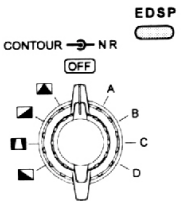
Advanced Features

EDSP



Enhanced **D**igital **S**ignal **P**rocessing uses A/D (Analog to Digital) & D/A (Digital to Analog) conversion techniques under microprocessor control to achieve total enhancement of signals at the audio (rather than IF) level. The major capabilities offered by EDSP lie in the area of heterodyne/random noise reduction and audio bandpass filtering. Digital filters have many advantages over their analog counterparts in that they can meet tighter specifications on parameters such as voltage and temperature drift and noise problems.

The FT-1000MP uses a 16-bit, state-of-the-art NEC μPD77016 CMOS digital signal processor chip featuring a 30-nS Instructions Cycle, 33 MHz Clock frequency, a 16 x 16-bit and 40-bit multiply accumulator, 40-bit Barrel Shifter, and 64 K Bytes Program ROM.

DSP enhancement is basically a four-step process. Audio input is sampled several thousands of times per second, then the frequency and amplitude of the audio are converted into a digital representation of the analog waveform that resembles ascending and descending "staircases" by the A/D (analog-to-digital) converter. This is later changed into digital serial bitstream as raw data for analysis and processing.

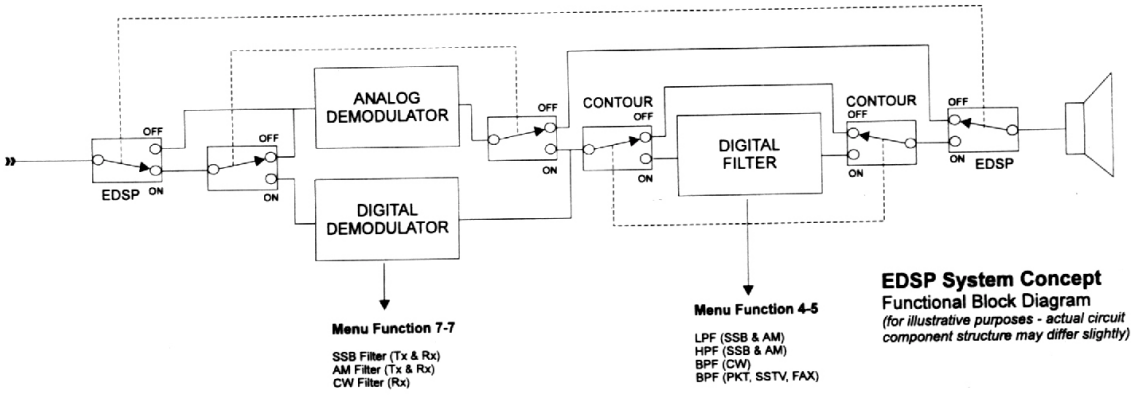
Information is extracted from digital data, and the EDSP chip performs complex mathematical calculations according to pre-programmed routines known as algorithms. Algorithms are processed then compared against a set of parameters (or threshold if you will) based on a phenomenon known as "correlation". The degree of correlation depends on the type of audio: random noise has relatively little correlation,speech contains moderate correlation, with heterodynes (and QRM) being highly correlated. The EDSP microprocessor is programmed with various parameters corresponding todifferent known audio phenomena.

EDSP allows the frequency sprectrum of a received signal to be modified according to a specific set of parameters for the desired effect (QRM reduction, audio tailoring, etc.). Certain types of audio interference leave a distictive signature or "footprint", which can be recognized, and "processed out" of the digitally-reconstructed audio from the EDSP chip. Also, digital filters are constructed which emulate traditional low-pass, high-pass, band-pass, and band-stop filters, except with steep skirt shaping and performance possible with digital technology. EDSP also allows direct "digital" demodulation of audio for receive, as well as direct modulation of audio for transmit.

Introduction

EDSP Functions

The EDSP circuitry in the FT-1000MP allows digital enhancement of both transmitted and received audio. A basic primer on DSP was given to inform you more about this capability than just the panel label and button location. Now you can customize its filtering capabilities and use it to reduce QRM and tailor audio response for each operating mode.



EDSP System Concept
Functional Block Diagram
(for illustrative purposes - actual circuit component structure may differ slightly)

TX Audio Enhancement - Four microphone audio responses can be chosen using menu selection 4-4. Since audio characteristics voice vary between people, these settings enable tailoring your transmitted audio for best clarity.

TX IF Filter Selection - Normally, both 2.4 kHz filters are selected in the transmit IF chain. However, with EDSP operation, you can select 6.0 kHz filters for wider frequency response on transmit audio. The effect of this filter selection is directly related to menu selection 7-7 (below). The desired filter is chosen with menu selection 5-9, and is only active when EDSP is turned on.

EDSP Modulation and Demodulation

TX EDSP Modulation - Early-stage transmitted SSB audio is applied directly to EDSP circuitry for processing. EDSP filter parameters can be matched to voice characteristics for optimum audio tailoring and sound effect.

TX EDSP Demodulation - For SSB, CW and AM, receiver 3rd IF output is applied directly to EDSP circuitry for demodulation and processing. Bypassing conventional filters and utilizing EDSP digital filter offers optimized bandwidth and frequency response.

Menu selection 7-7 configures the settings for both Rx and Tx EDSP (see table below).

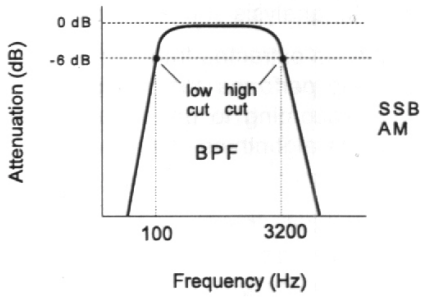
EDSP Modulation and Demodulation Menu Selection 7-7	
Mode	**Settings**
SSB (Rx)	OFF 100~3100 Hz 300~2800Hz
SSB (Tx)	OFF 100~3100 Hz 150~3100Hz 200~3100 Hz 300~3100 Hz
CW (Rx)	OFF ON (100~3100 Hz)
AM (Rx)	OFF ON (70~3800 Hz)

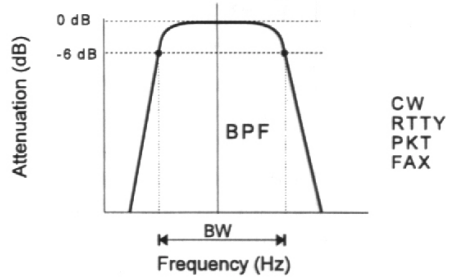
RX Audio Enhancement - EDSP offers both noise reduction and several user-configurable filter networks. Noise reduction is accomplished by four settings selected by the front panel **NR** control. Each setting has correlation parameters optimized to reduce random noise, static, pulse/man-made noise and heterodynes with little degradation of the desired signal.

QRM reduction is enhanced by various DSP filter networks. The front panel **CONTOUR** control selects low-, mid- and high-cut filters along with a band pass filter (see below).

EDSP CONTOUR Selections		
CONTOUR Selection	**Filter Type**	**Application**
◭	BPF (Band -Pass)	QRM rejection
◢	LCF (Low - Cut)	high-freq. emphasis
◮	MCF (Mid - Cut)	high & low freq. emphasis
◺	HCF (High - Cut)	low-freq. emphasis

The low-, mid-, and high-cut filters are pre-set for different audio emphasis. The bandpass filter, however, is used for QRM rejection and can be user-tailored for SSB, CW, AM and Digital operation. The lower and upper frequency cut-off of each mode-respective BPF is adjusted by menu selection 4-5, With the **CONTOUR** control set to the BPF (◭) position, the low- and high-cutoff setttings for the bandpass filter are selected automatically as you change modes. See the illustration below and the table at the top of the next page for filter and cut-off ranges.



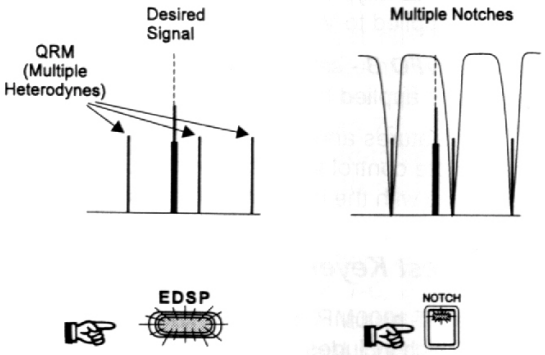


EDSP BPF Selection & Parameters Menu Selection 4 - 5			
Mode	**BPF**	**Cutoff Range (Hz)**	**Default Cutoff (Hz)**
SSB	High Cut	1000 ~ 4500	3200
	Low Cut	100 ~1800	100
CW	Bandwidth	60/120/240	240 (BW)
AM	High Cut	1000 ~ 4500	3200
	Low Cut	100 ~ 1800	100
DIGITAL	PKT	800 ~ 2500 Hz, preset	
	SSTV	1000 ~ 2500 Hz, preset	
	FAX	1300 ~ 2500 Hz, preset	

EDSP Auto Multiple Notch Filter - On page 34, we previously discussed basic IF notch filter operation and how it is used to attenuate heterodynes. EDSP offers multiple-notch capability within the AF (rather than IF) bandpass with the press of a button.

With the conventional (455 kHz 3rd IF) notch filter, only a single offending heterodyne at a time can be attenuated by pressing the **NOTCH** button and slowly rotating the inner **NOTCH** control. Notch tuning can sometimes be critical, as you have to position the control for maximum "depth" by ear.

With the multiple notch, EDSP circuitry examines the AF bandpass and the correlation of the signals present. After correlation parameters are compared, unmodulated signals (heterodynes) are identified and notched out. As EDSP dynamically checks the audio, new heterodynes will be identified and notched, one by one, as they appear. See the illustration below.



EDSP Auto Multiple Notch Action

Notch Filter Operation Menu Selection 2 - 9	
NOTCH Mode	**Operation**
MANUAL	Conventional, manually- controlled IF Notch
AUTO	EDSP Auto Multiple-Notch
SELECT	Selectable - with EDSP off, functions as manual notch, with EDSP engaged, auto multiple notch takes effect

Theoretically, an infinite amount of notches could be inserted to attenuate each new heterodyne; however, the total notch bandwidth would approach that of the audio passband, and, progressively notch all audio. One limitation of the EDSP auto multiple notch feature is that it is only for use with SSB modes.

It is important to realize that notch operation is determined by two things:

- The setting of menu selection 2-9.
- If EDSP is active or not when the **NOTCH** button is pressed.

The **NOTCH** button still activates the IF notch circuit, but you must determine which type of notch (manual or EDSP-auto) will take effect via menu selection 2-9 (see the box below). For the auto notch feature (and all other EDSP functions), the **EDSP** button *must be engaged* for signal processing to occur.

Important Note About EDSP

An advantage of EDSP is the flexibility for the user to customize or "tailor" received and transmitted audio. Menu selections 4-4, 5-9, and 7-7 each have distinct effects on the sound of your transmitted audio. The "ultimate" combination of these settings will of course vary between users personal taste, and for the desired effect (distinctive audio, QRM penetration, etc.).

The easiest way to immediately hear the effect of different EDSP settings is to use the transceiver's built-in MONITOR circuit to listen to your audio while transmitting. In this way, you can step through the various setting combinations, and select the ones that appeal the most to you, or the receiving station.