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Code300-A

Professional DSP Data Analyzer and Decoder

Software for DOS, Windows 95 and Windows 98 - last release available v 2.5

CODE300-A are available now and will replace the DOS-only versions. The new decoders do work in a DOS box of WINDOWS® 95 and WINDOWS® 98 in multitasking environment. WINDOWS® NT is NOT supported yet! CODE300-A is the latest in a line of developments from HOKA in Digital Signal Processing (DSP) technology to hit the HF decoding scene.

It is the world's first and only fully remote controllable Software Data Analyser, Demodulator and Decoder with matched filters, based on a standard IBM PC compatible.



CODE300-A does use the same fairly inexpensive hardware as CODE30-A, but is delivered completely in a 19" rack PC, containing a Pentium 200 MMX, 16 MB RAM and a harddisk with 2.0 GB, Sound Card, SVGA 3D or ET4000, operative system MS DOS and AT-keyboard.

As approved in CODE30-A, we still design our own DSP software using a PC and NOT with a special DSP hardware.

History of CODE300 and CODE3

Hoka's CODE3 revolutionized the HF Radio Monitoring industry because it offered a high performance data analyzer and flexible decoder which was adaptive to future needs for little cost. The simple hardware interface (LF3) still amazes us at how well it performs! Keeping the hardware as simple as possible and allowing all the hard work to be done by the software has resulted in CODE3 managing to keep up with nearly all the latest RTTY signals heard on HF. We have been able to offer a faster delivery time from initial interception of a new keying system than any other hardware decoder on the market today. We are still the market leader with highly sophisticated data analysis modules and over 50 different systems decodeable on the standard CODE300-A. That is many more features than commercial equipment 20 times in price! The analysis side of CODE300-A is unique. Some competitive hardware decoders allow one to output the data bit-stream, but with CODE300-A there are over half a dozen analysis tools available, each fully documented. Using just these tools alone, Hoka Electronics is able to analyze new keying systems and write new software modules to decode them.

Software CODE300-A

Software consists of three major parts, a sophisticated DSP Data Analyser, a high tech demodulator and a decoder able to decode over 50 completely different keying systems as follows but any other mode could be supplied in a very short time:

HF systems

- AUTOSPEC 10/20/50
- ARQ-6 70
- ARQ-6 90 - ARQ-6 98
- ARQ-E / ARQ 1000 D
- ARQ-N
- ARQ-E3 / CCIR 519
- ARQ-S / ARQ 1000 S
- ARQ CCIR 625 A
- ARQ-SWE
- ARQ-POL
- DUP-ARQ / ARTRAC
- RS-ARQ 240 MERLIN mode 5/7/8
- RS-ARQ 228 mode 5/7/8
- RAC-ARQ / MEROD
- HC-ARQ
- ASCII
- SITOR A/B CCIR 625 AUTO
- DIRTY SITOR A
- TWINPLEX
- MORSE / CW
- BAUDOT + Wx Synop Decoder AAXX BBXX
- BAUDOT F7B 2 CH
- FEC CCIR 625 B
- FEC-A / FEC 100
- FEC 100 INTERLEAVE
- FEC 100 RAW
- FEC-S / FEC 1000 S
- HNG-FEC
- ROU-FEC
- TORG 10/11
- PICCOLO MK VI 6 toni
- PICCOLO MK VI 12 toni
- COQUELET 8
- COQUELET FEC AUTO
- COQUELET AUTO ONLY
- COQUELET 13
- TDM CCIR 242 1,2,4 ch
- TDM CCIR 342 1,2,4 ch
- PACKET RADIO AX-25 Hf 300 Baud, VHF 1200 Baud
- PACTOR 1,2,3,4,5,6,7
- PSK 31
- G-TOR
- FACSIMILE AM / FM
- HELL
- NUM 13
- MIL 141-188 ALE
- HDFL HF-ACARS
- FIRE
- CROWD 36
- CIS 14 / AAMOR 96 BD
- 81-81
- ANNEX 10
- GMDSS HF / VHF
- DCF 77
- and many others on request.

VHF systems

- DTMF
- EEA
- EIA
- EURO
- CCIR 1
- CCIR 2
- CCITT
- NATEL
- VDEW
- ZVEI 1
- ZVEI 2
- DCSS
- CTCSS
- POCSAG 512 / 2400
- ERMES
- ATIS
- ACARS
- BOS-FMS
- FLEX
- MPT 1327

The most sophisticated 5-tone SELCALL decoder / analyzer for all known systems is integrated. Making 'fingerprinting' easy, the analyzer for these systems enables you to measure the tone duration and frequency (offset) of any tone.

The detected five-tone-sequence is printed together with a time/date stamp and can be saved on disk. All this measurements are made in real time! To enable real 'on-air' monitoring, the S/N ratio of the signal may decrease to up to - 5 db for detection of a tone sequence! The calculated value of the S/N is shown in display.

Besides this a WATERFALL module enables one to put different rasters in picture to see the good tone sequence.

An IF-spectrum display on 10 Kc center with up to 20 Kc frequency span, zoom, waterfall etc. upgrades your receiver to a real HF-spectrum monitor receiver.

CODE300-A integrates one of the best filter demodulators for extremely signal conditions with a unique decoder and a sophisticated signal analyzer, together with a DAT recorder with minimal 30 minutes storage capacity into one system.

Any kind of 'production work' as well as any signal analysis can be done with only one system: CODE300-A! Phase modulated signals as multitone signals well, 5-tone decoder, testgenerator, sophisticated signal analyzer with e.g. EYE PATTERN diagram? CODE300-A has it!

Nearly all system decoders are set, on initial entry, to the most commonly found values of Baud speed, Shift, Character Repetition Cycle etc. as appropriate for the keying system to make it easier for learners to 'get up and running' as quickly as possible. Many modules are also quite able to determine these settings for themselves by analysing the signal whilst decoding it. E.g. the Sitor (Amtor) modules can automatically adjust between ARQ Mode A and FEC Mode B without any user intervention. About 40 different keying systems are included in our Auto Classification module. After measuring the Baud speed, press [ENTER] to jump via the Classify module into the monitored signal. What could be easier?

Full user control over most parameters are possible. E.g. Unshift On Space (by default CODE300-A reacts correctly to third shift keyboards to stop the output becoming stuck in figures - but it is still useful to switch this in on really noisy signals!), Shift On Space (great for

those noisy Meteo station signals!), Carriage Return Inhibit (saves screen space and printer paper on press stations), force Letters or Figure shift, select upper or lower case output, block length parameters (e.g. 4 or 8), force re-synchronisation, ANY Baud speed between 5 and 800 Baud with easy quick selection of the most commonly found ones (i.e. 25, 36, 45.5, 50, 72, 73, 75, 81, 82.5, 84, 96, 100, 100.1, 125, 144, 192, 200, 240, 300), along with fine manual adjustment in small increments. Auto Threshold Control follows your receiver's drift. The decoder's centre frequency can be adjusted to anywhere between 250 and 3500 Hertz to allow for all types of receiver and demodulation methods (CW, SSB, RTTY etc).

Another unique feature to CODE300-A is the ability to save all incoming RAW digitised audio to disc (up to 30 minutes) for later analysis! A complete DAT recorder/player in one decoding system. This record/play facility can also be used for any kind of audio signal, from phase modulated signals up to AM broadcast! View ALL channels of multi-channel systems at once on screen (and their status e.g. RQ, Beta, Alpha, IRS, ISS etc.), and not just those that are keying traffic. Save all four channels, at the same time, to disc even!

FEC transmission systems transmit each traffic character at least twice so as to allow the genuine recipient equipment to reconstitute any corrupted characters. Unlike some other hardware decoders that simply print the first character received, CODE300-A implements the system's error correction protocol to maximise the received characters without error. (In fact we go one better than that - if both characters are received in error then CODE300-A will attempt to reconstruct the character sent from the good elements of both corrupted characters!)

Why CODE300-A ?

Some of these facilities have been realized in the "old" CODE3 and CODE3 Gold Professional, why Code300-A ? We don't sit on our laurels!

A couple of years ago it was decided that DSP technology was the answer to even higher performance. Digital Signal Processing and in particular FIR filters permits a level of performance only bettered by the most expensive mechanical filters. Mechanical filters can be made to perform better than an 'equivalent' software FIR filter except they are extremely inflexible. CODE300-A offers an infinite variety of bandwidths that is just not possible by any other means.



AD LF1-A Demodulator

CODE300-A does not use an 'off the shelf' DSP card quite simply because DSP Cards require one to 'download' the software into their onboard processor's memory. To adjust the centre frequency by 10 Hz or alter the Baud Speed, or even the Shift settings would require one to download a new set of software into the DSP card and start all over again. But in the meantime you have lost the incoming signal whilst trying to set up the card!

DSP of CODE300-A

But how does the DSP part of the CODE300-A software work?

After the initial A to D conversion, the centre frequency of the system being monitored (which maybe anywhere within the normal SSB or CW passband of your receiver), is shifted down to DC. The signal will now consist of two, in-phase and quadrature, components.

This complex signal is then passed through a software 'roofing filter'. Because the filter is performed by the software rather than hardware, the specifications are far better than any analog filter could ever be. How about a transition from Passband to Stopband of less than 200 Hz!

The bandwidth of this filter is automatically calculated and optimized dependant on the set shift and baud speed. Change the baud speed or the shift by even small increments and the roofing filter will always compensate automatically for the best bandwidth! The FIR filter is configured using two possible sources of information. One can either manually select the shift and baud speed settings or better still, use the measured parameters of the signal. After this 'roofing filter', the signal is then ready to be demodulated by one of many demodulation methods, some of which are user selectable as follows.

Frequency discriminator demodulators must always have a low pass filter to remove any high frequency keying components. Therefore a special and optimized low pass filter is constructed in software which, just like the roofing filter, is dependant on the set baud speed and shift. Because the roofing filter and the post detection low pass filter are both set up from parameters derived by measuring the signal being received, this frequency discriminator will give a much better performance than the frequency discriminators you may be used to working with up to now. Another benefit of software filtering is that this discriminator will accurately demodulate signals with a shift from 2000 Hz down to an amazing 10Hz with almost identical performance throughout its range!

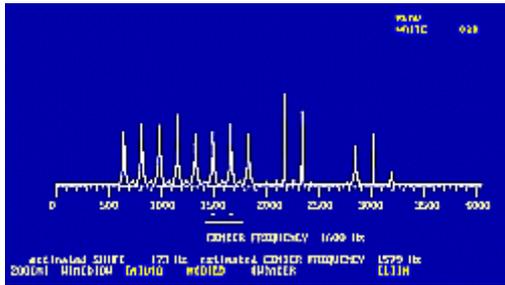
All frequency discriminators are intolerant of some degree of mistuning, CODE300-A's FSK discriminator allows for mistuning of up to about one third of the shift without any degradation of performance so is very useful for when one is simply 'tuning around'.

The Frequency Exchange Keyed (FEK) Demodulator uses matched filters. Using matched filters requires a little more care. With most hardware units, the filter widths and shifts are preset, and any signal decoded which does not match these pre-set values will not decode at the hardware's maximum performance. With CODE300-A's matched filters they are infinitely variable! After using the software tools within CODE300-A to measure the monitored system's shift and baud speed, CODE300-A automatically sets up optimized matched filters to those precise measured values. No two systems have identical shifts and baud rates but CODE300-A will always be able to ensure that it will be decoded using matched filters that give you the maximum performance.

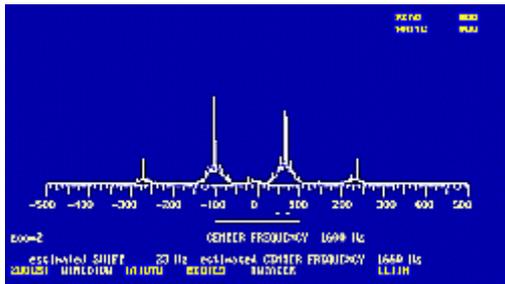
A simple 2 tone RTTY signal only requires two matched filters and so it is easy to construct dedicated hardware to decode them very well. But what about 4, 6, 8, 13 and 36 tone (or more) systems? No hardware decoder can compete with CODE300-A in this respect because on a 486DX it is easy to implement 13 matched filters for a 13 tone system! Can you imagine the complexity of constructing a 13 tone demodulator? No wonder CODE300-A is the only commercially available general purpose system able to demodulate these more complex systems. Other demodulators include OOK (On Off Keying) for Morse code, 2DPSK and 4DPSK.

A built-in audio amplifier from a D to A which means that one can generate signals. Yes, generate a Piccolo Mk6, a Coquelet or ARQ-E or TDM or ARQ6-90 etc. One is able to select from a growing number of signals which are being written and added to this module all the time. At the moment one can select from approximately 30 different systems AND add in a precise amount of Gaussian 'white' Noise too! Select a certain level of S/N and use the signal as a test signal source for testing other decoders, or for training purposes even! Digitally

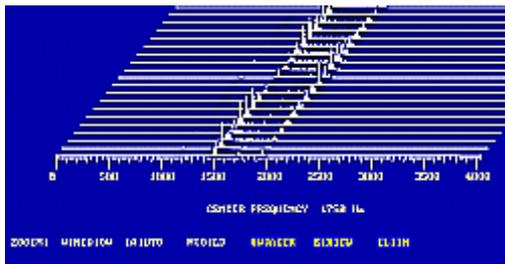
record the output and play it back through the CODE300-A input for testing the performance of our software even!



0 - 3800 Hz Audio Spectrum Analyzer showing VFT signal (J7B)



Zoom 2 - showing just one of the channels of the VFT signal. Note the total lack of adjacent signals due to the filtering !!!



Waterfall in Skew mode 0 - 3800 Hz



Phase display module showing PSK on 198 kHz Radio 4

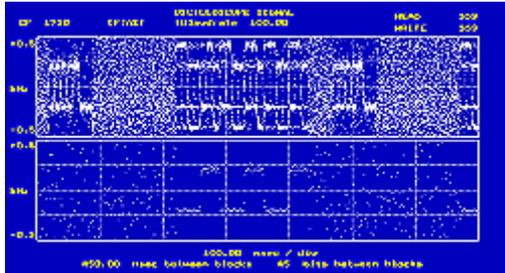
Data Analyser

The Analysis of unknown or even known systems is a very important part to serious radio monitoring on Short Wave. Whether to increase one's personal knowledge about the numerous different keying signals or just attempting to analyse something new and apparently undecodeable - a good data analyser is an important tool.

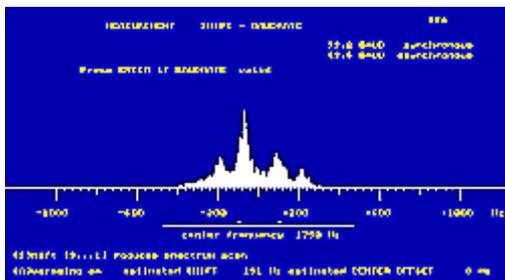
Many decoders available today can offer baud speed measurement - so can CODE300-A, but CODE300-A goes much further than that. CODE300-A is able to measure system parameters never before available with hardware decoders. Baud speed to a genuine accuracy of 0.0001 Baud (fingerprint), the keying system's shift to the nearest 1 Hz, look and measure individual element lengths, mark to space ratio, test for synchronous/asynchronous, graphically display the element patterns. Auto-correlate the keyed signal's bit pattern to search for tell tale signs of repetitiveness, or not!

Display the analysed keyed signal with varying decoding alphabets (ITA2, ITA3, ITA2-P, CCIR476, CCITT5) with character, bit or no interleaving, various character lengths (from 5 to 9), various channel polarities - all to try to identify the keying system's construction. The facilities made available by using this Data analysis software will go a long way towards reducing the number of times one says 'I wish I knew what this system was'!

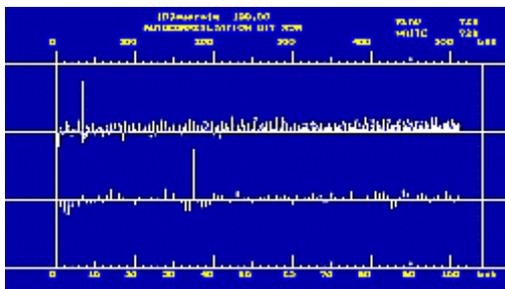
The following screen dumps show just some of the modules available:



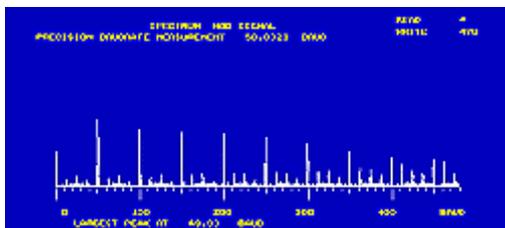
Oscilloscope showing four frequency Twinplex signal



Shift Speed Measurement module showing four frequency Twinplex



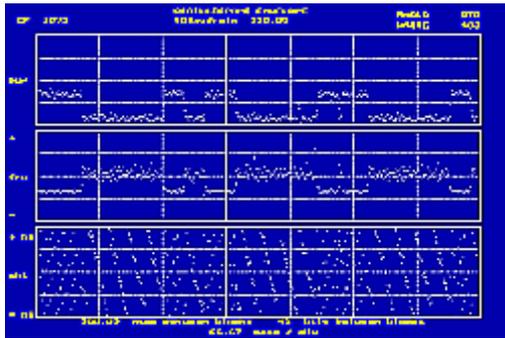
AutoCorrelation Bit module showing 100 Baud Sitor B with 35 element repetition. Top screen half shows bits from 0 to 512, Bottom half is the first 100 bits 'zoomed' in.



Autocorrelation MOD of unknown signal after FFT shows it to be a 50 Baud signal



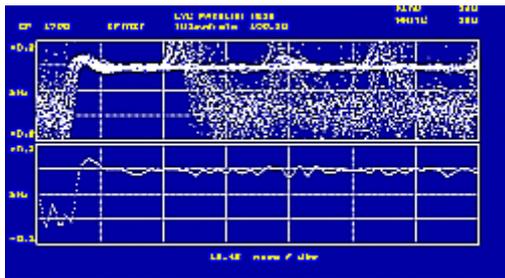
Speed Bit module showing Asynch. 7 1/2 element of 50 Baud Baudot signal



Amplitude, Frequency, Phase Oscilloscope



Straddle showing a tuned RTTY signal



EYE Diagram show RTTY signal with RX bandwidth too small

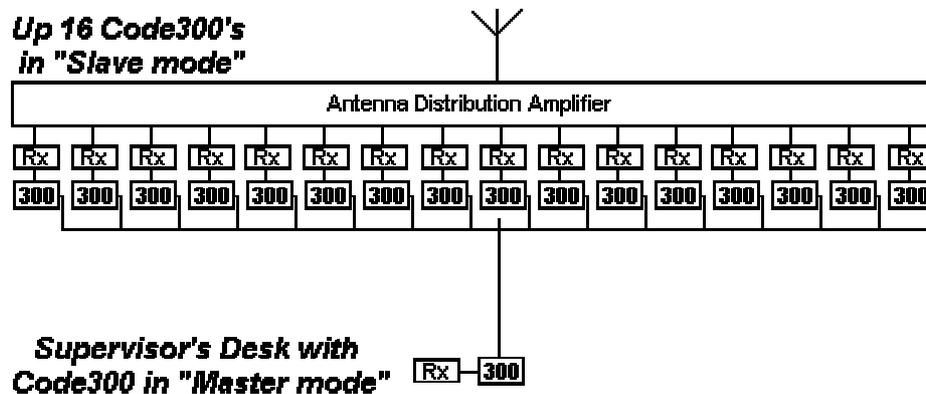


EYE Diagram show fairly good signal

Remote Control - Master/Slave operations

Code300-A is remote controlled via RS-232 COM port so as to allow up to 16 Code300-A's (in "Slave" mode) to be remotely controlled from just one Code300-A (in "Master" mode)! A picture paints a thousands words so here is a typical setup in a Monitoring Station.

Typical Monitoring Station Installation



The Supervisor's desk contains a standard desktop PC with monitor, keyboard and printer. The Code300-A software is set to run in "Master Mode" so that it can control the remotely located Code300-A's. The supervisor tunes/scans the bands looking for signals of interest. Once a suitable target is identified for further analysis, the supervisor's Code300-A is used to make the initial diagnosis of the keying system. Once the system is identified and the parameters correctly adjusted (e.g. system, shift, baud speed, demodulator type etc.), the supervisor presses [Ctrl][S].

A spare remote receiver "channel" would now be identified and commanded to replicate its settings into the remotely-sited slave receiver. (This is usually supplied as a standard firmware facility with any modern commercial grade radio receiver. For example the Racal RA3701 and RA3791 families of receiver allow the downloading of receiver settings into other remotely-sited receivers.)

The [Ctrl][S] command brings up the Slave control screen. Each of the 16 remote slaves's status are then displayed on-screen. The receiver's associated slave Code300-A is then commanded to be loaded with exactly the same parameters as the Supervisor's Code300-A.

From this point onwards, the slave Code300-A will save to disc all decoded incoming traffic. At any time after setting up the slave, its status can be queried and it's decoded saved text transmitted down to the Supervisor's Master Code300-A's hard disk for offline storage or analysis.

The Code300-A software can be set to be a "Master", a "Slave", or a "Stand-Alone" (this last mode is effectively just like a standard Code30). Therefore if, for example, the Supervisor's unit failed, any one of the Slave units can be quickly hot swapped into "Master" mode and moved to the supervisor's desk until permanent repairs can be made.

Technical specification

Hardware specification of CODE300

- Pentium 300 MHz or higher running MSDOS.
- 32 MB intern RAM, upgradable.
- 3.2 GB harddisk, 3,5" disk drive 1,44 MB for software update.
- SVGA video card with ET4000 chipset, 1 MB video RAM.
- 101 AT key keyboard.
- 19 " rack model, built in cooling fan.
- Dimensions: 7 inch (18 cm) high, 17 inch (44 cm) deep, 19 inch (48 cm) wide.
- Weight appr. 20 Kg. Working on 115/ 230 V, 200W power supply.

Rear connections

- Output for video monitor D15, keyboard DIN 7, power supply in/out EURO.
- RS 232 like connector for master/slave D9.
- RS 232 connector D9, parallel (printer) port D25.
- Two audio inputs, one audio output, built in loudspeaker, volumecontrol.

General Features

- Fully integrated demodulator and decoder
- Mark and Space frequencies in 1Hz increments
- Baudrate control from 10 to 800 Baud, VHF systems up to 4800 Baud
- FIR roofing filter
- FIR matched filters for binary and multitone FEK
- Highly linear frequency discriminator with 'integrate and dump' low pass filter for FSK
- All selectable parameters may be set from the keyboard or imported from the various measurement modules
- Integrated test generator for most systems with selectable signal/noise ratio
- Phase Plane for frequency measurements of CW signals with 0.01 Hz resolution

The following alphabets are included in CODE300

- International ITA 2
- National Scandinavian
- US MIL
- M2 CYRILLIC
- M2 LATIN
- M19 CYRILLIC
- M19 LATIN
- GREEK
- HEBREW
- ARABIC ATU 70 and ATU 80
- FARSI
- ARABIC ATU 70 and 80 LATIN
- Amateur Upper Lower Case
- USER DEFINED types are optional or on request available
- SYNOP DECODER (AAXX and BBXX) included for BAUDOT, TORG and ARQE3, including a worldwide database.

Demodulator Specifications

- Demodulator Specifications
- Input impedance: 200 Kohm
- Nominal input level: +16 to -16 dBm (into 600 ohm selectable in 6dB steps)

- Maximum level: +30dBm without damage
- Dynamic range: Better than 40dB
- Input frequency range: 1 Hz to 3800 Hz
- Mark/Space centre frequency: Selectable from 200 to 3600 Hz in 1 Hz steps
- Shift: Selectable from 10 to 1800 Hz in 1 Hz steps
- Baud speed: Selectable up to 2400 Baud in 0.01 Hz steps
- Roofing filter bandwidth FIR filter: automatically adjusted according to selected/measured shift and baudrate
- Post-detection filter (FSK): automatically adjusted according to selected/measured baudrate
- Matched filter bandwidth (FEK): automatically adjusted according to selected/measured baudrate
- Bit error rate: Within 3dB of theory (white gaussian noise, non-fading channel)
- Modulation types detected: OOK, BFSK, MFSK, 2DPSK, 4DPSK and commercial 4, 6, 8, 13 and 36 tone FEK demodulators already implemented, also AM for SAT-FAX.
- Others on request.

Features of Audio Spectrum Analyzer

- 60 dB dynamic range, 512 point resolution frequency display
- 2 Zoomed display facilities. (1800 Hz and 900 Hz), display width of 0 Hz to 3800 Hz.
- Linear and Logarithmic vertical display representation
- Short time-window selectable, Video averaging and Maximum hold
- Waterfall display with vertical or 45 degree skew.
- Integrated frequency raster lines for all SELCALL modes.