audible. Modem-, fax- and other digital data is heard as noise. Voice transmissions appear equal to the signals on an analogue line.

# PICCOLO-MK6 and PICCOLO-MK12

| | |
|---|---|
| Frequency range | HF-MODES |
| System | MFSK |
| Tone duration | 50 ms or 25 ms |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## PICCOLO-MK6 OPERATION MENU

| PICCOLO-MK6 | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | Tone 50ms |
| Tone 25 ms | Force LTRS-FIGS | Print Preselection: N T1/T2 | |

PICCOLO-MK6 and PICCOLO-MK12 are MFSK (multi frequency shift keying) systems. The earlier PICCOLO 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 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 code words.

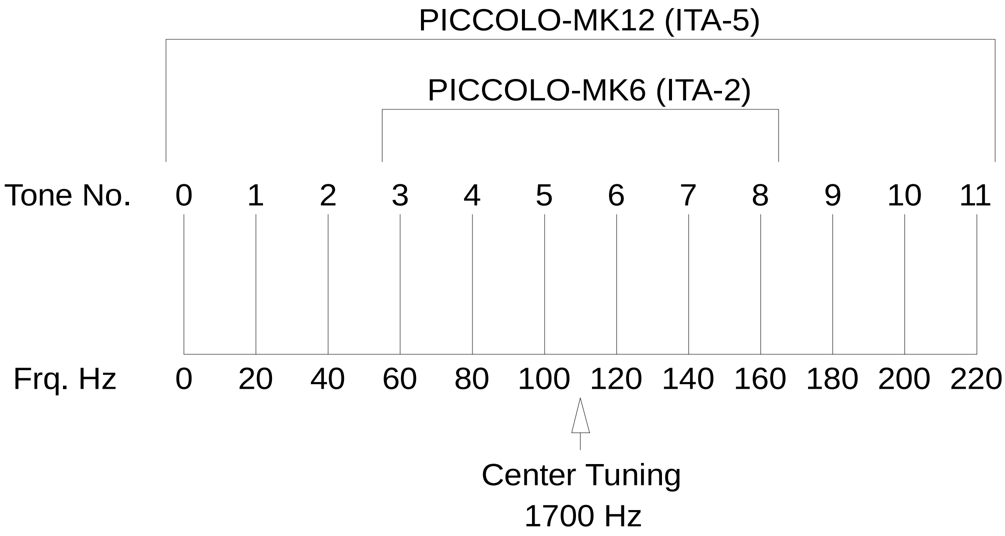
PICCOLO-MK12 transmits ITA-5 characters. To transfer 7 bit ASCII characters twelve tones are required. This produces 144 combinations of which 128 are used. The transmission speed is equivalent to an asynchronous data rate of 110 Baud.

The WAVECOM software displays four sub 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 sub windows. Known or recognisable text output can then readily be observed in one of the subw indows.

If the decoded data is to be printed the menu field ” Print Pre-selection: N T1/T2” must be used to select the desired data window as printer output source.

The decoder or receiver must be tuned to obtain the midpoint be-

# TONE ASSIGNMENT OF PICCOLO-MK6 AND PICCOLO-MK12




tween tones 5 and 6 as the center frequency. In the case of IDLE (standby) transmissions these two tones are keyed at rate of 100 ms and tuning becomes quite simple.

Decoding of PICCOLO and COQUELET systems requires receivers with good frequency stability: Thus state-of-art receivers using PLL or DDS frequency synthesis are 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 or disabled using the ”Demodulator” menu field.

The ”DSP mode” demodulator is intended for use with MFSK systems. This mode may be selected in the ”Demodulator” menu field via the ”Select Mode” option. The center frequency should be set to approximately 1700 Hz, lower settings may lead to higher error rates.

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 data transitions. 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 in clear.

# POCSAG

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | PAGER |
| Baudrate | 512, 1200 or 2400 Bit/s |
| Modulation | DIRECT FM |
| Receiver setting | FM 15 KHz, narrow |
| Signal source | IF (only) |

# POCSAG OPERATION MENU

| | | | |
|---|---|---|---|
| POCSAG | | | |
| Analysis | Demodulator | Options | 512.00 Baud |
| 1200.00 Baud | 2400.00 Baud | Auto Speed | ECC is on |
| Message Filter | US-ASCII | | |

The pager services introduced by a number of PTT administrations uses 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 4 different call modes:

**Tone only pagers (Mode 0 + 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.

**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 in the pager unit and can be stored in part.

**Alphanumeric pagers (Mode 3)**
The type which is most easy to use, is the alphanumeric pager where the transmitted message is displayed on the pager unit 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.

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 Bits 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. A W4100DSP AUTO-MODE for monitoring these systems is in preparation.

# POCSAG SIGNALLING

Generally activation of the HF carrier is followed by the transmission of a preamble or bit synchronisation 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 contain the actual information are transmitted, each batch being 17 x 32 bit or 544 bits long.

| Preamble | 1. Batch | 2. Batch | 3. Batch |
|---|---|---|---|
| >576 bit | 544 bit | 544 bit | 544 bit |

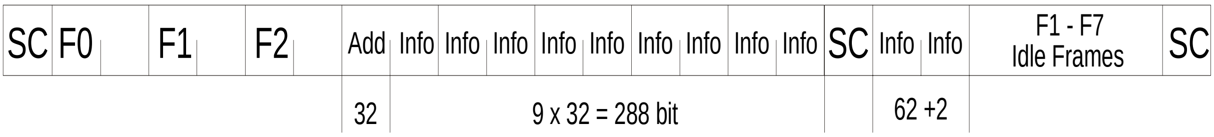
The structure of a batch is fixed : Each batch starts with a 32 bit synchronisation codeword with a fixed content.

The synchronisation 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.

| SC | F0 | F1 | F2 | F3 | F4 | F5 | F6 | F7 |
|---|---|---|---|---|---|---|---|---|
| 32 | 2x32 bit | 2x32 bit | 2x32 bit | 2x32 bit | 2x32 bit | 2x32 bit | 2x32 bit | 2x32 bit |

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 to which it has been assigned. A pager synchronises 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 filled with 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. Should the frame containing the end of a message not require to send a new address, it is filled with IDLE codes until a new address needs to be sent or a new synch word occurs.

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

| | |
|---|---|
| Frequency range | HF-MODES |
| System | DUPLEX |
| Baudrate | 100.0 or 200.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## POL—ARQ OPERATING MENU

| POL-ARQ | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 100.0 Baud | 200.0 Baud | 96.0 Baud var | Force LTRS-FIGS |

POL-ARQ operates at a speed of 100 and 200 Baud on the radio link.

To synchronise to this operating mode select baud rate. By selecting the ”AUTO” option, the automatic determination of frequency shift 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 synchronisation 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). The WAVECOM software automatically detects the character repetition cycle.

# PRESS-FAX

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FAX-SSTV-HELL |
| Drum speed | 120 RPM |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## PRESS FAX OPERATION MENU

| PRESS-FAX | | | |
|---|---|---|---|
| Analysis | Auto | Manual | Demodulator |
| Options | Drum Speed | IOC Modul | Zoom |
| Phase | Nor. Polarity | Fine Speed | Right to Left |

The transmission of press fax images on short-wave is based on grey 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 synchronisation 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 ”Manual” the decoding starts immediately and the drum speed and IOC can be programmed manually via the ”Drum Speed” and ”IOC Modul” menu fields. The selected parameters are displayed in the screen’s status line.

The W4100DSP allows a continuous and smooth alignment of the image as it is being received via the ”Phase” menu field. By turning the trackball left or right or by using the left-right cursor keys on the front panel the entire image can be shifted into the correct position.

The image may be enlarged via the ”Zoom” menu field. The received image can now be smoothly repositioned by moving the track ball. The resolution of the internally stored image is considerably higher than that of the available VGA standard.

The ”Options\Colours” menu field has a submenu with three fields ”16 grey levels”, ”Black/White” and ”User-defined”. The latter menu field allows press images to be coloured. This pseudo-colouring only affects the video display and this format can not be printed.

# PSK-31

| | |
|---|---|
| Frequency range | HF-MODES |
| Frequency Europe | 3.580 MHz, 7.035 MHz, 14.07080 MHz |
| System | STANDARD |
| Baudrate | 31.25 Baud |
| Carrier Modulation | DBPSK, DQPSK |
| Modulation | SSB |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# PSK-31 OPERATING MENU

| | | | |
|---|---|---|---|
| PSK-31 | | | |
| Analysis | Demodulator | Options | 31.25 Baud |
| Nor. Polarity | | | |

With PSK-31, a modern, very narrow-band and reliable mode is available, which is exactly what the radio amateurs need. The good behaviour against disturbances is achieved by the use of DPSK modulation. Two demodulators can be selected:

For normal use DBPSK can be selected to demodulate a bi-phase modulated signal. The baudrate is fixed to 31,25 Baud and is optimised to transfer the data rate, which an OM can input on a keyboard by hand.

Alternatively DQPSK can be selected to demodulate a four-phase modulated signal. Before transmitting additionally redundancy was generated by a convolution encoder with a code rate of 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 CR=1/2.

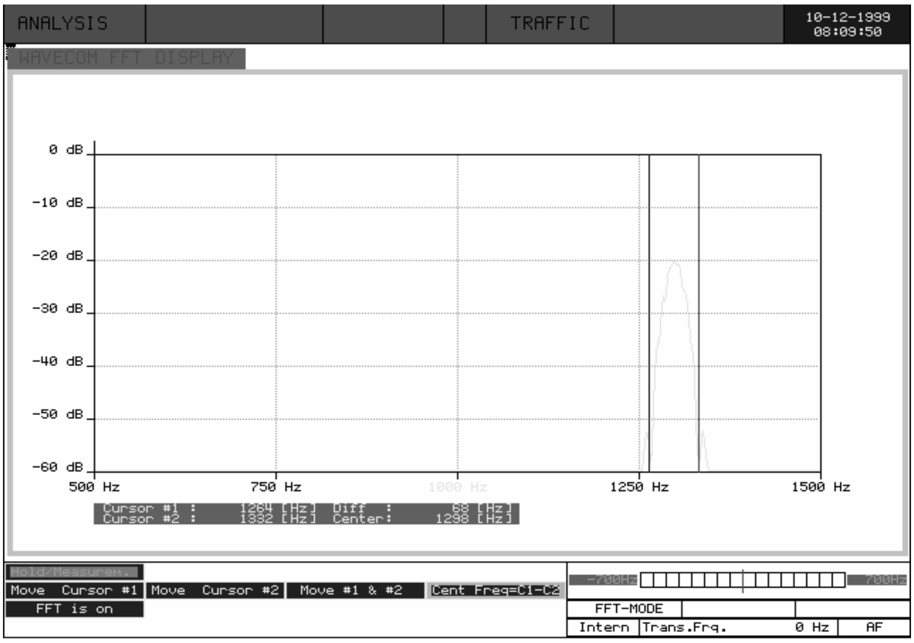
To separate the transferred characters, two zeros are inserted between every character. Thus the characters can be separated clearly, as long as no two successive zeros appear in the character itself. This was taken into consideration when designing the alphabet.

To optimise 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 OF PSK-31

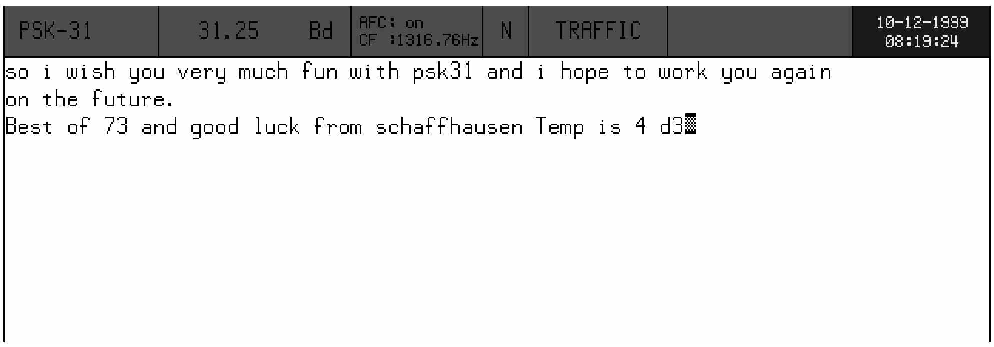
The first step is to look for a valid PSK-31 signal in the Real-Time-FFT analysis. Because a lot of PSK-31 traffic can be found on the amateur bands, it is possible that within a bandwidth of 4kHz more than one PSK-31-Signal occurs. A typical PSK-31 signal has the following spectrum:

## Tuning a PSK-31 Signal




The bandwidth of the display of the spectrum can be switched between 500Hz, 1000Hz, 4000Hz and 24000Hz. After that with the left cursor the lower limit and with the right cursor the upper boundary of the interesting signal can be selected. When the cursors are placed the center frequency can be calculated and adjusted. The bandwidth is fixed to 100Hz to suppress neighboured signals. Now PSK-31 can be started by pressing the baudrate button.

## PSK-31 Amateur Traffic



To ensure, that the system can handle drifting signals or a rough adjusted center frequency, AFC can be enabled in the menu "Demodulator". The carrier tracking function is activated now. The adjusted center frequency is displayed on the right side of the baudrate field. If the deviation between the tracked and the adjusted center frequency is too big, the center frequency should be corrected. The carrier tracking only works in a range of:

| | |
|---|---|
| DBPSK | Center +/– 8Hz |
| DQPSK | Center +/– 4Hz |

Hence adjustment of the center frequency must have a certain accuracy.

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 with USB 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 main menu by switching "Polarity".

# RUM—FEC

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 164.48 or 218.3 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## RUM—FEC OPERATION MENU

| RUM-FEC | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 164.48 Baud | 218.30 Baud | 96.0 Baud Var | Bit inversion |
| Nor. Polarity | ECC is on | Force LTRS-FIGS | ITA-2 |

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 code-word length of 16 bits where each of the 32 used bit com-binations corresponds to an ITA-2 character.

The RUM-FEC alphabet is de-signed to obtain a maximum Hamming distance for error detection. The actual ITA-2 alphabet is not contained in the code table. Error correc-tion is done , like in the case of HNG -FEC, by table look-up of the bit pattern (character) closest resem-bling the character in error.

RUM-FEC has a bit spread of 128 bits , each new character starting at intervals of 16 bits. The software synchro-nises to traffic as well as to idle bit patterns.

Bit inversion is often used. The bit inversion pattern may be selected from the ”Bit in-version” field.

Error correction may be en-abled or disabled using the ”ECC is on/off” field.

In RUM-FEC mode the signal polarity (sideband) can be manually selected by clicking on the ”Nor. Polarity/Inv. Polarity” field. If polarity changes during a transmis-sion, synchronisation will not be lost.

# SELCAL ANALOG

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | SELCAL analog |
| Modulation | INDIRECT FM |
| Receiver setting | FM 12 KHz, narrow |
| Signal source | AF (only) |

# SELCAL OPERATING MENU

| SELCAL ANALOG | | | |
|---|---|---|---|
| SELCAL Analysis | Demodulator | Options | ZVEI-1 |
| ZVEI-2 | CCIR | EEA | EIA |
| CCITT | VDEW | DTMF | More... |

Selective call systems is an efficient supplement to the voice traffic. An earlier method was the so-called single-tone-mode using five different tone frequencies. Later two-tone-modes followed, where the call number is transmitted as frequency combinations. The two-tone-method is still used.

Later 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 an 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 a nominal one duration of 70 ms, the duration of a single tone may vary +/- 15 ms.

Modifications of the tone allocation and tone duration has led to numerous systems despite many standards.

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 "Setup\Global Settings" a "Timestamp" function can be enabled to add date and time to each call.

Only the EURO (EuroSignal) system uses six consecutive tones. The worldwide telephone signalling standard DTMF mode transmits two simultaneous tones.

# TONE ALLOCATION OF THE DIFFERENT TONE CALL SYSTEMS

| DIGIT | ZVEI-1 | ZVEI-2 | CCIR | EEA | EIA |
|---|---|---|---|---|---|
| 0 | 2400 | 2200 | 1981 | 1981 | 600 |
| 1 | 1060 | 970 | 1124 | 1124 | 741 |
| 2 | 1160 | 1060 | 1197 | 1197 | 882 |
| 3 | 1270 | 1160 | 1275 | 1275 | 1023 |
| 4 | 1400 | 1270 | 1358 | 1358 | 1164 |
| 5 | 1530 | 1400 | 1446 | 1446 | 1305 |
| 6 | 1670 | 1530 | 1540 | 1540 | 1446 |
| 7 | 1830 | 1670 | 1640 | 1640 | 1587 |
| 8 | 2000 | 1830 | 1747 | 1747 | 1728 |
| 9 | 2200 | 2000 | 1860 | 1860 | 1869 |
| A | 2799.9 | 2599.9 | 2400 | 1055 | 2151 |
| B | 810 | 2799.9 | 930 | 930 | 2432.9 |
| C | 970 | 810 | 2246.9 | 2246.9 | 2010.1 |
| D | 886 | 886 | 991 | 991 | 2292.0 |
| E | 2599.9 | 2400 | 2110 | 2110 | 459 |
| F | | | | | |
| TONE DURA-TION | 70 ms | 70 ms | 100 ms | 40 ms | 33 ms |

| DIGIT | VDEW | EURO | CCITT | NATEL | DTMF |
|---|---|---|---|---|---|
| 0 | 2280 | 979.8 | 400 | 1633 | 941/1336 |
| 1 | 370 | 903.1 | 697 | 631 | 697/1209 |
| 2 | 450 | 832.5 | 770 | 697 | 697/1336 |
| 3 | 550 | 764.4 | 852 | 770 | 697/1477 |
| 4 | 675 | 707.4 | 941 | 852 | 770/1209 |
| 5 | 825 | 652.0 | 1209 | 941 | 770/1336 |
| 6 | 1010 | 601.0 | 1335 | 1040 | 770/1477 |
| 7 | 1240 | 554.0 | 1477 | 1209 | 852/1209 |
| 8 | 1520 | 510.7 | 1633 | 1336 | 852/1336 |
| 9 | 1860 | 470.8 | 1800 | 1477 | 852/1477 |
| A | 2000 | 433.9 | 1900 | 1633 | 697/1633 |
| B | 2100 | 400.0 | 2000 | 600 | 770/1633 |
| C | 2200 | 368.7 | 2100 | 1995 | 852/1633 |
| E | 2300 | 1153.1 | 2200 | 2205 | 941/1633 |
| E | 2400 | 1062.9 | 2300 | 1805 | 941/1209 |
| F | | 339.9 | | | 941/1477 |
| TONE DURA-TION | 100 ms | 100 ms | 100 ms | 70 ms | 70 ms |

# CTCSS-SELECTIVCALL SYSTEM

The CTCSS selective calling system is defined according to EIA standard RS-220 and operates in the sub-audio range. Applying this Continuous Tone Controlled Squelch System a lot of users on the same receiving frequency can select single or groups of users. A CTCSS controlled receiver only switches on, in case a carrier modulated with the pre-programmed CTCSS tone is received. For this system 63 tones are defined:

## TONE ALLOCATION OF CTCSS SELECTIVCALL SYSTEM OF IEC489

| Tone no. | Frequency Hz | Tone no. | Frequency Hz | Tone no. | Frequency Hz |
|---|---|---|---|---|---|
| 1 | 67.0 | 22 | 114.6 | 43 | 162.2 |
| 2 | 71.9 | 23 | 114.8 | 44 | 163.1 |
| 3 | 74.4 | 24 | 117.7 | 45 | 167.9 |
| 4 | 77.0 | 25 | 118.8 | 46 | 169.0 |
| 5 | 79.7 | 26 | 120.9 | 47 | 173.8 |
| 6 | 81.0 | 27 | 123.0 | 48 | 176.9 |
| 7 | 82.5 | 28 | 124.3 | 49 | 179.9 |
| 8 | 85.4 | 29 | 127.3 | 50 | 186.2 |
| 9 | 88.5 | 30 | 127.7 | 51 | 188.0 |
| 10 | 90.0 | 31 | 131.2 | 52 | 192.0 |
| 11 | 91.5 | 32 | 131.8 | 53 | 192.8 |
| 12 | 94.8 | 33 | 134.8 | 54 | 197.2 |
| 13 | 97.4 | 34 | 136.5 | 55 | 202.7 |
| 14 | 100.0 | 35 | 138.5 | 56 | 203.5 |
| 15 | 102.6 | 36 | 141.3 | 57 | 209.0 |
| 16 | 103.5 | 37 | 142.4 | 58 | 210.7 |
| 17 | 105.6 | 38 | 146.2 | 59 | 218.1 |
| 18 | 107.2 | 39 | 146.3 | 60 | 225.7 |
| 19 | 108.5 | 40 | 150.3 | 61 | 233.6 |
| 20 | 110.9 | 41 | 151.4 | 62 | 241.8 |
| 21 | 111.5 | 42 | 156.7 | 63 | 250.3 |

# SI—ARQ

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 96.0 or 200.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## SI—ARQ OPERATING MENU

| SI-ARQ | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 96.0 Baud | 192.0 Baud | 200.0 Baud | 96.0 Baud Var |
| Force LTRS-FIGS | | | |

SI-ARQ operates at speeds of 96 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.

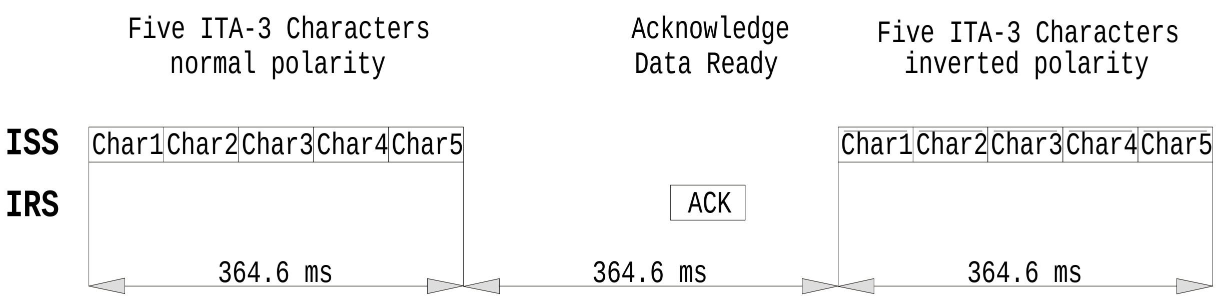
SI-ARQ uses the ITA-3 alphabet for data transmission and error detection. Data blocks usually consist of 5 or 6 characters.

One transmission cycle is made up of twice the length of a character block. Should 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) however 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

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 100.0 or 200.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# SI-FEC OPERATING MENU

| SI-FEC | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 96.0 Baud | 192.0 Baud | 96.0 Baud Var | Force LTRS-FIGS |
| | | | |

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 sound of SITOR-FEC. However, SI-FEC is used very seldom and stations mostly switch to this mode only under extremely bad transmission conditions.

The SI-FEC mode uses the ITA-3 alphabet for data protection. Each character is sent twice, but spread in time. The repeated character is transmitted with inverted polarity.

For a pair of characters which have been decoded and recognised as error-free one character is displayed. If both characters are received in error and underscore (_) character is played.

# SI-AUTO

Fully automatic tuning to signal center, shift, center frequency and transmission modes SI-ARQ (Mode A) and SI-FEC (Mode B) may be achieved by selecting ”SI-AUTO” mode.

# SITOR-ARQ

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## SITOR-ARQ OPERATING MENU

| SITOR-ARQ | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 100.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | ITA-2 |
| | | | |

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” menu field.

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

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## SITOR-FEC OPERATING MENU

| SITOR-FEC | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 100.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | ITA-2 |

The SITOR-FEC operating mode is used in broadcasting applications where a return channel is not required. Two sub modes are in use : General broadcasting to a number of stations or selective addressing of only a single station.

SITOR-FEC transmissions are used in maritime radio communication to distribute traffic lists, news and safety and weather information. Amateurs also use the FEC mode for calls to all (CQ calls).

The selective FEC mode is used when the receiving station must operate under radio silence conditions and hence can not transmit.

In most cases SITOR-FEC transmissions occur at a rate of 100 Baud using the standard shift of 170 Hz. The transmission is a continuous bit stream.

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 in white on the screen. If one of the two characters is in error, the correct one is displayed in red. The underscore (_) character is displayed if both characters are received in error.

# SITOR-AUTO

Fully automatic tuning to signal center, shift, center frequency and transmission modes SITOR-ARQ (Mode A) and SITOR-FEC (Mode B) may be achieved by selecting ”SITOR-AUTO” mode.

# SPREAD-11, SPREAD-21 and SPREAD-51

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FEC |
| Baudrate | 102.63 or 68.5 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# SPREAD-51 OPERATING MENU

| SPREAD-51 | | | |
|---|---|---|---|
| Analysis | Auto | Demodulator | Options |
| 62.3 Baud | 68.5 Baud | 102.63 Baud | 137.0 Baud |
| 96.0 Baud Var | ECC ison | Force LTRS-FIGS | |

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 with 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 from the same character will be in error is reduced considerably using such bit spreading.

The software synchronises with traffic or idle characters and the polarity is automatically detected. 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

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FAX-SSTV-HELL |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

# SSTV OPERATING MENU

| SSTV | | | |
|---|---|---|---|
| Analysis | Demodulator | Start/Restart | Martin1/3 |
| Auto Color | Sync Picture | Freerun is on | Run |
| | | | |

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 only used by radio amateurs.

The basic standard has a resolution of 120 x 120 pixels and requires 8 s for the transfer of an image, which increases up to 32 s for higher resolutions.

The system parameters of SSTV were never standardized and because of this a confusing number of modes have surfaced. In addition to the standard modes, manufacturers of SSTV equipment often include new modes so that an overview of the different modes is quite impossible.

Presently WAVECOM has restricted itself to the adjustment of the resolution. In the "Traffic Mode" menu the various line-pixel values may be selected. This allows displaying most SSTV transmissions, but requires a certain confidence with the transmissions. Future versions will enable the calling up of one system at a time, however a valid list is not yet available. A summary gives information on the more important SSTV modes.

# SSTV STANDARDS FOR SYNCHRONIZATION

| | |
|---|---|
| Synch Tone | 1200 Hz |
| Black Tone | 1500 Hz |
| White Tone | 2300 Hz |
| Picture Synch | 30 ms |
| Line Synch | 5 ms |

| Mode | | Typ | Time | Resolution Line x Pixel | Note |
|---|---|---|---|---|---|
| Robot | 8 | S/W | 8 s | 120 x 128 | |
| | 12 | S/W | 12 s | 120 x 320 | + 120 x 128 |
| | 24 | S/W | 24 s | 240 x 320 | + 240 x 256 |
| | 36 | S/W | 36 s | 240 x 320 | + 240 x 256 |
| | 12 | Color | 12 s | 120 x 128 | |
| | 24 | Color | 24 s | 256 x 256 | + 120 x 128 |
| | 36 | Color | 36 s | 256 x 256 | + 240 x 256 |
| | 72 | Color | 72 s | 256 x 256 | + 240 x 256 |
| Wraase | 24 | RGB | 24 s | 128 x 128 | |
| | 48 | RGB | 48 s | 256 x 128 | |
| | 48Q | RGB | 48 s | 128 x 128 | |
| | 96 | RGB | 96 s | 256 x 256 | |
| | 96Q | RGB | 96 s | 256 x 128 | |
| Martin | M1 | RGB | 114 s | 256 x 320 | + 256 x 256 |
| | M2 | RGB | 58 s | 256 x 320 | + 256 x 256 |
| | M3 | RGB | 57 s | 128 x 128 | |
| | M4 | RGB | 29 s | 128 x 128 | |
| Scottie | S1 | RGB | 110 s | 256 x 320 | + 128 x 128 |
| | S2 | RGB | 71 s | 256 x 320 | + 128 x 128 |
| ScanMate | 1 | RGB | 391 s | 512 x 310 | |
| | 2 | RGB | 261 s | 512 x 310 | |
| | DX | RGB | 269 s | 256 x 256 | |
| AVT | 24 | RGB | 24 s | 128 x 128 | + 120 x 128 |
| | 90 | RGB | 90 s | 240 x 320 | + 240 x 256 |
| | 94 | RGB | 94 s | 200 x 320 | + 200 x 320 |
| | 188 | RGB | 188 s | 320 x 400 | |

Various modes transmit a grey level scale in the first 8 or 16 lines. These lines are not available for image data transfer.

In the table above ”S/W” means black-white. Modes designated with ”COLOR” transmit colours as luminance and chrominance information whereas RGB modes transmit colours as red, green and blue values.

All AVT modes operate without line synchronization and at start of transmission a digital header of 5 s is sent.

# SWED-ARQ

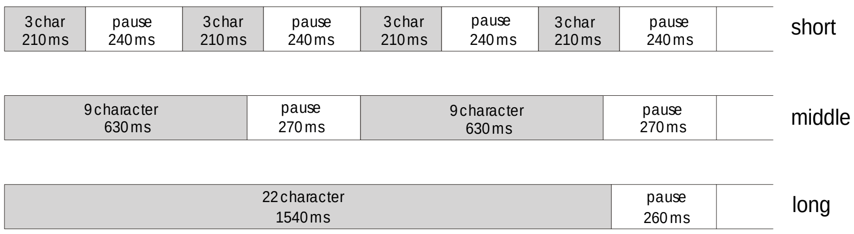
| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## SWED-ARQ OPERATING MENU

| SWED-ARQ | | | |
|---|---|---|---|
| Signal Analysis | Auto | Demodulator | Options |
| 100.0 Baud | 96.0 Baud Var | Force LTRS-FIGS | |

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 favourable propagation conditions prevail the system will switch over 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 screen status line as either short, middle or long.




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 synchronisation 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, synchronisation may be re-established.

When phasing the software automatically detects block length and polarity.

# TWINPLEX

| | |
|---|---|
| Frequency range | HF-MODES |
| System | SIMPLEX |
| Baudrate | 100.0 Baud |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## TWINPLEX OPERATING MENU

| TWINPLEX | | | |
|---|---|---|---|
| Signal Analysis | Demodulator | Options | 100.0 Baud |
| 96.0 Baud Var | Force LTRS-FIGS | Fixed Shift | Var. Shift |
| Y-BV1 Channel | Y-BV2 Channel | ITA-2 | |

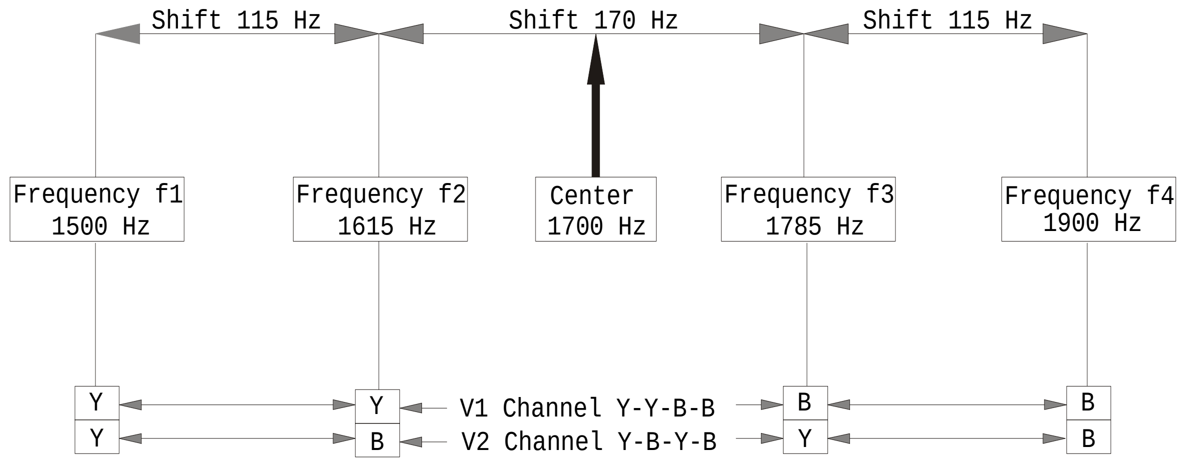
TWINPLEX F7B is a FSK modulation technique with four modulation frequencies. Two transmission channels V1 and V2 are obtained through a combination of the modulation frequencies.

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. Six standard combinations are available in the ”Fixed Shift” 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 and 65-170-65 Hz. In addition, any desired combination may be programmed using the ”Var. Shift” menu.

In addition to shift variations, Twinplex systems may utilise very different keying assign-

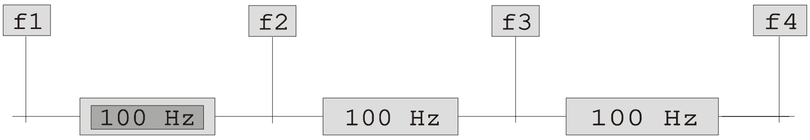
## TWINPLEX (F7B) PRINCIPLE OF OPERATION



ments. 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” menu field. In the ”Y-B V2 Channel” menu field 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.

# GRAPHIC DISPLAY IN THE "VAR. SHIFT" MENU FIELD




## MEASUREMENT AND DETERMINATION OF TWINPLEX FREQUENCY SHIFTS

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 ”Direct mode”. Software versions 2.6.00 and later will automatically switch to this mode. Alternatively the selection may be done manually via the ”Demodulator\Select Mode” menu field.

The proper assignment of the V1 and V2 channel keying combinations must be set up using the ”Y-B V1 Channel” and ”Y-B V2 Channel” menu fields.

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 synchronisation 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 can not be distinguished from each other.

# WEATHER-FAX

| | |
|---|---|
| Frequency range | HF-MODES |
| System | FAX-SSTV-HELL |
| Drum speed | 60, 90 or 120 RPM |
| Resolution | IOC 288 or IOC 576 |
| Modulation | SSB or DIRECT-FSK |
| Receiver setting | CW, LSB or USB |
| Signal sources | AF or IF |

## WEATHER FAX OPERATING MENU

| WEATHER-FAX | | | |
|---|---|---|---|
| Analysis | Auto | Manual | Demodulator |
| Options | Drum Speed | IOC Modul | Zoom |
| Phase | Nor. Polarity | Fine Speed | Left to Right |

A number of stations world-wide transmit weather charts on a regular schedule. During the transmission of an image a characteristic and easy 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). The receiver bandwidth should be set accordingly in the Demodulator menu.

By selecting the ”Auto” function, the software waits for the IOC identifier and synchronisation 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 the ”Manual” function the software starts immediately. The drum speed and the IOC may be manually selected in the fields ”Drum Speed” and ”IOC Modul”. The selected values are displayed in the system status line on the display. 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, with 90 rpm at one and a half times 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 shortwave.

The software allows the user to align image edges with display edges during reception. Click on ”Phase” and move the image, by moving the trackball either left or right until correct image alignment has been achieved.

The displayed image may be enlarged via the ”Zoom” menu field. Parts of the enlarged image may then be inspected by moving the track ball. It should be noted that zooming stops further capture of the image.

Images are received in 16 grey levels. Weather fax images are normally purely black/white. Grey level representation nevertheless results in a markedly improved image quality.

Using the ”Options\Colours” menu field, black-and-white weather images may be converted into pseudo-colour images. For each of the sixteen possible intensity values a combination of red, blue and green colour intensity can be assigned. A printout of such images is however not possible.

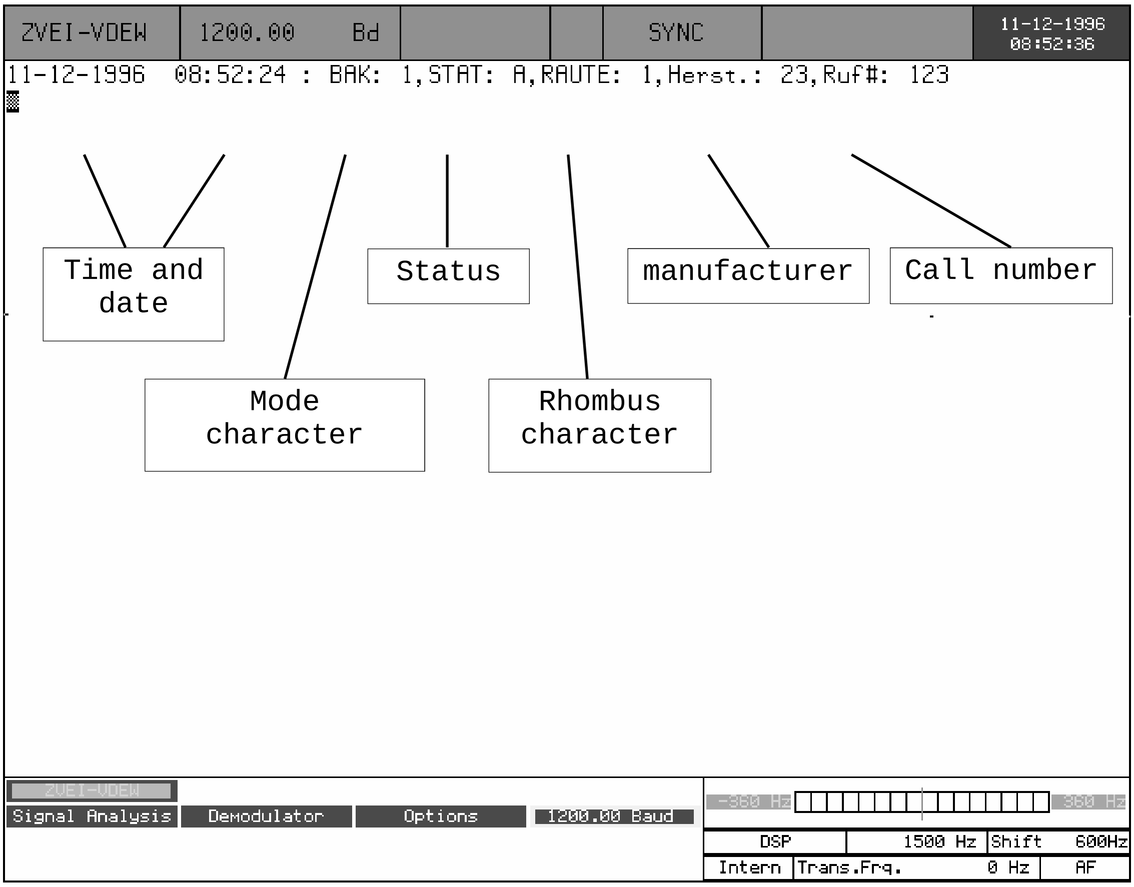
# ZVEI-VDEW DIGITAL

| | |
|---|---|
| Frequency range | VHF/UHF-MODES |
| System | SELECAL digital |
| Baudrate | 1200 Bit/s |
| Modulation | INDIRECT FM |
| Receiver setting | FM 12 KHz, narrow |
| Signal source | AF (only) |

# ZVEI-VDEW OPERATING MENU

| ZVEI-VDEW | | | |
|---|---|---|---|
| Analysis | Demodulator | Options | 1200.00 Baud |

# DIGITAL ZVEI-VDEW SELECTIVE CALL



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 Bit/s and the nominal FFSK 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 block synchronization sequence follows. Data is protected by using 8 bit redundancy.

**Mode labelling (BAK:)** Can assume 16 values for the various call types:

0 User defined
1 Call to mobile
2 Call to base station
3 Identification
4 Acknowledgement
5 Sequence telegrammed
6 Separation call
7 Reserve
8 Priority call
9 Status request
10 -
14 Reserve
15 Emergency call

**Status (STAT:)** 4 bits are available. Their use is not determined.

**Rhombic labelling (RHOMBUS:)** 4 bits used as supplementary manufacturer information. The use is not determined.

**Manufacturer identification (PROD:)** Two digits. The classification is determined by ZVEI.

**Call number (Call#:);** The call has three digits. The hundreds digit is transmitted first and the ones’ digit is transmitted last.

Group calls are transmitted as pseudo-tetrads of '1111' (16). For a group call for a group 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.

# TECHNICAL SPECIFICATIONS

# HARDWARE

## CASE

- Shielded 19” rack-mount
- Zinc plated steel sheet metal
- Height 3U, Width 53U, Depth 370 mm
- Weight 10.5 kg

## FRONT PANEL

- LED indicators for Traffic, Synch, Phasing, Error, Idle and RQ
- LED indicators for V1-B, V1-Y, V2-B and V2-Y data
- LED indicator for PRINT-ON and PRINT-OFF
- Keys: CURSOR UP, CURSOR DOWN, CURSOR LEFT and CURSOR RIGHT
- Keys: ENTER and ESCAPE
- Keys: RESET, PRINT ON-OFF, PRINT SCREEN and REMOTE ON-OFF
- LED tuning indicator: 16 element bar graph
- LED level indicator: 10 element bar graph
- Floppy disk drive 3 1/2”, 1.44 MB, PC-DOS compatible

## REAR PANEL

- Euro mains power plug with fuse holder
- 15 pin HD D-Sub connector for VGA monitor
- 9 pin D-Sub (F) connector for Trackman Mouse
- 9 pin D-Sub (M) connector for serial RS232 interface #1
- 9 pin D-Sub (M) connector for serial RS232 interface #2
- 25-pin D-Sub (F) connector for Centronics printer interface
- 9-pin D-Sub (M) connector for external demodulator
- 9-pin D-Sub (F) connector external digital receiver data
- 9-pin D-Sub (F) connector for 2.048 Mbps PCM interface
- BNC connector for AF input
- BNC connector for HF input
- BNC connector for 455 kHz IF input
- BNC connector for 10.7 Mhz IF input
- BNC connector for 21.4 Mhz IF input

## PROCESSOR UNIT

- TMS34010 Graphics System processor
- 32 bit CMOS processor with host interface
- 50 Mhz system clock with 166 ns execution time
- 8 MB system DRAM
- 0.5 MB video DRAM

- 16 kB SRAM with battery backup
- 256 kB BOOT EPROM
- Floppy controller WD37C65C, UART 16C452
- HDLC-USART VL85C30, RTC 72421

# VIDEO

- Text 80 characters x 26 lines
- VGA graphics 640 x 480 pixels
- 16 colours and/or grey levels
- VGA-PC compatible
- H-sync, V-sync or C-sync with selectable polarity

# DEMODULATOR

- **Signal processor I** DSP56002-66 Mhz
- Program memory I 192 KB SRAM 20 ns
- Data memory I 192 KB SRAM 20 ns

- **Signal processor II** DSP56002-66 Mhz
- Program memory II 192 KB SRAM 20 ns
- Data memory II 192 KB SRAM 20 ns

- 16 bit A/D converter ADC16071CIN

- Frequency synthesis using direct digital synthesis (DDS) HSP45102

- PCM-30 encoder PCM PLL-MV1442 2.048 Mbps encoder

- AF output 12 bit D/A converter DAC AD667

- Digital Receiver Input SSI DSP56001/2 Standard Format

# INTERFACES

**AF Input**

| | |
|---|---|
| Frequency range | 0.4 - 8 kHz |
| Bandwidth | +/- 3 kHz |
| Resolution | 1.0 Hz |
| Signal level | > 10 mV - 5 V |
| Input impedance | > 2.0 kOhm |

**HF Input**

| | |
|---|---|
| Frequency range | 8 kHz - 1.5 MHz |
| Bandwidth | +/- 15 kHz |
| Resolution | 1.0 Hz |
| Signal level | > 10 mV - 5 V |
| Input impedance | > 2.0 kOhm |

**IF Input I**

| | |
|---|---|
| Input frequency | 440.0 kHz - 470.0 kHz |
| Bandwidth | +/- 15 kHz |
| Resolution | 1.0 Hz |
| Signal level | > 10 mV - 5 V |
| Input impedance | 50 Ohm |

**IF Input II**

| | |
|---|---|
| Input frequency | 10.685 MHz - 10.715 MHz |
| Bandwidth | +/- 15 kHz |
| Resolution | 1.0 Hz |
| Signal level | > 10 mV - 5 V |
| Input impedance | 50 Ohm |

**IF Input III**

| | |
|---|---|
| Input frequency | 21.385 MHz - 21.415 MHz |
| Bandwidth | +/- 15 kHz |
| Resolution | 1.0 Hz |
| Signal level | > 10 mV - 5 V |
| Input impedance | 50 Ohm |

**PCM Input**

| | |
|---|---|
| Standard | CCITT G.703 |
| Clock frequency | 2048 kbps +/- 50 ppm |
| Code | HDB3 |
| Max. jitter | 0.25 UI (122 ns) |
| Input | Balanced |
| Impedance | 120 Ohm |
| Mark level | 3 V |
| Space level | 0 +/- 3V |
| Pulse width | 244 ns |

**Digital Receiver Input**

| | |
|---|---|
| Format | SSI-RACAL RA3790/1 |
| Input | Frame sync, clock, data |
| Digital clock | 1.536 Mhz |
| Frame sync | 64 kHz (4 x 16 kHz subframes) |
| Synchronization | Falling edge |

**External Demodulator**

| | |
|---|---|
| Input level | TTL or RS232 |
| Max. frequency shift | <= +/- 15 V |
| Input | V1-data, V2-data |
| Synchronization | Internal |

**External Data and Clock/Strobe**

| | |
|---|---|
| Input level | TTL or CMOS |
| Max. frequency shift | <= +/- 5 V |
| Input | Data, strobe |
| Synchronization | External, negative or positive |

**AF Output**

| | |
|---|---|
| Frequency range | 400 - 4000 Hz |
| Converter resolution | 12 bit |
| Output voltage | Max. 2 Vpp |
| Output impedance | < 100 Ohm |

# TECHNICAL DATA DSP-DEMODULATOR

**DSP FSK F1B Demodulator**

| | |
|---|---|
| Center frequency | 0.6 KHz - 16.0 KHZ |
| Frequency shift | 10 - 3500 Hz |
| Data rate | 10 - 3000 Baud |

**DSP MARK-SPACE Demodulator**

| | |
|---|---|
| Center frequency | 0.6 KHz - 16.0 KHZ |
| Frequency shift | 10 - 3500 Hz |
| Data rate | 10 - 300 Baud |

**DSP 4FSK F7B Demodulator**

| | |
|---|---|
| Center frequency | 0.6 KHz - 16.0 KHZ |
| Frequency shift | 50 - 3500 Hz |
| Data rate | 10 - 1200 Baud |

**DSP MFSK Demodulator**

| | |
|---|---|
| Center frequency | 0.6 KHz - 16.0 KHZ |
| Data rate | 4 ms - 1000 ms |
| Frequency shift | 10 Hz - 3500 Hz |
| Amount of tones | up to 64 simultaneous |

**DSP FFSK Demodulator**

| | |
|---|---|
| Center frequency | 0.8 KHz - 16.0 KHz |
| Frequency shift | 10 - 16000 Hz |
| Data rate | 10 - 9600 Baud |

**DSP GFSK Demodulator**

| | |
|---|---|
| Center frequency | 0.8 KHz - 16.0 KHz |
| Frequency shift | 50 - 16000 Hz |
| Data rate | 10 - 9600 Baud |

**DSP CW Demodulator**

| | |
|---|---|
| Center frequency | 0.6 KHz - 16.0 KHz |
| Bandwidth | 50 Hz - 1200 Hz |
| Keying speed | 5 WPM - 500 WPM |

**DSP AM-FAX Demodulator**

| | |
|---|---|
| Standard AM-carrier frequency | 2400 Hz |
| Transmission bandwidth | 1800 Hz |

**BPSK Demodulator**

| | |
|---|---|
| AF input frequency range | 0.4 kHz – 16.0 kHz |
| HF input frequency range | 16.0 kHz – 1.5 MHz |
| IF input frequency range | 10.685 MHz – 10.715 MHz |
| Center frequency | 0.4 kHz – 3.5 kHz |
| Symbol rate | 25.0 – 2400 Bits/s |

**QPSK Demodulator**

| | |
|---|---|
| AF input frequency range | 0.4 kHz – 16.0 kHz |
| HF input frequency range | 16.0 kHz – 1.5 MHz |
| IF input frequency range | 10.685 MHz – 10.715 MHz |
| Center frequency | 0.4 kHz – 3.5 kHz |
| Symbol rate | 25.0 – 2400 Bits/s |

**DPSK Demodulator**

| | |
|---|---|
| AF input frequency range | 0.4 kHz – 16.0 kHz |
| HF input frequency range | 16.0 kHz – 1.5 MHz |
| IF input frequency range | 10.685 MHz – 10.715 MHz |
| Center frequency | 0.4 kHz – 3.5 kHz |
| Symbol rate | 25.0 – 2400 Bits/s |

**PCM Input**

| | |
|---|---|
| Standarisation | CCITT G.704 |
| Bitrate | 2.048 MBit/s |
| Amount Bits per Time Slot | 8, numbered from 1 to 8 |
| Sampling rate | 8000 Hz |
| Amount Time Slots per Frame | CEPT, 32 Slots |
| Control frames | 0 and 16 |
| Time Slot 0 | Frame alignment (FAS) |
| Time Slot 16 | Multiframe aligment (MAS) |
| Amount Frames per Multiframe | 16, numbered from 0 to 15 |

**PCM Modulation**

| | |
|---|---|
| Standardisation | CCITT G.711 |
| Modulation type | Pulse Code Modulation (PCM) |
| Sampling rate | 8000 Hz +/- 50 ppm |
| Amount Bits per Time Slot | 8 |
| Encoding procedure | A-law or U-law |
| Transmission mode | Bit 1 (MSB) first |

**Audio Output**

| | |
|---|---|
| Frequency range | 50 - 3000 Hz |
| D/A Converter | 12-Bit |
| Output voltage | max. 2 Vpp |

**Digital Receiver Input**

| | |
|---|---|
| RACAL data format: | Mode 1<br>23-bit filtered IF I-component<br>Mode 2<br>23-bit filtered IF Q-component<br>Mode 3<br>8 bit signal strength and<br>15 bit audio<br>Mode 4<br>8 bit signal strength and<br>15 bit audio |

# Software HF modes

- automatic demodulator adjustment for FSK signals
- automatic mode analysis
- automatic decoding of the detected mode
- automatic detection of transmission modes
- automatic detection of shift and center frequency
- automatic detection of baud rate
- automatic detection of signal polarity
- automatic detection of repetition cycle
- automatic phasing
- integrated error correction for all FEC modes
- integrated error correction for all modes using block coding
- continuous measurement of baud rate and keying speed
- automatic detection of drum speed in FAX modes
- automatic detection of IOC in FAX modes
- ZOOM and PHASE function in FAX modes
- split-screen display of sub-channels in TDM modes
- automatic detection of all PACTOR systems (I-V)
- automatic phasing to all block lengths in SWED-ARQ and SI-ARQ modes
- automatic phasing on all baud rates in PACTOR and G-TOR
- PRINT SCREEN function without loss of incoming data
- real-time multitasking kernel for concurrent control and decoding

| | |
|---|---|
| ACARS | VHF air-ground communications system<br>2400 Bit/s NRZI<br>BCD, ASCII ITA-5 |
| ALIS | Simplex ARQ System<br>228.66 Baud<br>ITA-2 Alphabet |
| ALIS-2 | HF simplex ARQ system<br>240.82 Baud<br>8FSK 720 Bit/s symbol rate<br>ITA-5 |
| ARQ-E | Single channel Duplex System<br>48 - 288 Baud<br>ITA-2 with parity |
| ARQ-E3 | Single channel Duplex System<br>48 - 288 Baud<br>ITA-3 Alphabet |
| ARQ-N | Single channel Duplex System<br>96, 192 Baud<br>ITA-2 with parity |
| ARQ-M2-242 | TDM Duplex REC242<br>96 and 87 Baud<br>Alphabet ITA-3 |

| | |
|---|---|
| ARQ-M2-342 | TDM Duplex REC342-2<br>96, 200 and 87 Baud<br>Alphabet ITA-3 |
| ARQ-M4-242 | TDM Duplex REC242<br>192 and 172 Baud<br>Alphabet ITA-3 |
| ARQ-M4-342 | TDM Duplex REC342-2<br>192 and 172 Baud<br>Alphabet ITA-3 |
| ARQ-N | HF single channel duplex ARQ system<br>96, 192 Baud<br>ITA-2 with parity |
| ARQ6-90 | Simplex ARQ System<br>200 Baud<br>Alphabet Sitor |
| ARQ6-98 | Simplex ARQ System<br>200 Baud<br>Alphabet Sitor |
| ASCII | Asynchronousousous System<br>50 - 1200 Baud<br>Alphabet ITA-5<br>Bulgarian-Alphabet |
| ATIS | River Rhine identification system<br>1200 Baud<br>BCD |
| AUTOSPEC | FEC System<br>68.5 - 137 Baud<br>Bauer Alphabet |
| BAUDOT | Asynchronousousous System<br>45 - 600 Baud<br>ITA-2 Alphabet |
| BULG-ASCII | HF asynchronous duplex ARQ system<br>110 – 1200 Baud<br>ITA-5, Bulgarian ASCII |
| CIS-11 | DUPLEX System<br>100.01 Baud<br>M2 Alphabet |
| CIS-14 | DUPLEX System<br>96 - 192 Baud<br>M2 Alphabet |
| CIS-36 | MFSK-System<br>40 and 10 ms<br>M2 Alphabet |
| CODAN | HF digital selective call system<br>100 Baud<br>ASCII, BCD |

| | |
|---|---|
| COQUELET-8 | MFSK System synchronous<br>37.5 and 75 ms<br>Alphabet No. 403 |
| COQUELET-13 | MFSK System asynchronous<br>75 ms<br>Alphabet No. 401 & 402 |
| COQUELET-80 | Synchronous MFSK system<br>37.5, 50, 75 ms<br>ITA-2, Bagdad-80<br>FEC option |
| CW-MORSE | Morse Telegraphy<br>20 - 400 BPM<br>Morse and Morse-Cyrillic |
| DGPS | Differential DGPS information system<br>100, 200 Baud<br>ITA-5, Binary with block coding |
| DUP-ARQ | Semi-Duplex ARQ System<br>125 Baud<br>ITA-2 with Block-Coding |
| DUP-ARQ-2 | Semi-Duplex ARQ System<br>250 Baud<br>ITA-5 with Block-Coding |
| DUP-FEC-2 | Duplex System<br>125 and 250 Baud<br>ITA-5 with Block-Coding |
| ERMES | Pager system<br>3125 Bit/s 4PAM<br>ASCII ITA-5, Binary |
| FEC-A | FEC System<br>96 - 288 Baud<br>ARQ1A convulgent |
| FELDHELL | HF synchronous image telegraph system<br>122.5 Baud<br>Character pixel images (7x7) |
| FMS-BOS | VHF digital selective call system<br>1200 Baud<br>ASCII ITA-5, Binary |
| GMDSS/DSC | HF/VHF digital selective call system<br>100 Baud (HF), 1200 Baud (VHF)<br>ASCII ITA-5, Binary |
| GOLAY | VHF/UHF pager system<br>adaptive 300, 600 Bit/s<br>ASCII ITA-5, Binary |

| | |
|---|---|
| G-TOR | Simplex ARQ System<br>adaptiv 100, 200, 300 Baud<br>ITA-5 with Block-Coding |
| HC-ARQ | Simplex ARQ System<br>240 Baud<br>ITA-2 with Block-Coding |
| HNG-FEC | FEC System<br>100.05 Baud<br>ITA-2 with 10 Bit Redundancy |
| ICAO-SELCAL | HF aircraft analog selective calling system<br>Tone duration 1000 ms<br>Standard Annex 10 tones |
| INFOCALL | VHF/UHF pager system<br>1200 Bit/s<br>ASCII |
| METEOSAT | Satellite weatherfax<br>240 RPM<br>IOC 288 |
| MPT1327 | Trunked radio dystem<br>1200 Bit/s<br>ASCII ITA-5, Binary |
| NOAA-GEOSAT | Satellite weatherfax<br>120 RPM<br>IOC 576 |
| PACKET-300 | Amateur AX.25 System<br>300, 600 Baud<br>ITA-5 with Block-Coding |
| PACKET-1200 | Amateur AX.25 system<br>1200 Baud<br>ITA-5 with block coding |
| PACKET-9600 | Amateur AX.25 System<br>9600 Baud<br>ITA-5 with block coding |
| PACTOR 1-5 | Simplex ARQ System<br>adaptiv 100, 200 Baud<br>ITA-2 with Block-Coding |
| PCM-30 | Satellite-Modes<br>2.048 Mbit/s |
| PICCOLO-MK6 | MFSK System synchronous<br>25 and 50 ms<br>Alphabet ITA-2 |
| PICCOLO-MK12 | MFSK System synchronous<br>25 and 50 ms<br>Alphabet ITA-5 |

| | |
|---|---|
| POCSAG | VHF/UHF pager system<br>512, 1200, 2400 Bit/s FFSK<br>ASCII ITA-5, Binary |
| POL-ARQ | Single channel Duplex System<br>100 and 200 Baud<br>Alphabet SITOR |
| PRESS-FAX | Press FAX System<br>60 - 240 RPM<br>IOC 352 and 576 |
| PSK-31 | FEC System<br>31.25 Baud<br>DBPSK and DQPSK |
| RUM-FEC | FEC System<br>164.5 and 218.3 Baud<br>16 Bit Alphabet |
| SELCAL | Annex-10 Selcal<br>Tone duration 1000 ms<br>Standard tones |
| SI-ARQ | Simplex ARQ-System<br>96 and 200 Baud<br>Alphabet ITA-3 |
| SI-AUTO | AUTO SI-ARQ and SI-FEC<br>96 and 200 Baud<br>Alphabet ITA-3 |
| SI-FEC | FEC System<br>Alphabet ITA-3 |
| SITOR-ARQ | Mode A ARQ<br>100 Baud<br>Alphabet Sitor |
| SITOR-AUTO | AUTO Mode A and B<br>100 Baud<br>Alphabet Sitor |
| SITOR-FEC | Mode B FEC<br>100 Baud<br>Alphabet Sitor |
| SPREAD-11 | FEC System<br>68.5 - 137 Baud<br>10 Bit Bauer Code |
| SPREAD-21 | FEC System<br>68.5 - 137 Baud<br>10 Bit Bauer Code |
| SPREAD-51 | FEC System<br>68.5 - 137 Baud<br>10 Bit Bauer Code |

| | |
|---|---|
| SSTV | Amateur Television<br>8, 16 32 Secands |
| SWED-ARQ | Simplex ARQ System<br>100 Baud<br>Sitor-Alphabet |
| TWINPLEX ARQ | Simplex ARQ System<br>100 Baud<br>Sitor-Alphabet |
| WEATHER-FAX | Wetter-Fax Systems<br>60 - 240 RPM<br>IOC288 and 576 |
| ZVEI-1 | Analog selective call system 5 tones<br>Tone duration 70 ms |
| ZVEI-2 | Analog selective call system 5 tones<br>Tone duration 70 ms |

# HF SIGNAL AND DATA ANALYSIS

**FFT Baudrate (Signal Analysis)**
- automatic determination of baud rate
- measurement range 20 to 1,000 Baud
- accuracy of first measurement Simplex better than 0,2%
- accuracy of first measurement Duplex/FEC better than 0,1%
- graphic display of baud rate spectrum

**FFT Shift Measurement (Signal Analysis)**
- automatic determination of signal shift up to 3,500 Hz
- graphic display of captured signal spectrum
- shift measurement possible with movable cursors
- continuous display of cursor difference in Hz
- repeated measurement with averaging function

**Code Analysis**
- automatic display and adjustment of shift and center frequency
- automatic mode detection of most data and teletype systems
- simultaneous display of text in LTRS-FIGS mode of the detected system
- separate test of synchronous Baudot systems
- automatic change over to the detected mode

**Real-Time FFT Spectrum Display (Signal Analysis)**
- graphical display of more than 20 colour frames per second
- real-time FFT of 4048 pixels and a dynamical range > 60 dB
- four adjustable bandwidths from 500 Hz to 24,000 Hz
- averaging measurement with 64 measurements freely pre-selectable
- free movable cursors for difference measurements
- graphical peak-hold function
- four pre-selectable window types

**Real-Time Waterfall (Signal Analysis)**
- graphical display of more than 20 colour frames per second
- real FFT of 4048 pixels and a dynamical range > 60 dB
- four adjustable bandwidths form 500 Hz to 24,000 Hz
- graphical display with 40 measurements
- free movable cursors for difference measurements
- four pre-selectable window types

**Real-Time Sonogram (Signal Analysis)**
- graphical display of more than 20 colour frames per second
- real FFT of 4048 pixels and a dynamical range > 60 dB
- four adjustable bandwidths form 500 Hz to 24,000 Hz
- graphical display with 40 measurements
- free movable cursors for difference measurements
- four pre-selectable window types

**Real-Time MFSK Analysis**
- graphical display of the received frequency values
- acquisition time 1 ms to 15 ms per measured value
- four adjustable frequency ranges from 300 Hz to 3000 Hz
- storage of up to 2,750 measurements
- free movable cursor for frequency and difference measurements
- continuous indication of cursor X-Y positions

**IAS-Baudrate (Variable Baudrate)**
- continuous baudrate measurement
- continuous baudrate indication update
- very high resolution up to 0.001 Baud depending on signal quality and measurement interval

**Autocorrelation (Autocorrelation)**
- rapid determination of periodicity up to 200,000 bits
- full screen X-Y cursor positioning with trackball
- X-Y zoom to full screen size
- continuous numeric display of cursor position

**Alphabet and Bit Analysis F1B and F7B (Bit Analysis)**
- graphical display with 5 - 2048 bits per line
- continuously adjustable display line length
- full-screen trackball x-y cursor positioning
- user adjustable cursor step interval
- user alphabet selection
- logical symbol display of extracted bit patterns
- simultaneous display of LTRS-FIGS levels for normal or inverted signal polarity
- simultaneous display of FIGS-LTRS levels for normal or reversed bit patterns
- continuous calculation and display of the number of bit combinations
- user adjustable bit interleave length with graphical marking of bit positions

**Bit Length Analysis (Bit Length)**
- real-time sampling of the V1 data with 10 us resolution
- automatic calculation and graphic display of bit length distribution
- graphic display of bit patterns with programmable resolution
- graphically adjustable display of bit patterns with points of measurements
- continuous calculation and display of bit pattern positions
- two movable cursors with continuous display of difference measurement
- freely movable cursor with conversion to resultant baud rate

**Bit Length Analysis (Raw V1-Data)**
- graphical display of the V1-shift keying wiht full screen display
- free adjusting of the time between 0.02 s to 0.65 s per graphic line
- colour display of signal polarity inversion changing
- free movable measurement indicator (full-screen)
- instant output of the time of a polarity inversion in ms and reversed baudrate

# Software VHF/UHF modes

- Signal analysis for VHF/UHF procedures using DIRECT modulation
- Baudrate measurement up to 12'000 Baud
- Shift measurement up to 22'000 Hz
- Full screen display for INFOCALL
- Call number and transmission mode display for PAGER systems
- Time stamp function in all modes
- Integrated error correction for all modes using block coding
- PRINT SCREEN function without interruption of the data acquisition
- Real-time multitasking kernel for simultaneous decoding and data processing

| | |
|---|---|
| ACARS | Aircraft Communications<br>2400 Bit/s NRZI<br>BCD & ITA-5 |
| ATIS | Rhine Identification system<br>1200 Baud<br>BCD-Code |
| CCIR | analog selective call, 5 tones, 100 ms |
| CCITT | analog selective call, 5 tones, 100 ms |
| EEA | analog selective call, 5 tones, 40 ms |
| EIA | analog selective call, 5 tones, 33 ms |
| ERMES | Pager-System<br>3125 Bit/s symbol rate<br>6250 Bit/s data rate<br>Tone call, HEX and ASCII<br>Status line with system information |
| EURO | analog selective call, 6 tones, 100 ms |
| FMS-BOS | Selective call procedure<br>1200 Baud<br>BCD-Code |
| GOLAY | Pager-System<br>adaptive 300/600 Bit/s<br>ITA-5 with block coding |
| INFOCALL | Pager for stock exchange and press<br>1200 Bit/s<br>ITA-5 with block coding |
| MPT1327/1343 | Trunked Radio System<br>1200 Bit/s<br>Binary Hex station display and ITA-5 |
| NATEL | analog selective call, 5 tones, 70 ms |

| | |
|---|---|
| PACKET-1200 | Amateur AX.25 System<br>Indirect FSK<br>1200, 600 Baud<br>ITA-5 with block coding |
| PACKET-9600 | Amateur AX.25 System<br>Direct FSK, scrambled<br>9600, 4800, 2400 Baud<br>ITA-5 with block coding |
| POCSAG | Pager-System<br>512, 1200, 2400 Bit/s<br>ITA-5 with block coding |
| VDEW | analog selective call, 5 tones, 70 ms |
| ZVEI-VDEW | digital selective call<br>1200 Bit/s<br>BCD-Code |
| ZVEI-1 | analog selective call, 5 tones, 70 ms |
| ZVEI-2 | analog selective call, 5 tones, 70 ms |

**SATELLITE-SYSTEMS**

| | |
|---|---|
| PCM-30 | CCITT G.703<br>2048 KBit/s<br>Format HDB3 |
| METEOSAT | Satellite weatherfax AM<br>240 RPM<br>IOC 288 |
| NOAA-GEOSAT | Satellite weatherfax AM<br>120 RPM<br>IOC 576 |

# VHF/UHF SIGNAL AND DATA ANALYSIS

**Code Analysis DIRECT**
- automatic baudrate determination
- automatic shift determination
- automatic noise gate for burst transmissions
- automatic mode detection data systems
- automatic change over to the detected mode

**Code Analysis INDIRECT**
- automatic baudrate determination
- automatic shift determination
- automatic noise gate for burst transmissions
- automatic mode detection data systems
- automatic change over to the detected mode

**FFT Baudrate DIRECT**
- automatic baudrate determination
- measurement range 50 - 12,000 Baud
- accuracy of first measurement typically better than 1%
- graphic display of baudrate spectrum

**FFT Baudrate INDIRECT**
- automatic baudrate determination
- measurement range 50 - 12,000 Baud
- accuracy of first measurement typically better than 1%
- graphic display of baudrate spectrum

**FFT Shift Measurement DIRECT**
- automatic determination of signal shift up to 22,000 Hz
- graphic display of captured frequency spectrum
- shift determination with movable cursors
- continuous display of cursor difference in Hz
- continuous measurements with averaging
- accuracy up to 1200 bit/s typically 5%
- precise bitrate independent determination of center frequency

**FFT Shift Measurement INDIRECT**
- automatic determination of signal shift up to 3,500 Hz
- graphic display of captured frequency spectrum
- shift determination with movable cursors
- continuous display of cursor difference in Hz
- continuous measurements with averaging
- accuracy up to 1200 bit/s typically 5%
- precise bitrate independent determination of center frequency

**Real-Time-FFT spectrum display**
- graphical display with more than 20 color pictures per second
- genuine FFT with 4048 pixels and >60 dB dynamic
- four adjustable bandwidths between 500 Hz to 24,000 Hz
- Averaging measurement with up to 64 measurements freely pre-selectable
- movable cursors for difference measurements
- graphical Peak-Hold function
- four pre-selectable window filters

**Real-Time-Waterfall**
- graphical display with more than 20 pictures per second
- genuine FFT with 4048 pixels and >60 db dynamic
- four adjustable bandwidths between 500 Hz to 24,000 Hz
- graphical display with 40 measurements
- movable cursors for difference measurements
- four pre-selectable window filters

**Real-Time-Sonograms**
- graphical display with more than 20 pictures per second
- genuine FFT with 4048 pixels and >60 db dynamic
- four adjustable bandwidths between 500 Hz to 24,000 Hz
- graphical display with 40 measurements
- movable cursors for difference measurements
- four pre-selectable window filters

**Real-Time-SELCAL-Analysis**
- graphical display of the captured frequency values
- Acquisition time 1 ms to 15 ms per measured value
- four adjustable frequency ranges between 300 Hz 3000 Hz
- Analysis storage for up to 2750 measurements directly movable
- movable cursor for frequency- and difference measurement
- continuous indication of all X-Y cursor values

**Autocorrelation (Autocorrelation)**
- rapid determination of periodicity up to 200,000 bits
- Accuracy up to 2400 Bit/s
- full screen X-Y cursor positioning with trackball
- X-Y zoom to full screen size
- continuous numeric display of cursor position

**Bit Length Analysis (Bit Length)**
- real-time sampling of the V1 data with 10 us resolution
- automatic calculation and graphic display of bit length distribution
- graphic display of bit patterns with programmable resolution
- graphically adjustable display of bit patterns with points of measurements
- continuous calculation and display of bit pattern positions
- two movable cursors with continuous display of difference measurement
- freely movable cursor with conversion to resultant baud rate

**Bit Length Analysis (Raw V1-Data)**
- graphical display of the V1-shift keying with full screen display
- free adjusting of the time between 0.02 s to 0.65 s per graphic line
- colour display of signal polarity inversion changing
- free movable measurement indicator (full-screen)
- instant output of the time of a polarity inversion in ms and reversed baudrate

# ALPHABETS

| | |
|---|---|
| ITA-1 | 5 Bit Alphabet |
| ITA-2 | 5 Bit Baudot Alphabet |
| ITA-3 | 7 Bit Alphabet |
| ITA-5 | 7 Bit ASCII Alphabet |
| SITOR | 7 Bit Alphabet |
| ARQ1A | 7 Bit Alphabet |
| RUM-FEC Alphabet I | 16 Bit Alphabet |
| RUM-FEC Alphabet II | 16 Bit Alphabet |
| HNG-FEC Alphabet | 15 Bit Alphabet |
| Bauer Alphabet | 10 Bit Alphabet |
| Bagdad70 Arabic | 5 Bit Alphabet |
| Bagdad80 Arabic | 5 Bit Alphabet |
| TASS Cyrillic | 5 Bit Alphabet |
| ITA-2 Cyrillic M2 | 5 Bit Alphabet |
| Third Shift Cyrillic M2 | 5 Bit Alphabet |
| Third Shift Greek | 5 Bit Alphabet |
| Transparent | 5 Bit Alphabet |
| Morse Standard | Standard Latin Morse with special characters |
| Morse Cyrillic | Standard Cyrillic Morse |

# PRINTER DRIVER

EPSON 9 pins and compatible matrix printers
EPSON 24 pins and compatible matrix printers
HP Paintjet
HP Thinkjet
HP Deskjet 500
HP Deskjet 510
HP Deskjet 500 C
HP Deskjet 550 C
HP Deskjet 560 C
HP Deskjet 600
HP Deskjet 660 C
HP Deskjet 850 C
HP Laserjet II+ and compatible laser printers
HP Laserjet III+ and compatible laser printers

The **colour printers**
Paintjet, Deskjet 500C, Deskjet 550C, Deskjet 560C, Deskjet 660C and Deskjet 850C support the "Print-Screen" function.

# TELEPRINTER ALPHABETS

| NO. | ITA-1 Alphabet | 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 | Carriage 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 | Unperforated tape | |
| 30 | 1 1 0 1 1 | Y | 3 |
| 31 | 0 0 1 0 0 | L | = |
| 32 | 0 0 0 0 0 | P | % |

| 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 | Unperforated tape | |

| NO. | ITA-3 Alphabet | 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 | Unperforated 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 | |

# TELEPRINTER ALPHABETS

| NO. | ITA-4 Alphabet | 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 | Unperforated 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 | |

| 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 | Hex05 |
| 5 | 1 0 0 0 0 | E | 3 |
| 6 | 1 0 1 1 0 | F | Hex5D |
| 7 | 0 1 0 1 1 | G | Hex5B |
| 8 | 0 0 1 0 1 | H | Hex5C |
| 9 | 0 1 1 0 0 | I | 8 |
| 10 | 1 1 0 1 0 | J | Hex07 |
| 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 | Hex25 (%) | |
| 30 | 1 1 0 1 1 | Hex24 ($) | |
| 31 | 0 0 1 0 0 | Space | |
| 32 | 0 0 0 0 0 | Hex08 | |

| NO. | SITOR Alphabet | 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 | Unperforated 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 | |

# TROUBLESHOOTING

| PROBLEM | POSSIBLE CAUSE(S) AND REMEDY |
|---|---|
| Decoder does not operate. | Check power connection from mains supply and fuse.<br><br>Remove the unit’s power supply and check the second fuse in the power supply. |
| Software does not operate error-free. | Program on disk has been damaged (hardware write protection was removed).<br><br>Replace program disk.<br><br>Software 1.1.15 and higher needs 8 MB Memory |
| Software reports the loss of calibration data | On loading a new software version the calibration data may be lost for technical reasons |
| Software repeatedly reports the loss of calibration data. | Backup battery must be replaced. |
| No decoding is possible. | Check the AF or HF connections.<br><br>Check the setting of the "translation" frequency<br><br>Check the selection of signal input source<br><br>Check the state of the decoder’s “V1/V2 is intern/extern” setting.<br><br>Check the setting of "gain" |
| No data output from the serial or parallel interfaces. | Activate the Print-On function (PRINT Led must be on).<br><br>Check if receiving peripheral is ready (On-line).<br><br>Check the serial DTR handshake signal.<br>(The active/ready state corresponds to a positive voltage between 3-12 V). |

| PROBLEM | POSSIBLE CAUSE(S) AND REMEDY |
|---|---|
| Faulty character displays on peripheral equipment. | Check for matching baud rate and data formats on both sides (Serial interfaces).<br><br>Check the interface cables.<br><br>Check the DTR signal. |
| Loss of characters on serial or parallel interfaces. | Check printer performance with slower data rates.<br>Centronics cable is too long (2 meters max.). |
| No full scale display on LEVEL indicator. | Check maximum deviation for different signal types.<br><br>Check the setting "gain"<br><br>Use AF signal from speaker output as a test (AF signal level possibly too low).<br><br>Use different AF cable as a test. |
| Video Display is not correct. | Try another AF cable<br><br>Check the settings of the DIP switches 1, 3, 4 & 5 on the rear of the unit.<br><br>Try a different video monitor. |
| Printer output is incorrect. | Check the printer setting in the "Setup Functions \ Printer \ Printer Type" menu.<br><br>Try a different printer cable. |
| No baud rate display in the "Signal Analysis" function. | Check the state of the decoder's "V1/V2 is intern/extern" setting. |
| Trackball keys are switched | Set trackball type in "\SETUP\GLOBAL CONFIG" (Logitech or A4Tech) |
| Trackball A4Tech does not work properly | Switch slider on the right side of the trackball to setting "3" |

# FUSE REPLACEMENT

Before replacing the fuse, disconnect the AC mains cable from the unit's power supply. The fuse is located above the mains connector in a fuse holder which may be removed by pressing down the clip just above the ON-OFF switch. A 1 A slow-blow replacement fuse (for 115 Volts 2 A slow-bow) is required. Due to the power-on current surge through the EMI filter, fuses with lower ratings may not suffice.

# SIGNAL INTERFERENCES

All microprocessors emit a strong broadband noise signal through their control and data lines. To minimize this radiation, all WAVECOM decoders are fitted with HF chokes on their outputs. In addition a sturdy metal case is used to attenuate noise emissions.

**Antenna installation**
The antenna is the main factor influencing the presence of interfering signals. A well-designed long-wire antenna, installed well clear of any obstructions and which is correctly matched to the receiver input, seldom shows up interference problems. In setups where an active antenna is deployed in very close proximity to the decoder or monitor, interference is bound to be present, especially at frequencies between 3-10 MHz. Active antennas are generally more susceptible to noise interference. Certain types with tuneable pre-selectors do however exhibit better noise rejection characteristics.

**Receiver**
Receivers are often not sufficiently shielded or decoupled, resulting in interference signals entering the receiver directly. 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 cabling inside the building should be done using shielded HF cables.

**Grounding**
The best grounding for the system, is the cold water mains in a building. Hot water or heating are not necessarily grounded. Good effective grounding of the receiving equipment is always desirable - also for your personal safety.

**Location of decoder**
Despite metallic shielding of the receiver, the decoder may still radiate into the receiver, if placed in close proximity. This problem may be rectified by moving the decoder to a different location.

**Video Monitor**
If at all possible, use a monitor which conforms to the latest MPR-II or TCO-II radiation standards. The improvement in noise reduction offered by such equipment is significant and interference originating from these monitors can be expected to be negligible.

# CONDITIONS OF SALE

## WARRANTY

Despite careful testing of this product, component or functional failures may occur. WAVECOM ELEKTRONIK AG grants you a warranty for a period of 12 months from date of sale. 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 will be paid by the customer. In case of repair within the warranty period, WAVECOM will carry the costs of return shipping to the customer.

## OBLIGATION

The products of WAVECOM are sold on the basis of technical specifications valid at the time of sale. WAVECOM has no obligations to upgrade or modify equipment already sold.

## COPYRIGHT

The software of the W 4100DSP decoder is the intellectual property of WAVECOM and protected by international copyright law. Any duplication of program(s) is prohibited without the express and prior consent of WAVECOM ELEKTRONIK AG and punishable. In addition any warranty claims will become void.

## LIABILITY

Information contained in this manual may be changed at any time without prior notice. Despite careful preparation, this manual may contain errors or omissions and WAVECOM is not liable for any resulting losses or damages.

## LAWS AND REGULATIONS

Before using this equipment, take note of the laws and regulations of the telecommunications authorities in your country. It is the responsibility of the users of such 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 copyright laws or telecommunication regulations.

# Terms of delivery and prices

- **Prices may be taken from the attached price list**
- **Time of delivery on request**

Specifications may change without prior notice.

Buelach, 9th February, 2000

# LITERATURE

Klingenfuss Publications
COMPACT DISC RECORDINGS OF MODULATION TYPES

Klingenfuss Publications
GUIDE TO UTILITY STATIONS
ISBN 3-924509-13-1, Klingenfuss Verlag, Tübingen

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TELEGRAPH AND DATA TRANSMISSION OVER SHORTWAVE LINKS
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ISBN 3-8023-0086-6 , Vogel -Buchverlag, Würzburg

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