

HIGH GRADE HF ALL MODE TRANSCEIVER

FT-1000MP

TECHNICAL OVERVIEW

ENHANCED
DIGITAL
SIGNAL
PROCESSOR

EDSP



YAESU
...leading the way.SM

SPEED Control

This control is used for adjustment of the sending speed for the built-in electronic CW keyer.

SPLIT Key

This key places the transceiver into the "Split" mode, whereby the receiver is controlled by the Main VFO-A, and the transmitter is controlled by the Sub VFO-B. In dual receive operation, of course, both receivers may be used at the same time; the status of the "Split" mode does not affect Dual Receive operation.

SPOT Key

The CW [SPOT] key activates the "Spotting" oscillator, which provides the operator with an audio tone which matches--precisely--the pitch of the transceiver's (offset) CW transmitted note. In operation, zero-beating to an incoming signal is easily accomplished by pressing the [SPOT] switch, then adjusting the FT-1000MP's receiver frequency so that the tone of the other station's signal matches the Spot tone. This tone is a low-level sampling of the actual RF signal, not a separately generated audio oscillator which could become mis-aligned, so perfect alignment is always possible. The pitch of the tone (and the FT-1000MP's transmitted carrier) may be adjusted by using the PITCH control.

Speech Processor (RF)

The SSB RF Speech Processor, an analog signal-enhancement technique, increases average SSB power output by clipping the peaks of the voice envelope, filtering and amplifying the signal, and thus folding more available power into a compressed envelope. The RF clipping type of processor used in the FT-1000MP is superior to simple audio compressors used in some competing designs, in that it provides higher average power output with much lower distortion.

SQL (Squelch) Control

When no signal is present, the SQL control may be adjusted so as to silence the Main receiver completely. Although chiefly used in the FM mode, the FT-1000MP squelch circuitry is active in all operating modes.

SST-310

This is the product designation of the Siliconix® junction FETs, used in the FT-1000MP receiver front end, which are a key component in providing low noise and excellent intercept performance.

SUB SQL Control

Similar in operation to the Main receiver's "SQL" control, the "SUB SQL" control may be used to silence the Sub receiver when no signal is present. Since the Main and Sub receivers of the FT-1000MP are totally independent, a strong signal present on the Main receiver will not cause the Sub receiver squelch to open.

SWR Display

Visual indication of the SWR (Standing Wave Ratio) presented to the transceiver at the Antenna jack is provided via the Main Display digital meter. When the meter selection of "IC/SWR" is active, the SWR as seen by the transceiver will be displayed on the meter. If the SWR should exceed 3:1, the "HIGH SWR" icon will appear on the Main Display just to the left of the antenna-selection icons.

[T]

TRACKing Feature

The Main and Sub VFOs may be placed in a "slaved" or "TRACKing" mode by pushing and holding in the Main Dial's [LOCK] key and turning the Main Dial while holding the [LOCK] key in.

TRV (Transverter) Jack

This RCA-type jack provides low-level RF output (typically -10 dBm) for driving a VHF or UHF transmit converter. The HF power amplifier may be disabled during transverter operation, pursuant to the instructions provided on page 69 of the Operating Manual provided with the transceiver.

TUNE Key

Pushing in this key activates transmitter and the tuning function for the Automatic Antenna Tuner.

TUNER Key

Pushing in this key places the Automatic Antenna Tuner in the "active" condition, but does not activate the transmitter.

TX GND Jack

This RCA-type jack provides connections to a mechanical relay inside the FT-1000MP, which may be used for transmit/receive control of an external device such as a linear amplifier. This relay is designed to handle large voltages, but is not fast-acting enough for full CW break-in (QSK) applications. The TX GND jack is only active when the "LIN" switch is in the "On" position.

TX LEDs

These orange LEDs (Light Emitting Diodes) provide a visual indication of which VFO register is currently controlling the transmit frequency. Since only one VFO can be used at a time in the transmit mode, only one of these LEDs may be illuminated at any time (unlike the case of the RX LEDs, which both are illuminated during Dual Receive operation).

[U]

UP Key

Pushing this switch causes the operating frequency to be increased by 100 kHz (1 MHz when the [FAST] key is engaged), for quick movement around a band.

USB Mode Selection Key

Pressing this key activates the USB (Upper Sideband) mode of operation.

USER Key

Pressing this key activates the "User-Customized" mode, wherein a series of transceiver parameters such as oscillator frequencies, carrier points, and PLL offsets can be programmed so as to allow-one-touch access. A typical application of this feature is the setup of Packet using USB-side injection, since only LSB or FM modes are provided via the Packet mode. The setup of the "User" mode is accomplished via the Menu system.

[V]

Vcc/MIC Key and Indications

This key activates metering of the collector voltage present at the final amplifier transistors (Vcc) as well as a relative indication of the microphone input level.

VFO/MEM Key

Pushing this key repeatedly toggles Main channel operation between VFO (Variable Frequency Oscillator) operation and Memory Channel operation.

VFO Tracking

See "TRACKING Feature."

VFO Mode

The "VFO" mode defines the register which is being used for frequency control in either the Main or Sub channels. Two VFO registers per band per channel (Main and Sub) are provided. The VFO mode is separate from the Memory Channel mode, although in the FT-1000MP the distinction is less absolute, thanks to the convenience provided by the "Memory Tune" mode of operation, which allows the Main Dial to be used to tune off of a previously-stored memory channel.

VOX

This switch is used to activate the "VOX" (Voice Operated Xmit) feature, whereby the operator's voice or the activation of the CW key will cause the transmitter to be activated automatically. If the VOX mode is not active, then the PTT line must be closed to ground in order to activate the transmitter.

[W]

WIDTH Control

This control allows the operator to vary the IF bandwidth; the circuitry which is engaged by rotation of the WIDTH control acts as a "Dual IF Shift" control, which creates a region of common overlap between the passbands of the 2nd (8.215 MHz) and 3rd (455 kHz) IFs in the receiver. The IF Shift, Width, and EDSP bandwidth manipulation techniques all work together to combat interference and enhance intelligence recovery on incoming signals.

[μ]

μPC1037H

This is the product designator for the NEC® product detector integrated circuit. This IC provides outstanding balance and thermal stability as compared to traditional diode ring mixers/product detectors, and it allows superior receive operation as well as outstanding carrier suppression in the transmit mode.

μPD77016

This is the product designator for the NEC® Digital Signal Processor IC which is the heart of the FT-1000MP's EDSP System.

M E M O

18. SPECIFICATIONS

General

RX frequency range : 100 kHz - 30 MHz
 TX frequency ranges : 160 - 10 m amateur bands only
 Freq. Stability : $<\pm 10$ ppm ($-10 \sim +50^\circ\text{C}$)
 $<\pm 2.0$ ppm ($0^\circ \sim +50^\circ\text{C}$) w/TCXO-4
 $<\pm 0.5$ ppm ($0^\circ \sim +50^\circ\text{C}$) w/TCXO-6
 Freq. Accuracy : $<\pm 7$ ppm (except FM, $<\pm 500$ Hz)
 w/TCXO-4 : $<\pm 2$ ppm (FM $<\pm 460$ Hz)
 w/TCXO-6 : $<\pm 0.5$ ppm (FM $<\pm 500$ Hz)
 Operating temperature Range : ($-10^\circ \sim +50^\circ\text{C}$)
 Emission modes : LSB, USB, CW, FSK, AM, FM
 Frequency steps : 0.625/1.25/2.5/5/10 Hz for SSB, CW,
 RTTY & Packet ; 100 Hz for AM and FM
 Antenna impedance : 50 Ω unbalanced
 Power consumption :

| Input | Rx (no signal) | Rx (signal) | Tx (100W) |
|---------------|----------------|-------------|-----------|
| 10 ~ 125 VAC | 70 VA | 80 VA | 550 VA |
| 200 ~ 240 VAC | 80 VA | 90 VA | 600 VA |
| 13.8 VDC | 2.4 A | 2.8 A | 19 A |

Supply voltage : 100 ~ 125, 200 ~ 234 VAC, 50/60 Hz
 13.5 VDC (for Europe)
 Dimensions (WHD) : 410 x 135 x 347 mm
 Weight (approx) : 15 kg (33 lbs)

Transmitter

Power output : adjustable up to 100 watts
 (25 watts AM carrier)
 Duty cycle : 100% @ 50 watts, 50% @ 100 watts
 (FM & RTTY, 3-minute Tx)
 Modulation types :
 SSB : J3E Balanced, filtered carrier
 AM : A3E Low-level (early stage)
 FM : F3E Variable reactance
 AFSK : J1D, J2D Audio frequency shift keying
 Maximum FM deviation : ± 2.5 kHz
 FSK shift frequencies : 170, 425, and 850 Hz
 Packet shift frequencies : 200, 1000 Hz
 Harmonic radiation : at least 50 dB below peak output
 SSB carrier suppression : at least 40 dB below peak output
 Undesired sideband suppression : at least 50 dB below
 peak output
 Audio response (SSB) : not more than -6 dB from 400 to
 2600 Hz
 3rd-order IMD : -31 dB @ 100 watts PEP, or better
 Microphone impedance : 500 to 600 Ω

Receiver

Circuit type : quad-conversion super heterodyne
 (triple conversion for FM)
 Intermediate frequencies : Main Rx Sub Rx
 70.455 MHz 47.21 MHz
 8.215 MHz 455 kHz
 455 kHz
 Sensitivity :

(with preamp on, for 10 dB S/N, 0 dB μ -1 μ V)

| Frequency Mode (BW) | 150 - 250 kHz | 250 - 500 kHz | 0.5 - 1.8 MHz | 1.8 - 30 MHz |
|-------------------------|---------------|---------------|---------------|--------------|
| SSB, CW (2.4 kHz) | 5 μ V | 4 μ V | 2 μ V | 0.25 μ V |
| AM (6 kHz) | 40 μ V | 32 μ V | 16 μ V | 2 μ V |
| 29-MHz FM (12 dB SINAD) | - | - | - | 0.5 μ V |

Sensitivity ($-6 / -60$ dB) :

| Button | Modes | Minimum -6 dB BW | Maximum -60 dB BW |
|---------|------------------|--------------------|---------------------|
| 2.4 kHz | all except FM | 2.2 kHz | 4.2 kHz |
| 2.0 kHz | all exc. AM, FM | 2.0 kHz | 3.6 kHz |
| 500 Hz | CW, RTTY, Packet | 500 Hz | 1.8 kHz |
| 250 Hz | CW, RTTY | 250 Hz | 700 Hz |
| - | AM (wide) | 4 kHz | 14 kHz |
| | FM | 8 kHz | 19 kHz |

Dynamic Range : 108 dB (@50 kHz, 500-Hz BW, RF amp off)
 Squelch sensitivity :
 1.8 - 30 MHz (CW, SSB, AM) : <20 μ V
 28 - 30 MHz (FM) : <0.32 μ V
 IF rejection (1.8 - 30 MHz) : 80 dB or better (Main Rx)
 60 dB or better (Sub Rx)
 Image rejection (1.8 - 30 MHz) : 80 dB or better (Main)
 50 dB or better (Sub)
 IF shift range : ± 1.12 kHz
 Max. audio output : 1.5 W into 4 Ω with $<10\%$ THD
 Audio output impedance : 4 to 8 Ω

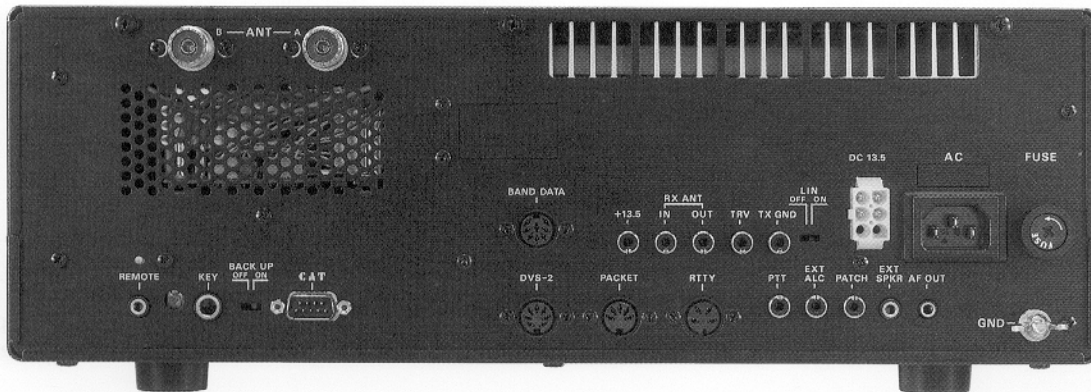
Specifications are subject to change, in the interest of technical improvement, without notice or obligation

19. Front Panel & Rear Panel

FRONT PANEL



REAR PANEL



20. OPTIONS



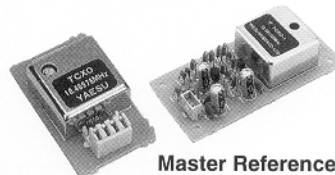
MH-31B8
Hand Microphone



YH-77STA
Lightweight Stereo Headphones

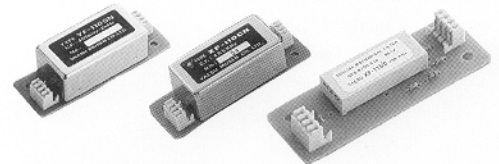
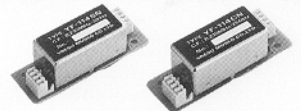


DVS-2
Digital Voice Recorder



TCXO-4 / TCXO-6 High-Stability
Master Reference Oscillator

IF Filter Options
Main Receiver Filters:
8.2 MHz (2nd IF) Filters



455 kHz (3rd IF) Filters
Sub Receiver Filter:



MD-100A8X
Desktop Microphone



FH-1
Remote Controller



FL-7000 Solid State Linear Amplifier



SP-8 Loudspeaker with Audio Filters and LL-7 Phone Patch Option

(B) Interfacing to Other Linear Amplifiers

T/R control can be accomplished either via the BAND DATA jack (for low voltage and low current, high-speed applications such as QSK CW), or via the TX GND jack. Other features assisting with ease of interfacing are:

- If the amplifier has a particularly long receive-to-transmit switching time, Menu Item 7-4 may be used to set a sequencing delay anywhere in the range 0~30 ms, so as to avoid activation of the FT-1000MP's ALC circuitry. When the transceiver's final amplifier protection sensor detects an incompletely-seated relay in the amplifier, power output from the transceiver will be suppressed so as to protect both the amplifier and the transceiver; Menu Item 7-4 allows inhibition of the output for a few milliseconds, to avoid the potential delay in generation of full power output caused by the ALC recovery time constant.
- If the linear amplifier uses vacuum tubes, or otherwise requires manual tuning, a simple circuit can be constructed for connection to the rear panel REMOTE jack, allowing the operator to send a

10W, 50W, or 100W carrier for tuning purposes, independent of the current operating mode (e.g. SSB). The Tuning Mode Power Adjustment parameter is set via Menu Item 4-3.

- The maximum power output from the transceiver may be limited to 10W or 50W, if desired, via Menu Item 4-0.
- ALC adjustment, when connected, is accomplished using the appropriate adjustment potentiometer on the rear panel of the linear amplifier.

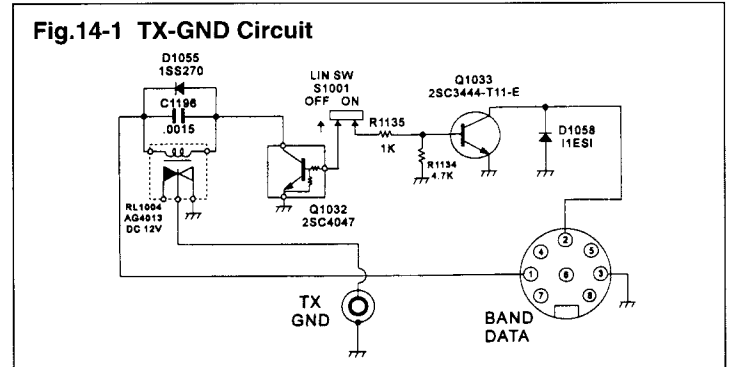
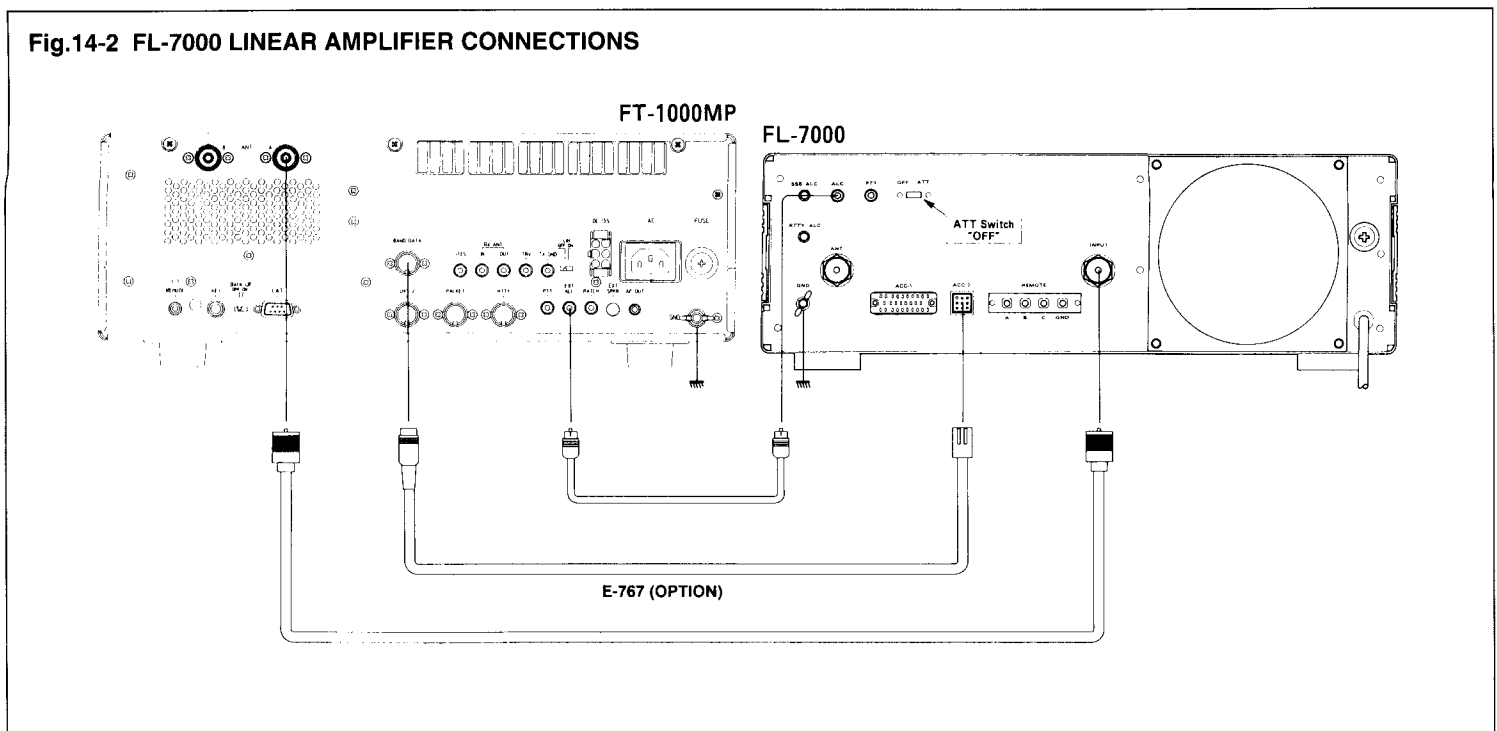


Fig.14-2 FL-7000 LINEAR AMPLIFIER CONNECTIONS



15. Transverter Interfacing

A dedicated transverter interconnection jack (RCA type) is provided on the rear panel for providing RF drive to an after-market transmit converter.

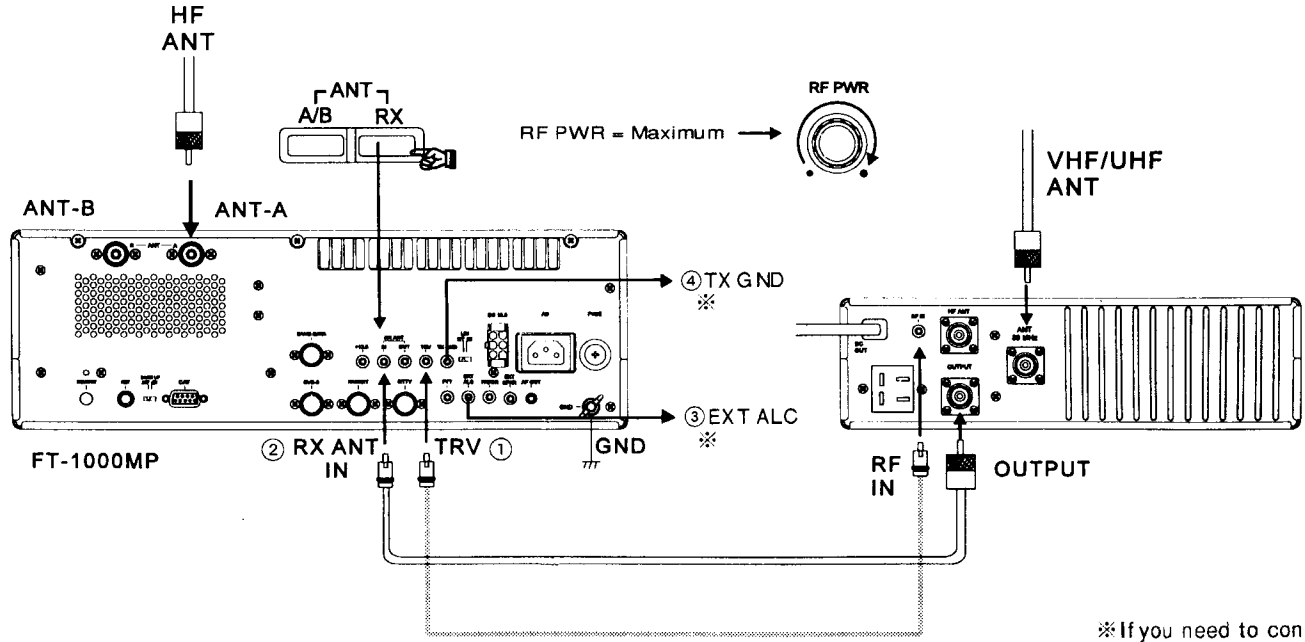
Receive converters may be connected to the RX IN RCA jack on the rear panel, as well, so as to allow utilization of the 28-30 MHz band as a tunable IF for your converter. Via Menu Item 3-3, the frequency display area of the LCD may be changed to show "50," "144," or "430" (MHz) during transverter operation.

A control line, available through the top-cover control panel, allows the final amplifier stage of the FT-1000MP to be disabled during transverter operation.

Table 15-1 TRANSVERTER CONNECTION

| | | |
|---|-----------|---|
| 1 | TRV | LOW LEVEL (-6dBm/50Ω) DRIVE TO TRANSMIT CONVERTER |
| 2 | RX ANT IN | TRANSVERTER RX LINE INPUT |
| 3 | EXT ALC | EXTERNAL ALC CONNECTION (-4V DC FLL PPOWER) |
| 4 | TX GND | CLOSURE TO GROUND ON TX |

Fig.15-1 TRANSVERTER CONNECTIONS



16. Top Panel Access and Control

Underneath a small “trap door” access panel on the top cover are a number of controls and switches that are rarely used during actual operation, but which may require occasional adjustment or re-setting. These include:

(1) HP-M

This control sets the audio level available from the main receiver to headphone jack A (3.5 mm plug).

(2) HPA-S

This control sets the audio level available from the sub receiver to headphone jack A (3.5 mm plug).

(3) HPB-M

This control sets the audio level available from the main receiver to headphone jack B (1/4 inch plug).

(4) HPB-S

This control sets the audio level available from the sub receiver to headphone jack B (1/4 inch plug)

(5) CW

This control adjusts the tuning meter segment indications for CW Center Tuning.

(6) RTTY

This control adjusts the tuning meter segment indications for RTTY Center Tuning.

(7) PKT

This control adjusts the tuning meter segment indications for PKT Center Tuning.

(8) A-VOX (VOX Anti-Trip)

This control adjusts the level of negative feedback of receiver audio to the microphone, to prevent the receiver audio from activating the transmitter (via the microphone) during VOX operation.

(9) DLAY (VOX Delay)

This control sets the hang time of the VOX circuit, between the moment you stop speaking and the moment the VOX circuit automatically returns the transceiver to the “receive” mode.

(10) VOX

This control sets the sensitivity of the VOX circuit, to establish the level of microphone audio needed to active transmitter.

(11) FM MIC

During FM operation, this control sets the microphone gain (and, hence, the transmitter deviation).

(12) TVR (Transverter Enabling Switch)

During transverter operation, this switch disables the FT-1000MP’s PA stage, conserving power and eliminating the need to connect a dummy load to the HF Antenna jack(s) during VHF/UHF operation.

Fig.16-1 TOP PANEL ACCESS and CONTROLS

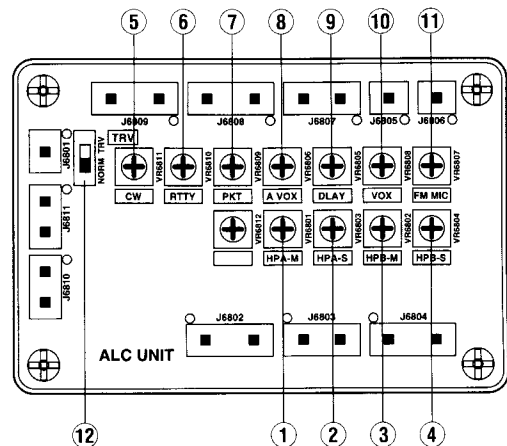
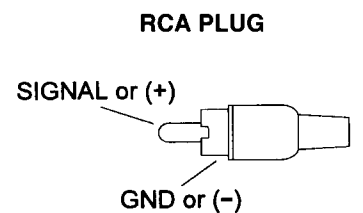
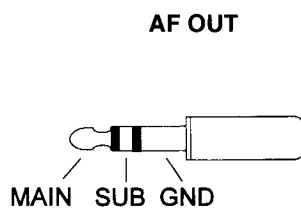
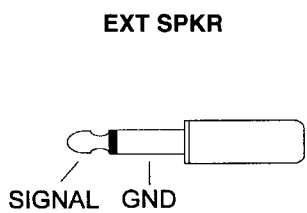
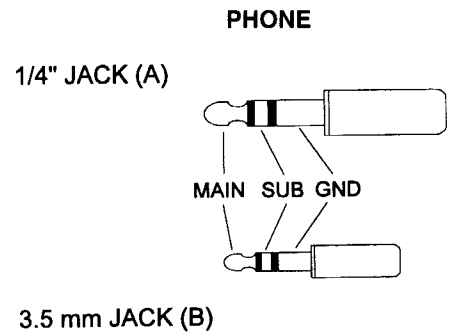
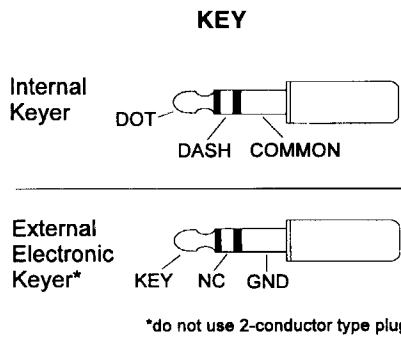
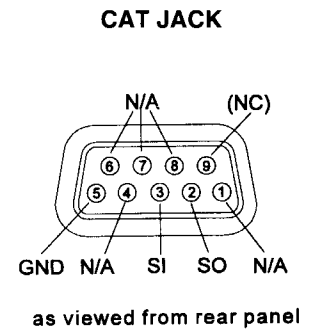
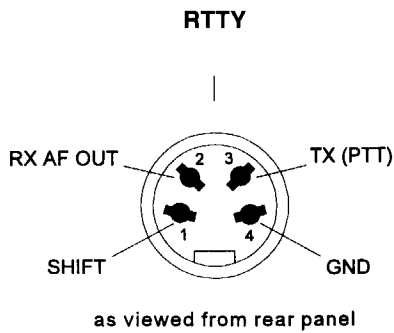
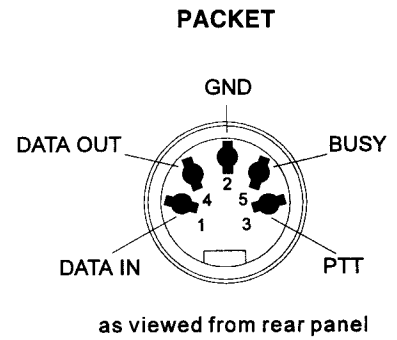
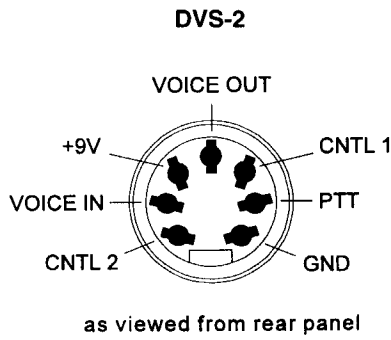
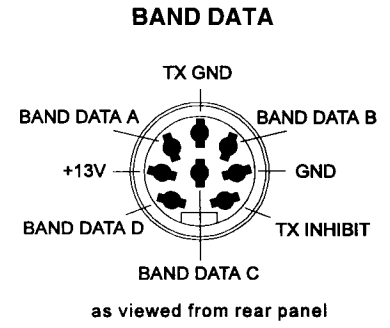
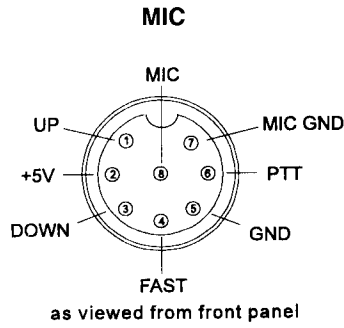


Fig.16-2 PLUG/CONNECTOR PIN OUT DIAGRAMS



17. Technical Glossary for the FT-1000MP

This section provides definitions and explanations of the terminology frequently encountered during operation of the FT-1000MP.

[A]

A/B Antenna Switch

This switch allows the operator to select from the two available transceive antenna jacks.

A↔B Key

Pushing this key swaps the contents of the Main and Sub VFO registers.

A▷B Key

Pushing this key copies the contents of the Main VFO register into the Sub VFO register.

AC Receptacle

This three-pin jack accepts AC power input. Voltages in the range 100~117 V and 200~234 V may be accommodated.

ADC (Analog-to-Digital Converter)

Digital signal processing, and certain other signal manipulation circuits, require that an analog signal be converted to digital form. The ADC is a conversion circuit which breaks up the analog signal into extremely fine segments, assigns a numerical value to each point on the signal according to its characteristics, and then feeds this data stream to the processing circuitry; the "desired" numbers and "undesired" numbers are then kept or discarded by software, according to the operational requirements of the moment.

AF OUT Jack

This 3.5 mm stereo jack on the rear panel provides fixed-level audio output for connection to a recording or decoding device such as a WeatherFax demodulator, or to a stereo amplifier. Peak signal level is 200 mV (rms) at an impedance of 600Ω. Main receiver audio is provided on the Tip connector, and Sub receiver audio is provided on the Ring connector.

AF REV Key

Pressing this key reverses the relationship of the Main and Sub receiver audio as adjusted by the AF Gain control on the front panel.

AFSK (Audio Frequency-Shifted Keying)

AFSK operation is a common technique for generation of the tones needed for digital mode operation. In AFSK operation, two audio tones are supplied by a Terminal Node Controller (TNC) to an SSB modulator, which amplifies them as though they were a voice signal. In the FT-1000MP, AFSK operation is supported via the "Packet" jack and the "PKT" mode of operation. AFSK operation can be easier to accomplish, especially for the neophyte digital operator, because the TNC's decoder is aligned to match the frequencies of its tone generator; therefore, if the operator's computer is successfully copying another station, the chances are good that a connection to that station will be easily possible. If the transmit frequency-shifted tones are generated inside the transceiver, the operator must be somewhat more watchful against accidental programming of transmit frequency offsets.

AGC Switch

The Automatic Gain Control (AGC) system for the receiver includes selectable receiver recovery times of Slow and Fast, with the "Auto" position providing different automatic selections depending on the mode. An "AGC Off" position is also provided, although in most instances the AGC should be left on.

ALC System

The transmitter's Automatic Level Control (ALC) system provides automatic control of the drive levels throughout the transmit chain, so as to promote good linearity on SSB, prevent excessive current consumption or RF output, protect the power amplifier from excessive SWR, and it also provides important reflected-voltage information which is used to control the action of the antenna tuner. Metering of the ALC level is provided on the front panel.

AM Mode Key

Pushing this key activates the AM mode. Pushing this key twice activates the Synchronous Detection mode on AM.

AMTOR

One of the most popular digital operating modes, AMTOR stands for AMateur Teleprinting Over Radio, and is an error-correcting mode of operation.

A▷M

Pushing and holding in this key for 1/2 second writes the contents of (Main) VFO-A into the currently-selected memory channel.

ATT (Attenuator) Switch

The Attenuator switch allows the operator to select receiver input attenuation levels of 6 dB, 12 dB, or 18 dB (one S-Unit steps) in situations where low noise figure is not needed.

Auto Notch Circuit

This popular feature of the EDSP automatically detects and nulls out any carriers or other beat signals within the receiver audio passband. Multiple beats can be eliminated using this circuit.

[B]

Back Up Switch

This switch, located on the rear panel, is used to turn the memory back-up battery on or off. When the switch is in its normal "On" position, memory contents and operational settings are preserved, even though main AC or DC power is cut off.

BAND Keys

These keys on the front panel keypad provide one-touch band change. Two VFO registers are provided for each band, allowing the owner to store, for example, one SSB and one CW "favorite frequency" on each band, if desired.

BAND DATA Jack

This eight-pin interlocking-type DIN connector is used for interconnection to the Yaesu Model FL-7000 Linear Amplifier. Automatic bandswitching information, T/R control, 13.5V DC, and transmitter-inhibiting lines are provided via this jack.

BANDWIDTH Key Matrix

These keys allow operator selection of the desired combination of 8.215 MHz (2nd IF) and 455 kHz (3rd IF) receiver filters.

BAND-PASS Filters (RF)

The FT-1000MP receiver front end includes a bank of eleven Band-Pass filters, which serve to protect the RF amplifier and 1st mixer stages from strong out-of-band signals. These filters are switched using PIN diodes on their inputs, so as to minimize 2nd-order intermodulation problems.

BK-IN Switch

Pushing in this switch activates the CW full break-in feature.

[C]

Carrier Point

The "Carrier Point" is the precise frequency at which the carrier is found in a signal's spectrum, even if it is suppressed (as in SSB telephony). Adjustment of the carrier point relative to the center frequency of an IF filter allows either high-frequency or low-frequency components to be enhanced or suppressed, depending on the mode of operation and the direction of the adjustment.

CAT Jack

The Computer Aided Transceiver (CAT) System, pioneered on Yaesu's FT-980 over a decade ago, now provides for easy interconnection directly to a serial cable from your personal computer's communication port via the rear panel (male) DB-9 CAT connector. The built-in TTL-to-RS-232C level converter eliminates the need for an external interface card. Serial communication is at 4800 baud, and the FT-1000MP is supported by most of the popular software packages available on the market today.

CLAR (Clarifier) Control/Switches

Offset tuning from the current operating frequency is provided by the Clarifier control and switches. An offset of up to ± 9.99 kHz may be set via the rotary Clarifier control, and then the RX (RIT) and/or TX (XIT) controls may be utilized to apply this offset to the receive, transmit, or both frequencies.

C/N (Carrier-to-Noise) Ratio

This is a measure of an oscillator's noise spectrum performance, used to evaluate the impact of the oscillator on a transmitter or receiver's net system performance. A quiet oscillator, like those used in the FT-1000MP, will have very, very low noise output either side of the carrier frequency.

Collins® Mechanical Filters

Collins® Mechanical Filters are available in both 2.75 kHz and 500 Hz bandwidths for the FT-1000MP (the SSB filter is factory installed; the CW filters--one each for Main and Sub receivers--are optional accessories). These 455 kHz filters utilize a new manufacturing process, and they provide extremely high reliability and stability, along with excellent signal reproduction characteristics.

COMP (Compression) Metering

During SSB operation utilizing the RF Speech Processor, the COMP scale on the meter indicates the Compression level in use. Adjustment of the Compression level is accomplished using the "PROC" (Processor) control on the front panel.

CPU (Central Processing Unit)

The CPU in the FT-1000MP is the main control and linking center of the FT-1000MP. The M37702 Main processor and its associated sub-processors and interface ICs allow an unprecedented degree of operating flexibility, memory capacity, and frequency resolution thanks to the high computational speed (25 MHz) and low-overhead control software architecture.

CPU Reset

Resetting of the CPU clears all VFO, memory, and antenna tuner memory settings to their factory defaults. To do this, turn off the [POWER] switch, then push the [SUB], [29], and [ENT] keys and hold all three in while turning the transceiver on.

Contour Control/Circuitry

The "Contour" circuits in the receiver EDSP allow the operator to select high-pass, low-pass, mid-band-cut, and band-pass responses by appropriately rotating the Contour control on the front panel. The equivalent function in the transmit mode is the Microphone Equalizer.

CTCSS (Continuous Tone-Controlled Squelch System)

A CTCSS Tone encoder is built into the FT-1000MP, allowing the operator to use a subaudible tone for access to 29 MHz repeater stations requiring such a tone. The CTCSS tone is automatically activated when the [RPT] key is pressed.

CW Mode Key

Pushing this switch activates the CW mode. Pushing this switch a second time places the transceiver in the "CW-Reverse" mode, which utilizes LSB-side injection instead of the default USB-side injection.

[D]

DC 13.5 Jack

This jack may be used for input of DC power, if AC power is unavailable. If both AC and DC power are applied to the transceiver, the external DC power source has priority and the internal AC power supply is disengaged. DC power requirements are 13.5 V at less than 20 Amps.

DDS (Direct Digital Synthesis)

Many of the important oscillator signals utilized in the FT-1000MP are generated using a DDS method, which provides extraordinarily fast lock-up time and low noise. The newly-designed DDS circuitry utilized in the FT-1000MP incorporates a 24-bit data stream, not the usual 18 bit; this allows 64 times more frequency resolution, thus providing the capability of tuning in steps of 0.625 Hz.

DFCS (Duct Flow Cooling System)

This unique Yaesu design concept provides highly-efficient heat transfer for the power amplifier, power supply, and antenna tuner units, thanks to the large cross-flow fan and heat sink.

DOWN Key

Pushing this switch causes the operating frequency to be lowered by 100 kHz (1 MHz when the [FAST] key is engaged), for quick movement around a band.

DUAL Key

Pushing this key activates the Dual Receive feature of the FT-1000MP, in which both the Main and Sub receivers are active at the same time.

DVS-2 Jack

This jack allows connection of the DVS-2 Digital Voice Recorder, a popular accessory among contest operators, which allows storage and playback of repetitive messages often needed during radiosport competitions.

Dynamic Range

The Dynamic Range of a receiver is a measure of its ability to withstand input from strong signals without (A) generating spurious signals of its own, or (B) shutting down due to blocking. The two most commonly-encountered measures of Dynamic Range are 2nd order dynamic range (where strong signals at f_1 and f_2 combine to produce an intermodulation response at $f_{im2} = f_1 + f_2$) and 3rd order Dynamic Range (where the intermodulation response appears at $f_{im3} = 2f_2 - f_1$ or $f_{im3} = 2f_1 - f_2$).

[E]

EDSP (Enhanced Digital Signal Processing) Switch/Circuit

The front-panel [EDSP] switch activates the EDSP feature both on transmit and receive, as enabled through any applicable Menu settings. Utilizing the NEC[®] μ PD77016 operating in a 16-bit environment at a maximum clock speed of 66.666 MHz, the EDSP system provides a wide variety of interference-fighting and signal-customization selections for the owner.

EXT ALC Jack

This RCA-type female connector is provided for injection of externally-generated, negative-going ALC voltage (typically, from a linear amplifier). The control voltage range is 0 to -4 Volts DC.

EXT SPKR Jack

This jack is used to connect an external speaker to the transceiver. The output is mixed (Main plus Sub Receivers), and the acceptable impedance is 4 ~ 16 Ω .

[F]

FAST Key

Pushing this key increases the rate of change of frequency during rotation of the Main Dial, scanning, or frequency-hopping using the [UP] and [DOWN] keys.

FUSE Holder

This socket on the rear panel holds the AC line fuse (8 Amps for 100 ~ 117 V, 4 Amps for 200 ~ 234 V). Separate DC fuses are provided in the (optional) DC cable.

***NOT AVAILABLE IN EUROPE**

[G]

Gain Balance

In many receivers, a byproduct of activating narrow-bandwidth filters is a significant loss of signal strength, due to the additional insertion loss of the narrow filters compared to standard 2.4 kHz SSB filters. In the FT-1000MP, a combination of attenuators (for low-loss elements) and amplifiers (for high-loss elements) maintains essentially unity gain over the entire range of available bandwidth selections, allowing the full benefit of improved signal-to-noise ratio to be realized as the bandwidth is narrowed.

GND (Ground) Lug

This threaded lug is used for connection to an earth ground.

[H]

HPF (High-Pass Filter) Circuits

High-Pass Filter circuits are used to protect later stages from strong signals which are lower in frequency than the current operating frequency. In the case of the FT-1000MP, three HPFs are provided, so as to roll off signals below the 80-, 40-, and 20-meter amateur bands, the most crowded, high-signal environments in the HF spectrum. Attenuation at half frequency is 36 dB or better, and these filters use relay switching so as to utilize no IMD-producing components (such as diodes) ahead of the protection afforded by the HPFs. The result is a 2nd-order intermodulation distortion intercept point typically better than +85 dBm.

[I]

IC

The "IC" indication on the front panel meter displays the current ("I") being drawn by the collectors ("C") of the final amplifier stage.

IF (Intermediate Frequency) Circuits

A modern superheterodyne transceiver utilizes one or more conversions to IFs, frequencies at which some task is to be performed. For example, since it currently is not possible to build a 250 Hz bandwidth frequency-agile CW filter that tunes the entire HF spectrum, the RF signal is converted to one or more IFs, in which the signal is passed through crystal or mechanical filters, amplified, and (in the case of the FT-1000MP) subjected to digital signal processing. The IFs used in the FT-1000MP are 70.455 MHz, 8.215 MHz, 455 kHz, and 10.24 kHz (EDSP) for the Main Receiver, and 47.21 MHz and 455 kHz for the Sub Receiver.

IF Filters

Pursuant to the above discussion, the FT-1000MP provides banks of up to four 8-pole crystal filters in the 8.215 MHz IF, and as many as five filters (crystal, ceramic, or Collins[®] Mechanical Filters) in the 455 kHz IF.

IMD (Intermodulation Distortion)

A condition whereby two or more signals mix in a device so as to produce a spurious response. Intermodulation can be a problem both on transmit and receive, and the design team for the FT-

1000MP have taken special care to ensure high immunity from intermodulation throughout the transceiver.

Intercept Point

In receiver design and evaluation, the concept of the "Intercept Point" is an important aspect of concern to engineers. The "Intercept Point" is an imaginary intersection point on a graph of two intersecting lines: one line represents increasing signal strengths of incoming signals, and the other line represents the (more rapidly) increasing signal strength of intermodulation signals. Where the input signals (typically two or more tones) and the intermodulation signals theoretically become the same strength is the "Intercept Point" for the specific type of intermodulation being evaluated, and a "higher" number clearly is "better." Because of gain compression in the RF and IF amplifiers, the Intercept Point can never be observed in practice; the Intercept Point is derived by extending the linear portions of the graphs of input signals and intermodulation signal(s) until they intersect.

The Intercept Point may be quoted in terms of the "Input Intercept" or the "Output Intercept." The two terms are related to the extent that the Output Intercept equals the Input Intercept plus the Gain of the stage under test. Thus, it is possible to specify the Input Intercept of a receiver system, but not a meaningful Output Intercept, because the value of the latter term would depend on the setting of the AF Gain (Volume) control.

IPO (Intercept Point Optimization)

By feeding the receiver first mixer directly, without any RF preamplification, the Intercept Point performance will be enhanced. Eliminating the RF preamplifier will, of course, degrade the Noise Figure (and, hence, the sensitivity) of the receiver, but on frequencies below about 10 MHz the RF preamplifiers may not be necessary (depending on the user's location, antenna, etc.). The potential improvement in Intercept performance is achieved due to (1) the reduction in gain ahead of the first mixer, and (2) the elimination of the RF preamplifier itself, which (since no amplifier is "IMD-free") could contribute to degraded Intercept performance under some conditions.

[K]

KEY Jacks

Two KEY jacks are provided, one each on the front and rear panels, allowing connection of a 1/2 stereo plug for keyer paddle, external electronic keyer, or straight CW key input. The "Key-UP" voltage is +5 V DC, and the "Key-Down" current is 0.5 mA. The two jacks are connected in parallel, thereby allowing the user to connect one jack to an external manual keyer and the other to a computer-driven keying interface for use in conjunction with contest logging software.

KEYER Switch

Pushing this switch activates the built-in Electronic Keyer circuit.

KEYPAD

The front panel keypad allows one-touch band change or direct frequency entry for both the Main and Sub VFO registers.

[L]

LIN Switch

The rear panel LINear switch is used to activate or de-activate the mechanical relay which is connected to the "TX GND" jack. If a linear amplifier is utilized whose T/R relay control voltage is less than about +40 V DC (at 300 mA or less), the relay may not be needed (the transistor-based control line connected to the "BAND DATA" jack may be used). For high-voltage relay control situations, however, the "TX GND" jack may be used once the "LIN" switch is set to the "On" position.

LOCK Switches

These switches, one each for the Main and Sub VFO dials, allow the respective dial mechanisms to be fixed (electronically) on the current frequency, so as to avoid accidental frequency change. Pushing the Main Dial's [LOCK] key in and holding it in while turning the Main Dial will activate the "Tracking" function, in which the Main and Sub VFOs are slaved (moving in tandem).

LSB Key

Pushing this key in activates the LSB mode. The green LED associated with this mode key will also become illuminated during RTTY or Packet operation if LSB-side operation is selected by the user.

[M]

M▷A Key

Pushing this key transfers the contents of the current memory channel into the register for VFO-A, and simultaneously will switch the transceiver from the memory mode to the VFO mode.

MAIN (AF Gain)

This control is used to adjust the volume level for audio produced by the Main receiver.

MC13020

This is the product designator for the renowned Motorola® IC which uses the C-QUAM method of AM detection. The FT-1000MP uses this IC for both synchronous and envelope detection of AM signals.

MCK Key

Pushing this key activates the "Memory Check" mode, a "scratchpad" condition whereby the contents of the memory channels may be inspected without actually changing the transceiver's current operating frequency. The "Memory Check" display replaces the Sub VFO frequency when this switch is pressed.

MDS (Minimum Detectable Signal)

The MDS is a measure of the minimum signal that can be detected by a receiver, and it is defined as the signal level which produces a 3 dB signal-to-noise ratio when compared to the zero-signal condition. Thanks to the low-noise design techniques and EDSP signal enhancement used in the FT-1000MP, MDS figures in the CW mode of -148 dBm or better are obtainable, making this transceiver particularly outstanding as a tunable IF for a VHF or UHF receive converter.

Memory Mode

This mode of operation utilizes the 108 regular memory channels plus the 5 QMB (Quick Memory Bank) memories to provide instant recall of a previously-stored frequency. In the FT-1000MP, frequency, mode, and bandwidth information are all stored at the same time.

MEM GROUP Key

Pressing this key toggles memory operation from the "All Channel" mode to the "Memory Group" mode, the latter of which allows more important memories to be segregated into up to four groups, so they may be inspected more quickly.

M TUNE Mode

The memory system allows the operator freely to tune off of a memory channel. This "M TUNE" (Memory Tune) mode turns the memory mode into a pseudo-VFO mode, because the memory channel can be retuned to any frequency within the range of the transceiver; mode and bandwidth may also be changed, and a retuned memory's contents may be. Pressing the [VFO/MEM] key once during Memory Tuning causes the register to revert to the original memorized frequency; another press of the [VFO/MEM] key shifts the transceiver into the VFO mode.

MEM/VFO CH Control

This knob, in its default configuration, is used to select from among the available memory channels. Through the Menu system, however, it may be changed into a "VFO Channel" selector, whereby the Main VFO will tune in user-defined steps (like 1 kHz or 5 kHz) for quick frequency excursions.

MIC Jack

This eight-pin jack accepts microphone input, along with PTT (Push To Talk) and scanning controls from the microphone. A +5 V line is also provided for powering the MD-100A8X Desk Microphone.

MIC Knob

This control provides adjustment of the microphone input level for SSB and AM operation.

Microprocessor (μ P)

See "CPU."

MONI Control and Switch

The MONItor feature utilizes the Sub Receiver to provide monitoring of the actual RF signal as it is being transmitted. This makes the Monitor ideal for making EDSP modulation or keying waveform adjustments. The [MONI] key turns the feature on and off, and the "MONI" knob adjusts the monitoring audio level.

MOX Switch

This switch, when pressed, activates the transmitter by closing the PTT (Push To Talk) line to ground.

[N]

NB (Noise Blanker) Control

This knob adjusts the detection level of the noise blanker circuitry.

NB1 Key

This key activates the narrow-pulse noise blanker, for blanking noises typically emanating from power lines, automotive ignition systems, etc.

NB2

This key activates the wide-pulse noise blanker, for those pulses emulating the width of the now-inactive "Woodpecker" over-the-horizon radar.

Noise Figure

The Noise Figure of a circuit or system, expressed in dB, is the amount of noise added by that circuit or system compared to the noise generated by a 50 Ω resistor at room temperature.

Noise Floor

See "MDS."

NR (Noise Reducer)

The EDSP Noise Reducer feature provides selection from among four noise-reduction protocols in EDSP. The operator rotates the "NR" control so as to find the setting that provides the best reduction of noise; it is impossible to predict which setting will be best, as the four settings represent different mathematical algorithms, not "blanking level" settings.

[O]

Over-Sampling

In the world of digital signal processing, an analog signal is converted into a digital signal by sampling the analog signal and "slicing" it into tiny segments, or samples. Clearly, the smaller (and, hence, more numerous) the samples, the better the resolution and quality of signal reproduction. The degree of Over-Sampling is one index of the digitizing resolution used, so as to gauge the expected signal quality after processing is completed.

[P]

PACKET Jack

This five-pin DIN connector is used for AFSK data input, data output, and PTT (Push To Talk) connections. This jack is active when the "PKT" mode is engaged.

PATCH Jack

This RCA-type jack may be used as an auxiliary microphone audio input port, or it may be used as an auxiliary AFSK data input port.

PHONES (A-B) Jacks

These front panel receptacles (3.5mm stereo and 1/2 stereo) may be used for connection of headphones. When using stereo headphones, the audio from the Main and Sub receivers may be separated during Dual Receive operation, if desired.

PITCH Control

This control is used to adjust the pitch of the CW monitor note, the CW carrier offset, and the center frequency of the receiver passband in tandem, so as to allow the operator to center all

aspects of CW operation around his or her preferred center frequency. Center frequencies anywhere from 300 Hz to 1050 Hz may be selected in 50 Hz steps.

PKT Mode Selection Key

This key activates the "Packet" (AFSK) mode of operation. Repeatedly pushing the [PKT] key allows alternate selection of the "PKT/LSB" and "PKT/FM" modes of operation. An emulation of "PKT/USB" can be set up utilizing the [USER] key, described later.

PMS Memory Channels

These channels (P1 ~ P9) are used for the PMS (Programmable Memory Scan) feature, by which the operator may define and store upper and lower sub-band limits for scanning.

POWER Switch

This is the main On/Off switch for the transceiver.

PROC Switch

Pushing this switch activates the RF Speech PROCessor.

PROC Control

Rotating this control allows adjustment of the compression level for the RF Speech PROCessor.

PTT (Push To Talk) Switch/Circuit

The PTT circuit, throughout the transceiver, is the overall transmit/receive control line. When this line is grounded, the transceiver is switched into the transmit mode; when the line is released from ground, the transceiver reverts to the (default) receive mode. The rear panel "PTT" RCA-type jack may be used for connection of a footswitch for hands-free phone operation, or it may be used for connection to a terminal unit's PTT line for T/R control during data operation. A PTT switch is also found on all Yaesu microphones specified for use with the FT-1000MP, and PTT input lines are also provided on "PACKET," "RTTY," and "DVS-2" jacks.

[Q]

QMB Channels

This is a specially-segregated memory bank of five channels which are available for very-quick storage and recall.

QMB RCL Key

This key is used for recall of the QMB channels.

QMB STO Key

This key is used to write the contents from the Main VFO to the Quick Memory Bank.

[R]

REMOTE Jack

This jack may be used for four different remote control functions, utilizing the optional FH-1 Keypad or a home-built version. The FH-1 may be used for controlling the built-in Contest Memory Keyer, or to replicate front-panel functions.

RF AGC

The RF-stage AGC circuit utilizes PIN diodes, which have excellent immunity from IMD as well as a wide control range for attenuation.

RF Amplifiers (Receive)

Three RF preamplifiers are provided in the FT-1000MP: one is a general purpose wideband preamp which utilizes four junction FETs in a parallel, push-pull configuration; the two others are specially "tuned" preamps, including a source-follower JFET amplifier for the low bands and a dual-gate MOSFET amplifier for the high bands. The RF Amplifiers are selected via the Menu system, and they also may be bypassed, if desired, by pressing the [IPO] (Intercept Point Optimization) key.

RF Gain Control

This control adjusts the gain of the RF and IF receiver stages, so as to allow the operator to control the total receiver system gain or the AGC threshold point precisely.

RF PWR Control

This control allows adjustment of the RF power output.

RPT Key

This key, when pushed, places the transceiver in the "Repeater" mode of operation when on 29 MHz in the FM mode. The "Repeater" mode activates a repeater shift function as well as a (subaudible) CTCSS tone generator.

RTTY Jack

This four-pin DIN connector is used for FSK data input, data output, and PTT control connections. This jack is active when the "RTTY" mode is engaged.

RTTY Mode Selection Key

Pressing this key activates the RTTY (Radio Teletype) mode (FSK). By repeatedly pushing this key, alternating selection of the "RTTY/LSB" and "RTTY/USB" modes is provided.

RX ANT Jacks

These RCA-type connectors may be used for connection of a dedicated receive-only antenna, for insertion of a special-purpose filter or amplifier, or for connection of a VHF/UHF receive converter.

RX ANT Switch

This front-panel switch allows the operator to select the device connected to the RX Antenna jacks on the rear panel. This switch action affects both the Main and the Sub receivers.

RX LEDs

These green LEDs (Light-Emitting Diodes) provide a visual indication of which receiver(s) are currently active. If both RX LEDs are illuminated, this indicates that the transceiver is in the Dual Receive mode.

[S]

SHIFT Control

This control is used for adjustment of the IF Shift circuitry, which is frequently useful in combatting nearby interference.

FUNCTION MENU

Table 11-1 TRANSCEIVER FUNCTION SETTING

| FUNC. No. | FUNCTION | SETTING RANGE | DEFAULT |
|-----------|--|--------------------------------|----------|
| 0-1 | MEMORY GROUP 1 CHANNELS | 1 ~ 99 | 01-99 |
| 0-2 | MEMORY GROUP 2 CHANNELS | 0 ~ 99 | OFF |
| 0-3 | MEMORY GROUP 3 CHANNELS | 0 ~ 99 | OFF |
| 0-4 | MEMORY GROUP 4 CHANNELS | 0 ~ 99 | OFF |
| 0-5 | MEMORY GROUP 5 CHANNELS | 0 ~ 99 | OFF |
| 0-6 | QUICK MEMORY CHANNELS | 1 ~ 5 | 5 |
| 0-7 | NONE | | |
| 0-8 | V ► M AUTO CHANNEL UP | ON / OFF | OFF |
| 0-9 | NONE | | |
| 1-0 | VFO A & B DIAL SPEED | x 2, x 4 | x 4 |
| 1-1 | SHUTTLE JOG DIAL SPEED | 1 ~ 100ms | 50ms |
| 1-2 | IF SHIFT / WIDTH STEP SIZE | 10 / 20 Hz | 10 Hz |
| 1-3 | MAIN VFO-A TUNING STEP SIZE | 0.625 ~ 20 Hz | 10 Hz |
| 1-4 | SUB VFO-B TUNING STEP SIZE | 0.625 ~ 20 Hz | 10 Hz |
| 1-5 | CHANNEL STEP SIZE | 1 ~ 100 kHz | 10 Hz |
| 1-6 | QUICK SPLIT OFFSET | 1 ~ 100 kHz (±) | 5 Hz |
| 1-7 | AUTOMATIC SELECTION OF THE AGC DECATE TIME | ON / OFF | OFF |
| 1-8 | CLAR M-TUNE FUNCTION | ON / OFF | ON |
| 1-9 | CLAR TUNING STEP SIZE | 0.625 ~ 20 Hz | 10 Hz |
| 2-0 | SCAN PAUSE | ON / OFF | ON |
| 2-1 | SCAN RESUME MODE | CAR STOP / CAR SLOW / CAR TIME | CAR STOP |
| 2-2 | NONE | | |
| 2-3 | MEMORY SCAN SPEED (DWELL TIME) | 100 ms ~ 1 s | 200 ms |
| 2-4 | VFO SCAN SPEED (DWELL TIME) | 1 ~ 100 ms | 10 ms |
| 2-5 | AUTO MEMORY WRITE | OFF / GROUP 1 / GROUPS ALL | OFF |
| 2-6 | MEMORY SCAN SKIP | OFF / ALL | OFF |
| 2-7 | SCAN DELAY TIME | 1 ~ 10 s | 5 s |
| 2-8 | NONE | | |
| 2-9 | IF NOTCH MODE | IF NOTCH / AUTO / SELECT | IF NOTCH |
| 3-0 | FREQUENCY DISPLAY | OFFSET / CARRIER | OFFSET |
| 3-1 | DISPLAY RESOLUTION | 10 Hz / 100 Hz / 1 kHz | 10 Hz |

| FUNC. No. | FUNCTION | SETTING RANGE | DEFAULT |
|-----------|---|--|--|
| 3-2 | ETS (Enhanced Tuning Scale) | CLAR / DIAL | CLAR |
| 3-3 | Transverter Frequency Display | OFF / 50 / 144 / 430 | OFF |
| 3-4 | Dimmer (Display Brightness) | LOW / HI | HI |
| 3-5 | Panel Display Mode | PITCH / CLAR / CH FREQ / OFFSET | CLAR |
| 3-6 | SUB VFO-B S-Meter | ON / OFF | ON |
| 3-7 | MAIN VFO-A Meter Peak-Hold | ON / OFF | OFF |
| 3-8 | SUB VFO-B Meter Peak-Hold | ON / OFF | OFF |
| 3-9 | NONE | | |
| 4-0 | RF Output Power (limit) | 100 / 50 / 10 W | 100W |
| 4-1 | KEY & PANEL BEEPER | ON / OFF | ON |
| 4-2 | KEY & PANEL BEEP PITCH | 220 ~ 7040 Hz or BEEP TUN ON / OFF | 880 Hz |
| 4-3 | TUNING DRIVE (AUTO POWER-DOWN) | 10 / 50 / 100 W | 50 |
| 4-4 | TX AUDIO EDSP | OFF, 1, 2, 3, 4 | OFF |
| 4-5 | <i>EDSP Filters</i> SSB LPF SSB HPF CW BPF AM LPF AM HPF DIGITAL FILTER | 100 ~ 3200 Hz 100 ~ 1800 Hz 60 / 120 / 240 Hz 1000 ~ 3200 Hz 100 ~ 1800 Hz PKT / SSTV / FAX | 3200 Hz 100 Hz 240 Hz 3200 Hz 100 PKT |
| 4-6 | DVS RX RECORDING | MAIN VFO / SUB VFO | MAIN VFO |
| 4-7 | DVS PTT CONTROL | ON / OFF | ON |
| 4-8 | HEADPHONE AUDIO | MONO / STEREO 1 / STEREO 2 | STEREO 1 |
| 4-9 | AF GAIN BALANCE CONTROL | SEPARATE / BALANCE | SEPARATE |
| 5-0 | 8.2 MHz FILTER | 2.4 K ON / OFF | ON |
| 5-1 | 8.2 MHz FILTER | 2.0 K ON / OFF | OFF |
| 5-2 | 8.2 MHz FILTER | 500 ON / OFF | ON |
| 5-3 | 8.2 MHz FILTER | 250 ON / OFF | OFF |
| 5-4 | 455 KHz FILTER | 2.4 K ON / OFF | ON |
| 5-5 | 455 KHz FILTER | 2.0 K ON / OFF | OFF |
| 5-6 | 455 KHz FILTER | 500 ON / OFF | OFF |
| 5-7 | 455 KHz FILTER | 250 ON / OFF | OFF |
| 5-8 | SUB VFO RX FILTER | ON / OFF | OFF |
| 5-9 | TX EDSP FILTER | 6.0 kHz / 2.0 kHz | 6.0 kHz |
| 6-0 | RTTY SHIFT | 170 / 425 / 850 Hz | 170 Hz |
| 6-1 | RTTY POLARITY | NORMAL / REVERSE | NORMAL |
| 6-2 | RTTY TONE PAIR | HIGH TONE / LOW TONE | HIGH TONE |

| FUNC. No. | FUNCTION | SETTING RANGE | DEFAULT |
|-----------|---|---|---|
| 6-3 | RTTY FREQUENCY DISPLAY | CARRIER / OFFSET | OFFSET |
| 6-4 | PACKET FREQUENCY DISPLAY OFFSET | ±3.000 kHz | -2.125 kHz |
| 6-5 | PACKET TONE FREQUENCY | 1170 - 2215 Hz | 2215 kHz |
| 6-7 | CTCSS TONE SELECT | 67.0 - 250.3 Hz | 88.5 Hz |
| 6-8 | TONE MODE | CONTINUOUS / BURST | CONTINUOUS |
| 6-9 | REPEATER SHIFT (TX OFFSET) | 0 - 200 kHz | 100 Hz |
| 7-0 | ELECTRONIC KEYSER MODE | IAMBIC 1 / BUG / IMABIC 2 | IMABIC 1 |
| 7-1 | KEYER DOT WEIGHTING | 0 (0.5) ~ -127 (2.0) | 10 (1 : 1) |
| 7-2 | KEYER DASH WEIGHTING | 0 (2.0) ~ 127 (4.5) | 30 (1 : 3) |
| 7-3 | KEYER CONTEST NUMBER | 0000 - 9999 | 0000 |
| 7-4 | KEYER BREAK-IN TIME | 0 - 30 ms | 5 ms |
| 7-5 | KEYER DELAY TIME | 0.00 - 5.10 | 0.00 |
| 7-6 | CONTEST NO. PLAYBACK STYLE | ID NO. 1, 2, 3, 4, 5, 6, 7, 8, 9, STYLE | |
| 7-7 | EDSP MODULATION & DEMODULATION | SSB (Rx) 100-3100Hz, 300-2800 Hz, OFF SSB (Tx) 100-3100Hz, 150-3100 Hz, 200-3100Hz, 300-3100 Hz, OFF CW (Rx) 100-3100Hz, OFF AM (Rx) 70-3800Hz, OFF | OFF OFF OFF OFF |
| 7-8 | SUB RECEIVER | ON / OFF | ON |
| 7-9 | REMOTE CONTROL FUNCTION | EL / PANEL / AIO / BIO | EL |
| 8-0 | FAST KEY OPERATION | CONTINUOUS / TOGGLE | TOGGLE |
| 8-1 | LOCK SELECTION | DIAL / PANEL / PRIMARY | DIAL |
| 8-2 | SPLIT OPERATION | NORM / AUTO / A-B | NORM |
| 8-4 | FRONT END RF AMP SELECTION | TUNED / FLAT | FLAT |
| 8-5 | ANT KEY FUNCTION | AUTO / ON / OFF | AUTO |
| 8-6 | USER SETTING MODE DISPLAY OFFSET RECEIVE PLL RECEIVE CARRIER TRANSMIT PLL TRANSMIT CARRIER RTTY OFFSET EASY SET | LSB, USB, CW (U&L), RTTY (U&L), PKT ±5.000 kHz ±5.000 kHz 450.000 ~ 460.000 kHz ±5.000 kHz 450.000 ~ 460.000 kHz ±5.000 kHz OFF / SSTV / FAX | LSB } see Table 11-4~ 11-7 (P.28) 0.000 kHz OFF |
| 8-7 | SUB RX AGC | AUTO / SLOW / FAST | AUTO |
| 8-8 | TUNER | ON / OFF | ON |
| 8-9 | CARRIER OFFSET RX LSB CARRIER TX USB CARRIER PROC. LSB CARRIER CARRIER OFFSET RX LSB CARRIER TX USB CARRIER PROC. USB CARRIER TX AM CARRIER | -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz -0.200 ~ 0.500 kHz | 0.000 kHz |

(B) Direct-Access Menu Mode

Besides pushing the [FAST] and [ENT] keys, there is another, more direct, way in which to access five frequently-used Menu items. By pushing [FAST] and the key shown below, the Menu Item shown in Figure 10-1 will be activated automatically, without the need to rotate the [MEM/VFO CH] knob.

Table 11-1 Direct-Access Menu Mode

| Number | Function | Switch |
|--------|-------------------------------|--------------------------|
| 2-9 | Notch Operation | NOTCH Switch |
| 3-4 | LCD Display Brightness | VCC MIC(METER) Switch |
| 4-5 | EDSP Receive Band Pass Filter | EDSP Switch |
| 7-5 | Keyer Delay | BK-IN Switch |
| 8-7 | SUB VFO Receiver AGC | RX-(SUB VFO-B) Indicator |

(C) [USER] Key

The FT-1000MP is designed to allow the user to program custom settings of the carrier injection point, frequency display technique, or other aspects of transceiver configuration of importance in digital communication. Once programmed, this custom configuration can be activated by pressing the [USER] key.

The functions which may be programmed in this manner, via Menu Item 8-6, include:

① Basic Mode

This selection defines the operating mode, similar to the pushing of one of the front panel Mode switches. It is important to set the correct mode, as it is impossible to modulate the transceiver via the Packet jack, for example, when the transceiver is in the USB mode.

The FM mode is not available via the [USER] key.

Table 11-2 Basic Mode Selections

| MODE | | | |
|-----------------|---------|-------------|-------------|
| Display | Mode | Display | Mode |
| L S b | LSB | r t t y - l | RTTY(LSB) |
| u S b | USB | r t t y - u | RTTY(USB) |
| R i - u P P F r | CW(USB) | P R c - l o | PKT(LSB) |
| R i - l o | CW(LSB) | | Default LSB |

② Display Offset

This setting allows the frequency display to reflect the carrier frequency, which may be (depending on the mode) different from the receiving zero-beat frequency. Total adjustment range is ± 5 kHz, with 5 Hz resolution.

Table 11-3 Display Offset Adjustment

| Display | dSP·oFSt | | | | | | |
|---------------|--------------------|----------|----------|-----------|-----------|-----------|-----------|
| | Display Offset | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | 0.000kHz | 0.000kHz | 0.700kHz | -0.700kHz | -2.125kHz | 2.125kHz | -2.125kHz |
| Range | -5.000kHz~5.000kHz | | | | | | |

③ Receiving PLL Offset

This setting allows alignment of the receive PLL and IF filter offset frequency.

Total adjustment range is ± 5 kHz, with 5 Hz resolution.

Table 11-4 RX PLL Oscillator Offset Adjustment

| Display | r-PLL | | | | | | |
|---------------|-------------------------|----------|----------|-----------|-----------|-----------|-----------|
| | RX PLL Frequency Offset | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | -1.450kHz | 1.450kHz | 0.700kHz | -0.700kHz | -2.210kHz | 2.210kHz | -2.210kHz |
| Range | -5.000kHz~5.000kHz | | | | | | |

④ Receiving Carrier Point

This setting allows alignment of the center frequency of the IF filter passband, without changing the RX frequency itself. This function is a "preset" for the IF Shift feature. The range of adjustment is 450~460 kHz.

Table 11-5 RX PLL Carrier Injection Point Adjustment

| Display | r-car | | | | | | |
|---------------|--------------------|------------|------------|------------|------------|------------|------------|
| | RX Carrier Point | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | 456.450kHz | 453.550kHz | 454.300kHz | 455.700kHz | 457.210kHz | 452.790kHz | 457.120kHz |
| Range | -5.000kHz~5.000kHz | | | | | | |

⑤ Transmit PLL Offset

This setting allow adjustment of the transmit carrier point, which sets the IF filter passband as in the case of the Receiving Carrier Point. In the case of Packet operation, this important setting determines the frequency range of the input tones from the TNC which will be permitted to pass without attenuation, an important consideration when setting up pseudo-USB AFSK operation in the "PKT-LSB" mode.

Table 11-6 TX PLL Oscillator Offset Adjustment

| Display | t-PLL | | | | | | |
|---------------|-------------------------|----------|----------|-----------|-----------|-----------|-----------|
| | TX PLL Frequency Offset | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | -1.500kHz | 1.500kHz | 0.700kHz | -0.700kHz | -2.125kHz | 2.125kHz | -2.120kHz |
| Range | -5.000kHz~5.000kHz | | | | | | |

⑥ Transmit Carrier Point

Table 11-7 TX PLL Carrier Injection Point Adjustment

| Display | t-car | | | | | | |
|---------------|-----------------------------|------------|------------|-----------------------------|------------|------------|--------------------------------|
| | TX Carrier Point | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | 456.500kHz | 453.500kHz | 455.000kHz | 455.000kHz | 455.000kHz | 455.000kHz | 457.120kHz |
| Range | LSB : 456.300kHz~460.000kHz | | | PKT : 456.300kHz~460.000kHz | | | USB : 450.000kHz~453.700kHz |
| | | | | | | | Others : 450.000kHz~460.000kHz |

⑦ RTTY Shift

This setting allows the RTTY Shift specification to be changed from its default 170 Hz specification. Note that, although a maximum shift of 5 kHz is possible to be programmed through software, the maximum realizable shift is 2.4 kHz, the width of the transmitter IF filter. This does not represent an operational limitation in practice, as the shifts used in the real world are much less than 2.4 kHz.

* Prior to Production Lot 05, the value for "TX-CAR" could not be set below 456.300kHz. For these earlier versions, the use of 456.300 kHz should produce satisfactory results.

Table 11-8 RTTY SHIFT Adjustment

| Display | r-tty-shft | | | | | | |
|---------------|--------------------|----------|----------|----------|-----------|-----------|----------|
| | RTTY SHIFT Offset | | | | | | |
| | LSB | USB | CW(USB) | CW(LSB) | RTTY(USB) | RTTY(LSB) | PKT(LSB) |
| Default Value | 0.000kHz | 0.000kHz | 0.000kHz | 0.000kHz | -0.170kHz | 0.170kHz | 0.000kHz |
| Range | -5.000kHz~5.000kHz | | | | | | |

(D) Customization of Carrier Points (Not in USER Mode)

The USB and LSB (suppressed) carrier injection point may be modified via Menu Item 8-9, so as to roll off either high-frequency or low-frequency components in the voice envelope. Similar to the receiver's "IF Shift" feature, this presetting of the carrier point provides yet another area whereby the frequency response of the transceiver may be tailored to the needs of the owner.

Permitted shifts in the carrier point are from -200 Hz to +500 Hz (in 10 Hz increments) on USB and LSB, and -3 kHz to +3 kHz on AM.

12. Personal Computer Control : The CAT (Computer Aided Transceiver) System

In the early 1980s, Yaesu pioneered the concept of the use of external control of an amateur radio transceiver, using a personal computer, with the introduction of the FT-980. More than a decade later, the FT-1000MP carries on this proud tradition.

Applications which support the FT-1000MP and other Yaesu transceivers are widely available for a wide variety of functions in a modern amateur radio station, including contest and DX logging, record-keeping, propagation studies, spectrum analysis, and shortwave listening. New on the FT-1000MP is the inclusion of a single-IC TTL-to-RS-232C level converter, thus eliminating the need for an external interface box as was previously required. Now, a standard serial data cable bearing a female DB-9 type connector may be connected directly to the FT-1000MP's rear panel CAT jack.

(A) Serial Communication Data Format

A typical five-byte command is shown in Figure 11-1 below. Note that the data bite are sent in reverse order, with the Least Significant Digit first, and the Most Significant Digit last. Set your computer's serial communications port for "4800,N,8,2" format (one start bit is used, as usual).

Table 12-1 CAT 5-BYTE COMMAND STRUCTURE

| Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 |
|----------|----------|----------|----------|--------------------|
| Argument | Argument | Argument | Argument | Instruction OPCODE |

Table 12-2 CAT DATA BYTE FORMAT

| Start Bit | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Stop Bit | Stop Bit |
|-----------|---|---|---|---|---|---|---|---|----------|----------|
| | | | | | | | | | | |

Example #1 : Set Main VFO-A to 14.25000 MHz

Breaking 14.250.00 MHz into its BCD component, we arrive at :

| 10's Hz | 100's Hz | 1's kHz | 10's kHz | 100's kHz | 1's MHz | 10's MHz | 100's MHz |
|---------|----------|---------|----------|-----------|---------|----------|-----------|
| 0 | 0 | 0 | 5 | 2 | 4 | 1 | 0 |
| 00 | | 50 | | 42 | | 01 | |
| Byte 1 | | Byte 2 | | Byte 3 | | Byte 4 | |

Inserting the 4-byte BCD-coded frequency (00, 50, 42, 01), the resulting 5-byte block should now look like this (again, in hex format) :

| Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 |
|-----------------------|--------|--------|--------|--------|
| 00 | 50 | 42 | 01 | 0AH |
| DATA / ARGUMENT BYTES | | | | OPCODE |



(B) Typical CAT Program Listing

A simple BASIC program listing, showing the procedure for storing a frequency into VFO-A and a memory register, is shown below.

■ SAMPLE PROGRAM LISTING (N88-BASIC/PC-9800 SERIES)

```

10 `CAT System Test Program for FT-1000MP
20 OPEN "COM ; N83NN" AS #1 : DIM RS (8)
30 PRINT ; INPUT "COMMAND 5times "; IS, JS, KS, LS, MS
40 R$(1) = " " : R$(2) = " " : R$(3) = " " : R$(4) = " " : R$(5) = " " : R$(6) = " " : R$(7) = " " : R$(8) = " " : F = 1
50 AS = CHR$( VAL ("&H"+LS)) : BS = CHR$( VAL ("&H"+KS)) : CS = CHR$( VAL ("&H"+JS)) : DS = CHR$(
  VAL ("&H"+IS)) : ES = CHR$( VAL ("&H"+MS))
60 PRINT #1, AS; BS; CS; DS; ES;
70 FOR I = 0 TO 30 : NEXT : GS = " "
80 IF LOC (1) = 0 TO 30 : NEXT : GS = " "
90 IF LEN (GS) < 255 THEN GS = GS + INPUT$( 1, #1) ELSE RS (F) = GS : GS = " " : F = F + 1
GOTO 80
100 GOTO 80
110 RS (F) = GS : IF LEN (RS (1)) = 0 THEN 30
120 L LEN (RS (1)) = LEN (RS (2)) + LEN (RS (3)) + LEN (RS (4)) + LEN (RS (5)) + LEN (RS (6)) + LEN (RS (7)) + LEN (RS (1))
130 PRINT : PRINT " ANSWER"; " L ; BYTE " : PRINT
140 FOR S = 1 TO 8
150 IF LEN (RS (S)) = 0 THEN 190
160 FOR Q = 1 TO LEN (RS (S))
170 PS = MID$( RS (S), Q, 1) : PR$ = RIGHTS (" 0" + HEX$( ASC (PS)), 2) + " "
180 PRINT PR$ ; : NEXT
190 NEXT : PRINT : GOTO 30
  
```

13. Data Communication Features Of The FT-1000MP

The FT-1000MP has the most complete package of data-mode operating features and flexibility available on any amateur radio transceiver. The FT-1000MP is easy to interface to popular terminal units, and operation is straightforward.

Dedicated Packet (AFSK) and RTTY (FSK) modes are provided on the FT-1000MP, allowing the user great flexibility in interfacing to a wide variety of FSK Terminal Units (TUs) or FSK/AFSK Terminal Node Controllers (TNCs). By using the different available modes (RTTY(USB), RTTY(LSB), PKT(LSB), PKT(FM), and the USER function), optimized carrier points, display offsets, and receive filter settings can be provided for the many operating modes utilized by today's active digital operator.

And while operation typically takes place on the Main VFO via the rear panel RTTY and Packet jacks, an internal switch may be set to route audio only from the Sub VFO, in case casual packet, fax, or other digital-mode monitoring is desired.

(A) Connections for AFSK Operation: Use Packet Jack/ Packet Mode (Or USER Mode)

For Audio Frequency-Shifted Keying (AFSK) operation, including Baudot AFSK generation by a TNC, the rear-panel Packet Jack and the front-panel "PKT" (Packet) mode selection generally provide the easiest interface and operation procedures.

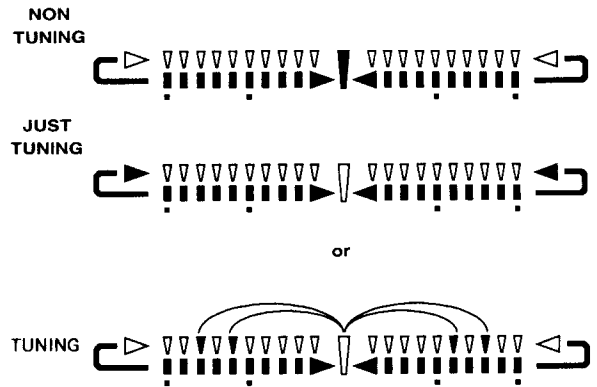
Table 13-1 RTTY MODE MENU SETTINGS

| MENU NUMBER | COMMENT | SETTING |
|-------------|-------------------------|------------------------|
| 6-0 | Shift Width Setting | 170/425/850 |
| 6-1 | | NORMAL/REVERSE |
| 6-2 | Tone Pair (Mark Signal) | HIGH 2125Hz/LOW 1275Hz |

In this configuration, transmit-audio tones are generated by the TNC which correspond to the expected receive tones; therefore, if the transceiver is properly configured, the frequency-centering

LEDs on the TNC and the computer monitor provide a visual indication of when the transceiver is properly tuned on frequency, no matter what mode is in use. Your transceiver's AFSK tones, being aligned according to what your TNC is "expecting" to receive, will consequently be aligned to what the other station's TNC is "expecting" to receive, and a perfect connection will easily be accomplished.

Fig.13-1 RTTY PACKET TUNING INDICATOR



The four interface lines of interest are: TX Audio, RX Audio, PTT (Push To Talk), and Ground, and they may be connected to the Packet DIN connector. During operation, the microphone is disabled, so it is not necessary to disconnect it. The front panel MIC Gain control, however, is functional, and it may be used in conjunction with the TNC's TX Audio adjustment potentiometer to achieve the proper audio drive level for the FT-1000MP. Even for Baudot operation, AFSK requires the use of the PKT mode.

For AFSK applications using the PKT(LSB) mode, but utilizing pseudo-USB injection, use the "USER" mode settings described on section 11-(C) of this Technical Overview.

Fig.13-2 RTTY/TNC SYSTEM CONNECTIONS

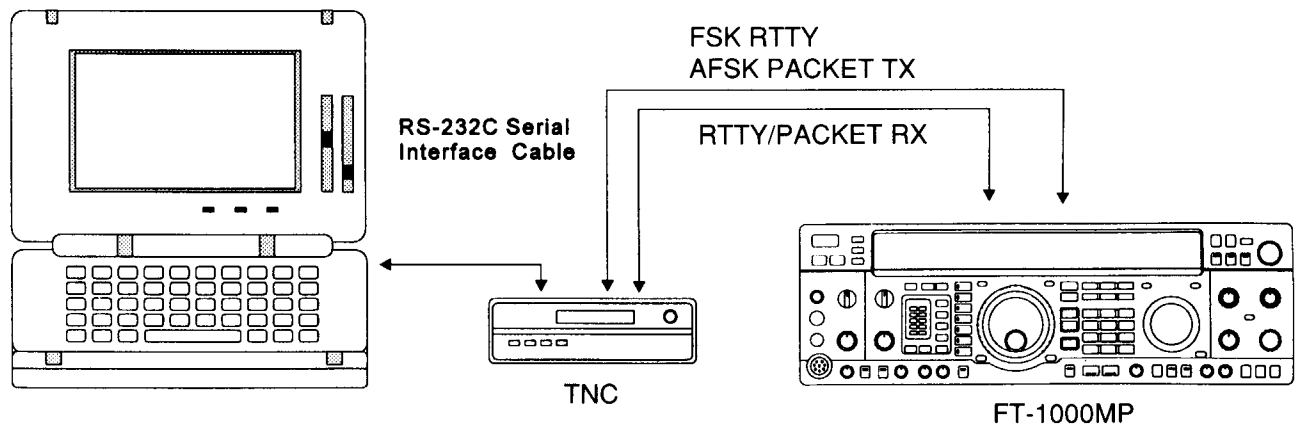


Fig.13-3 RTTY TERMINAL UNIT CONNECTIONS (FSK)

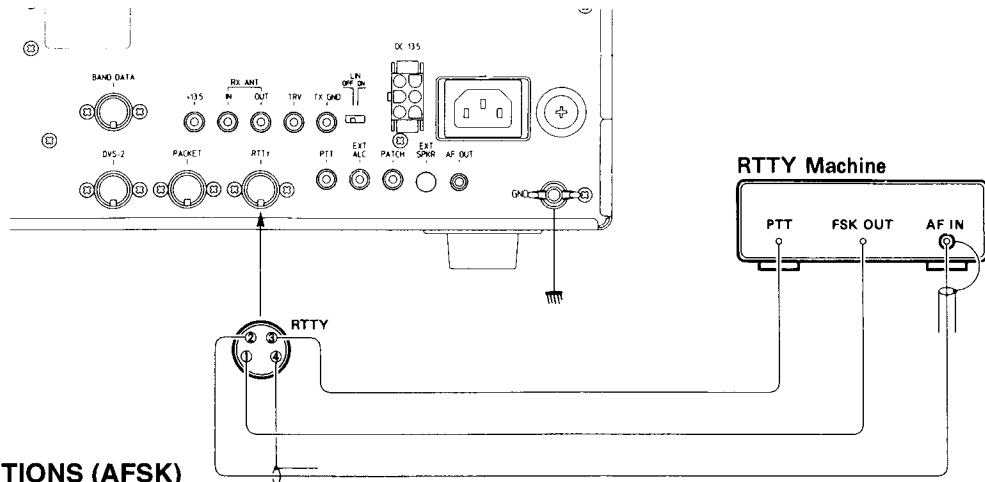
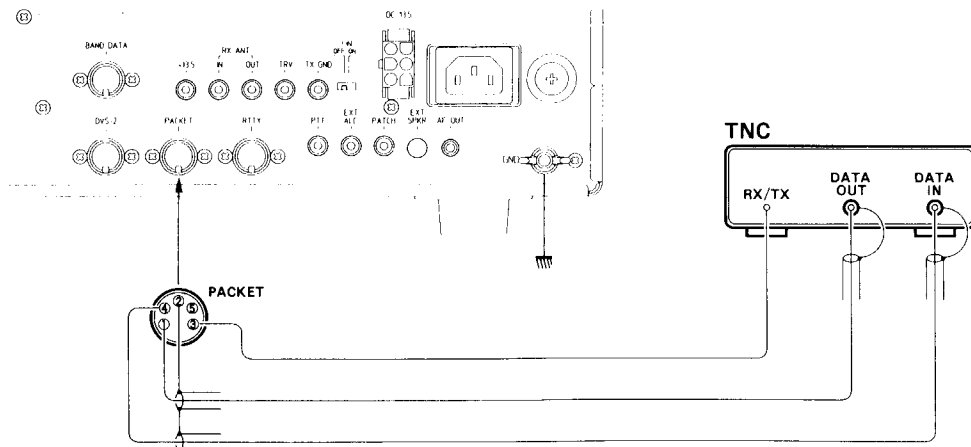


Fig.13-4 TNC CONNECTIONS (AFSK)



(B) Connections for FSK RTTY Operation

Thanks to the very-fast-acting DDS circuits, a true frequency-shifted keying carrier generator is provided on the FT-1000MP for RTTY use. Both USB and LSB injection techniques are available in the RTTY mode.

In this case, the “FSK” lead from the TNC or TU provides a short to ground. The action of opening and closing to/from ground causes the FT-1000MP to generate Mark and Space tones, shifted by the amount pre-determined via the Menu mode (typically, 170, 425, or 850 Hz shifts are used in the amateur service).

The four lines of interest from the TNC or TU to the FT-1000MP are the FSK (“Shift”) line, RX Audio, PTT, and Ground. All these are provided on the rear-panel RTTY DIN jack, and (as in AFSK operation) the microphone is disabled during transmission.

TX Audio from a TNC must not be connected to the “Shift” pin of the RTTY jack, as TX Audio is used in an AFSK environment; the “Shift” pin requires a closure to ground, instead.

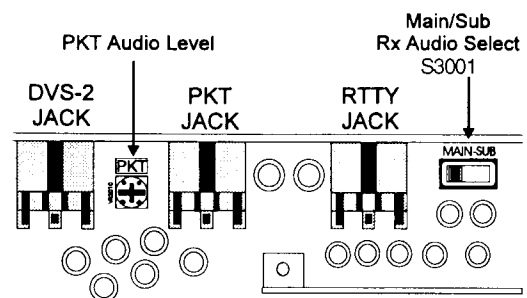
(C) Generic Connections to PATCH/PTT/AF OUT Jacks

Instead of using the dedicated “PKT” and “RTTY” modes, it is quite possible to utilize three rear-panel jacks for all data interface connections. Two of these jacks, PATCH and PTT, and RCA

connectors; the AF OUT jack requires a 3.5 mm stereo plug. In this configuration, the microphone must be disconnected from the front panel MIC jack, as it is wired in parallel with the rear panel PATCH jack. Then, select either the USB or LSB mode (not “PKT” or “RTTY”), and commence operation. The carrier point may be adjusted, if needed, via the Menu system, using Item 8-9.

The audio provided via the AF Out jack is stereo, at a fixed level of 200 mV rms per channel; impedance is 600Ω. The Tip connector is Main Receiver audio, and the Ring connector is Sub Receiver audio.

Fig.13-5 SUB BAND RX AUDIO SELECTOR SWITCH (AF UNIT)



(D) SSTV Scan Converter Connections

If your SSTV Scan Converter provides a microphone input, it is generally easiest to connect the TX Audio and PTT (and their grounds) via the front panel Mic Jack, and Receive audio and its ground via the AF OUT jack on the rear panel. Operation is identical to that described in the previous section; TX audio is then switched, at the Scan Converter, between Microphone Audio and SSTV Tones.

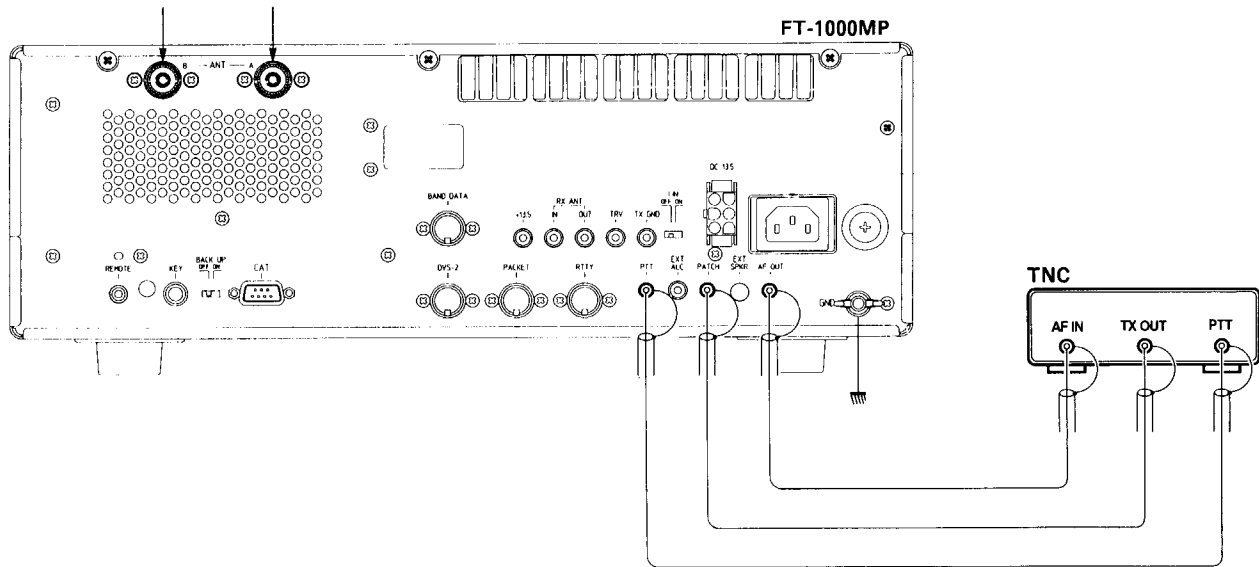
(E) Weather Fax Monitoring

Receive-only monitoring of WeatherFax or other such broadcasts is most easily accomplished via the rear panel AF OUT jack. As with the previously-described digital modes of operation,

reception via the AF OUT jack is preferred because the audio is provided at a fixed level, not affected by the AF Gain potentiometers on the front panel.

Connect the audio input line to the WeatherFax demodulator from the Tip or Ring connector of the AF Out jack, depending on whether you wish to use Main or Sub Receiver audio. Then, set the appropriate receiver to the USB mode, and set the frequency to 1.900 kHz below the published "carrier" frequency of the WeatherFax transmitting station. The software associated with your WeatherFax demodulator should provide automatic gray-scale adjustment.

Fig.13-6 SSTV SCAN CONVERTER CONNECTIONS



14. Linear Amplifier Interconnections

Thanks to the convenient jacks provided on the rear panel of the FT-1000MP, as well as several ingenious Menu selection options, linear amplifier interfacing to this transceiver is simple and elegant, solving problems often encountered with other designs.

Two methods of exercising T/R control over an external linear amplifier are available on the FT-1000MP:

- An open-collector NPN transistor is available via the BAND DATA jack, pin 2, capable of switching positive DC voltages less than 40V at current of 300 mA or less; the rear-panel [LIN] switch is turned off in this instance.
- A mechanical relay capable of switching up to 125V at 500 mA or 220V at 300 mA (AC or DC), accessed via the TX GND jack (providing a closure to Ground ("GND") on Transmit ("TX"));

the rear panel [LIN] switch is turned on in this case, enabling the relay.

Additionally, if the linear amplifier provides power-output-derived negative-going ALC voltage (typical range: 0V to -4V DC), the ALC line may be connected between the amplifier's "ALC" jack and the FT-1000MP's "EXT ALC" jack. If the amplifier's ALC voltage is derived from some other source (such as tube grid current), Yaesu recommends that this interconnection not be used.

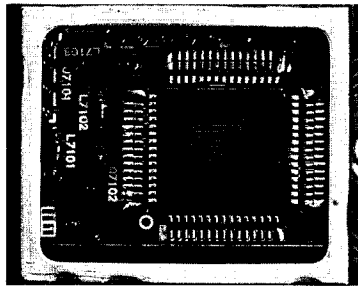
(A) Interfacing to Yaesu FL-7000 Solid-State 500W Linear Amplifier

T/R control, as well as automatic bandswitching data, are provided via the optional E-767 Band Data Cable. A second RCA-to-RCA jumper cable is also required for connection of the ALC control line.

(B) Super-High-Resolution (0.625 Hz) DDS

In a receiver designed to process weak signals (in the 0.1µ V region or lower) which may exist alongside very strong signals, it is important to generate a local oscillator signal with superior Carrier-to-Noise ratio. The proprietary new-generation DDS used in the FT-1000MP has achieved this objective, yielding a broadband noise C/N ratio on the order of -120 dBc/Hz at 2 kHz from a carrier, dropping by another 10 dB over the next 10 kHz of separation.

Moreover, its frequency step resolution is as fine as 0.625 Hz per step, which allows extremely subtle tuning in voice, CW or Packet operation. The main tuning mechanism utilized for the Main and Sub VFO dials is a highly accurate magnetic rotary encoder, which, pursuant to commands from the Menu system, can provide very slow tuning, if needed (as little as 625 Hz per turn). This is due to the 24-bit structure of the main DDS, which produces a frequency resolution 64 times better than usual DDS circuits available in amateur radio equipment.



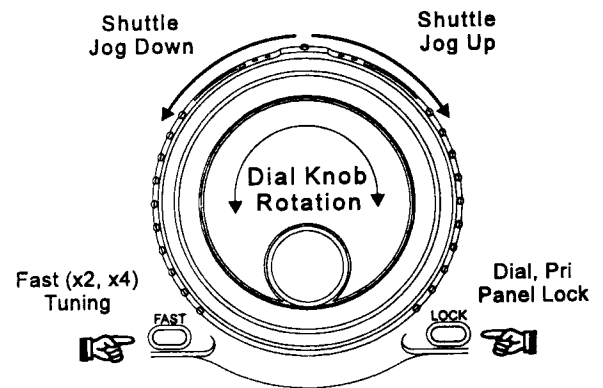
● DDS IC

New on the FT-1000MP is the Shuttle Jog dial, a spring-loaded rotary control just outside the Main VFO Dial, which allows variable-speed manual scanning up or down a band by a simple rotation of the Shuttle Jog to the left or right.

The processing of frequency data, being accomplished by the high-speed DDS, is sufficiently quick that FSK shifted-carrier signal generation is accomplished by actual shifting of the output frequency of the DDS, not by the switching of two audio tones as is often done in HF equipment.

In sum, the local oscillator system is yet another component of the overall design package, each portion of which complements the functions and capabilities of the others, so as to produce the highest level of total transceiver system performance ever made available in the amateur radio market.

Fig.4-3 SHUTTLE JOG DIAL



5. Control Circuitry

(A) Control Circuit Architecture

The circuits controlling the various functions consist of the main CPU, an I/O extender, EEPROM, custom ICs for dial control, and associated circuitry.

The Main CPU is a high-performance 16 bit single-chip M37702 IC, capable of processing amounts of data and its I/O functions rapidly, thanks to its external 25 MHz (!) clock speed. The CPU includes 2 kilobytes of internal memory, and an additional 2 kilobytes of EEPROM holds a vast amount of memory and menu data; as a result, in the event of memory backup battery failure, only the current VFO and antenna tuner contents will be lost, while the Menu settings and all frequency/mode memories will be preserved!

(B) High-Speed Dial Processing

Yaesu has pioneered the development of one-chip high-speed DDS technology in the amateur radio market, and the FT-1000MP is the crowning accomplishment in this proud tradition. Despite the extremely fine synthesizer steps, the CPU and dial data processing IC can accommodate even very rapid rotation of the dial without missing dial pulses and without any processing delay, thus emulating the "feel" of traditional analog tuning.

Through the Menu system, the tuning steps and tuning speed may be selected from a wide variety of choices, allowing an unparalleled

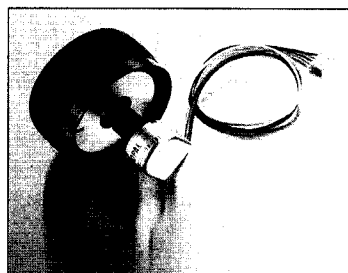
degree of customization of this extremely important component of the ergonomic design package.

Sparing no expense to provide first-class performance, even the Clarifier (RIT) control utilizes a highly-accurate magnetic rotary encoder, producing extremely predictable and smooth tuning.

Table 5-1 Main Dial Speed, per Rotation, Set Via Menu Item 1-0 (Step sizes for Main/Sub are set via Menu Items 1-3 and 1-4)

| Step Increment | Speed = "2" | Speed = "4" |
|----------------|-------------|-------------|
| 0.625 Hz | 310 Hz | 625 Hz |
| 1.25 Hz | 625 Hz | 1.25 kHz |
| 2.50 Hz | 1.25 kHz | 2.5 kHz |
| 5.00 Hz | 2.5 kHz | 5 kHz |
| 10.00 Hz | 5 kHz | 10 kHz |
| 20.00 Hz | 10 kHz | 20 kHz |
| 100 Hz | 50 kHz | 100 kHz |

* With [FAST] key engaged, dial speed increases by factor of 10.



● Dial

6. Display Features

(A) Large Display with Multi-Function Meter

In the FT-1000MP, the display is more than just an indicator of the operating frequency; it is a comprehensive display of many aspects of transceiver status and tuning conditions.

The newly-developed color reverse LCD was designed so as to provide a wide viewing angle for the many parameters displayed at any given time. The digital metering circuits have significantly less damping than do analog meters, so they are much more responsive during alignment and tuning steps. A Peak-Hold function is available, if desired.

During transmission, multiple parameters may be displayed, allowing the operator to watch power output plus two out of the following six parameters: ALC, SWR, Compression Level, PA Collector Current, PA Input Voltage, and/or Microphone Input Level. On receive, both Main and Sub Receiver S-meter indications are provided, along with a tuning meter (depending on the mode).

The transceiver's main CPU includes an Analog-to-Digital converter, which converts analog information, as needed, into digitally coded information which can be analyzed, processed, and displayed by the LCD. There are eight A/D converter input ports, allowing massive amounts of data to be processed without the perceptible time delay found in inferior designs.

(B) Frequency Display

Frequency indication is a primary task of the color LCD. However, with over four hundred available segments, the display could become rather cluttered and confusing with careful ergonomic design.

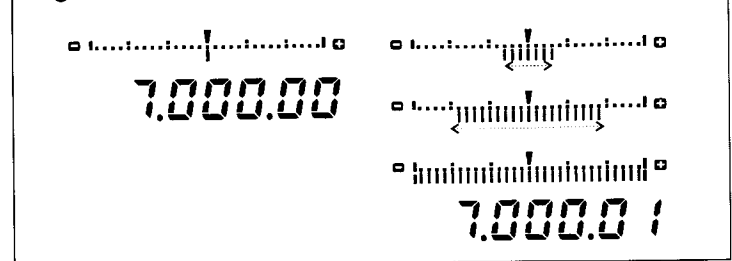
The FT-1000MP's frequency display features amber lighting, to set it apart from other indications on the LCD. The exact shade of color has been carefully chosen to provide the best visibility under a wide variety of ambient lighting conditions.

(C) Enhanced Tuning Scale Display

In its normal (default) mode, the Enhanced Tuning Scale shows a graphical indication of the Clarifier offset from the current operating frequency.

When operating within 5 Hz of the displayed VFO frequency, and when using the ultra-fine 0.625 Hz synthesizer tuning steps, the Enhanced Tuning Scale can also show you, on an expanding (outward) scale, the degree of offset from the highest-resolution digit on the display (one dot on the Enhanced Tuning Scale = 0.625 Hz). This can be of particular merit when tuning carefully on a packet or other digital station.

Fig.6-1 0.625Hz SCALE (1DOT = 0.625Hz)



● CLARIFIER ENHANCED TUNING SCALE

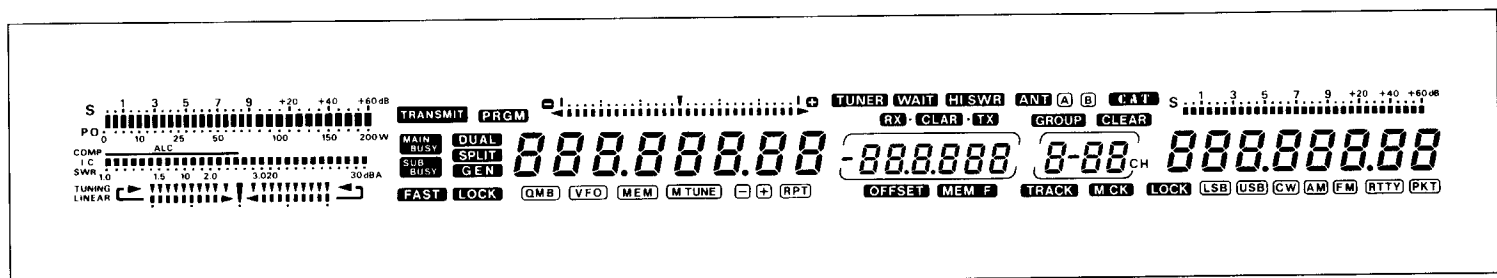
(D) Multi-Display Panel

A small multi-display panel, located between the Main and Sub frequency displays, can be commanded to display one of four items.

In its default condition, it displays the degree of Clarifier offset (in kHz). It can also be commanded to display (A) the frequency of the current memory channel (during VFO operation); (B) the frequency offset between the Main and Sub VFOs during Split operation; and (C) the current CW pitch (default = 700 Hz).

Table 6-1 Multi-Display Selections (Menu Item 3-5)

| | COMMENT | DISPLAY |
|--------------------------|---|------------------|
| <i>c L R c :</i> | CLARIFIER OFFSET | 000 |
| <i>c H a L - F :</i> | LAST-USED MEMORY CHANNEL FREQUENCY | 70000 MEM F |
| <i>a F F S E t :</i> | FREQUENCY DIFFERENT BETWEEN MAIN+SUB VFOS | 000000 OFFSET |
| <i>R I - P i t c h :</i> | CW PITCH CENTER FREQUENCY | C-700 |



7. World-Class CW Performance

The FT-1000MP is without peer with regard to CW performance, both on the receive and transmit sides.

(A) Full Break In (QSK)

Thanks to the ultra-fast DDS performance, full break-in operation without truncation of the characters is now possible, even at high sending speeds. If using a linear amplifier which adds T/R switching time, you can add keying delay time when using the internal electronic keyer, so as to compensate for the truncation caused by the external device.

Traditional "semi-break-in" operation using the VOX circuitry is, of course, included.

(B) Electronic Keyer Built In

The built-in keyer includes menu-driven settings for the dot-space and dash-space ratios, allowing the operator to customize the CW waveform according to his or her preferences.

Table 7-1 Electric Keyer Selections (Menu Item 7-0)

| | |
|---------|---|
| iAbic 1 | Electronic Keyer |
| buG | Mechanical "Bug" Emulation |
| iAbic 2 | Electronic Keyer with Automatic Character Spacing |

(C) CW "Normal/Reverse" Facility

Although CW "normally" is received using USB injection, the operator may select LSB injection by pressing the [CW] key a second time. This can be helpful in the avoidance of interference, or to avoid frequency shift when switching from LSB to CW to work a DX station on the low bands.

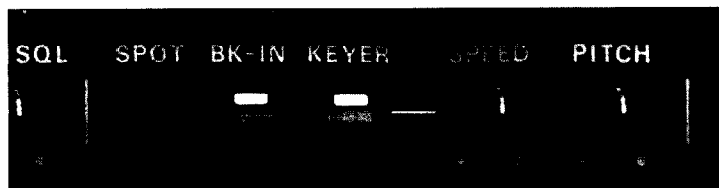
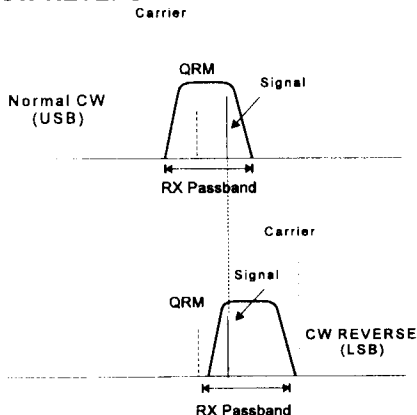


Fig.7-1 CW REVERSE



(D) CW SPOT

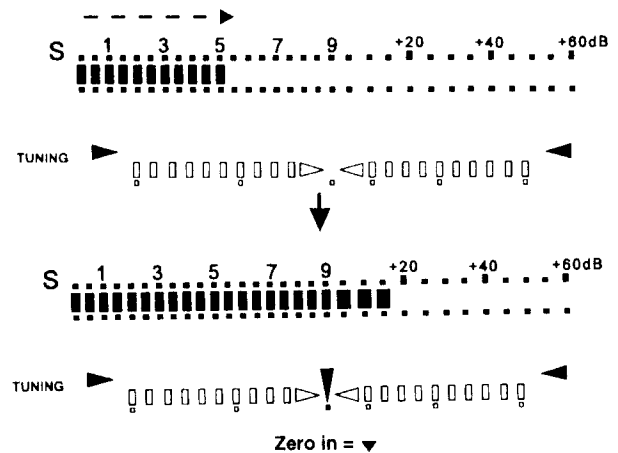
One of the more popular features of the FT-1000D and FT-990, the FT-100MP includes a momentary CW [SPOT] key, which causes a spotting tone of the same pitch as your (offset) CW carrier, to allow precise zero-beat alignment on another station.

(E) CW Tuning Meter

A new feature of the LCD is a CW tuning meter, which provides a visual aid in zeroing in on another station. Three arrow indicators tell the operator instantly when alignment is perfect.



Fig.7-2 CW TUNING METER



(F) CW Pitch Control

This front-panel rotary control allows the operator to shift (A) the center frequency of the receiver passband, (B) the pitch of the (offset) transmitter carrier, and (C) the corresponding pitch of the CW sidetone, so as to align all three parameters for the most comfortable CW pitch. Unlike some competing designs, the FT-1000MP can be aligned lower in frequency, with a total range of 300 ~ 1050 Hz (in 50 Hz steps), allowing operators who like to listen to low tones to do so.

(G) Two Key Input Jacks

Two 1/4 stereo key input jacks are provided, allowing the owner to connect either an iambic paddle (for use of the built-in electronic keyer), or an external keyer, "bug," or straight key.

(H) Contest Memory Keyer

The memory keyer function is activated and controlled via the rear panel "REMOTE" jack. By sending precise voltages from the optional FH-1 Keypad, a variety of functions are available, including:

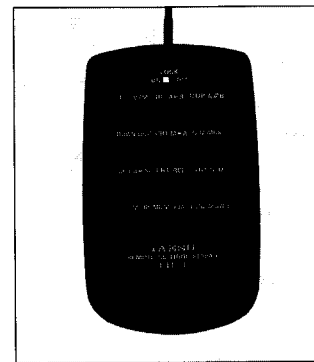
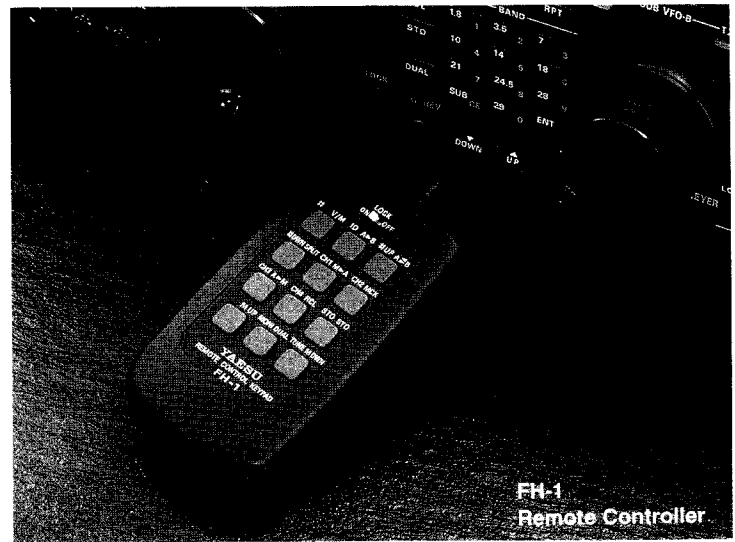
Table 7-2 Contest Memory Keyer Feature

| Key# | Function | Remote Control Feature |
|------|----------|------------------------|
| 1 | CHC | CQ Message |
| 2 | CHI | Contest # |
| 3 | CHU | Increment Contest # |
| 4 | CHD | Decrement Contest # |
| 5 | CH 0 | MSG 0 |
| 6 | CH 1 | MSG 1 |
| 7 | CH 2 | MSG 2 |
| 8 | CH 3 | MSG 3 |
| 9 | CHW | Write Memory |
| 10 | MONI | Playback (no Tx) |
| 11 | - | N/A |
| 12 | TUNING | Tune |

- Four memories which can store as many as 50 characters each;
- Your callsign can be stored for one-touch identification; and
- A contest serial number (e.g. "599001") may be imbedded in Memory Register #1. Keypad buttons allow manual incrementing or de-incrementing of the number, if necessary.

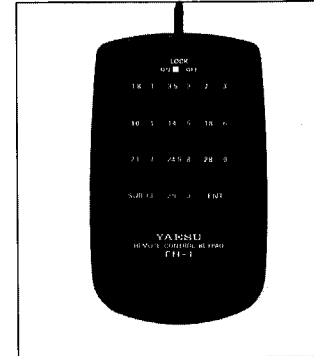
Table 7-3 CONTEST NUMBER TRUNCATION FORMAT

| NUMBER (Standard Morse) | | NUMBER (Cut Morse) | |
|-------------------------------|-----------|--|--------|
| 0 | ----- | "T" | - ** |
| 1 | .----- | "A" | .- |
| 2 | ..----- | "U" | ..- |
| 3 | ...----- | "V" | ...- |
| 5 | | "E" | . |
| 7 | -----. | "B" | -----. |
| 8 | -----. | "D" | -----. |
| 9 | -----. | "N" | -----. |
| | | **The standard Morse zero (0) can alternately be sent as "O" (-----) | + |
| 4-Digit Contest Number Format | | | |
| Default | Truncated | Disabled | N/A |
| XXXX | XXX | OFF | N/A |



I. Contest Memory Keyer - the recording and playback of repetitive contest messages are accomplished via the keypad.

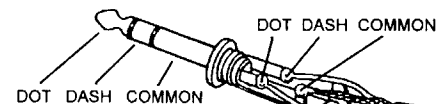
II. VFO/Memory Function Control - in this mode, the remote control keypad duplicates the front panel keys that relate to VFO/Memory selection and programming.



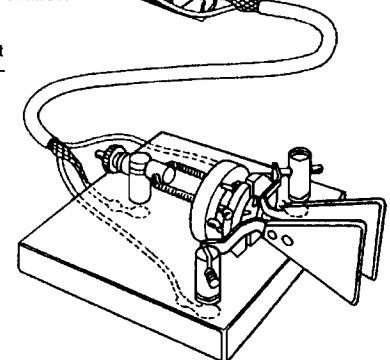
III. Main VFO-A Control - in this mode, the remote control keypad duplicates the functions of the front panel **BAND** keypad as applied to VFO-A.

IV. Sub VFO-B - same as above, except keypad inputs are applied to VFO-B.

Fig.7-3 KEY CONNECTION



*Note - only use 3-contact type 1/4" plug for key connections!



8. Convenience Features for HF Operation

The FT-1000MP includes a host of features designed to enhance your HF operating pleasure and convenience, whether you are at home or halfway around the world on a DX-pedition.

(A) Shuttle Jog Dial

The Yaesu-exclusive Shuttle Jog tuning enhancement provides a new and convenient way to tune. The Shuttle Jog is a spring-loaded rotary dial which surrounds the Main Tuning Dial; by leaning the Shuttle Jog to the left or right, frequency change (manual scanning) at a variable rate will commence. A slight deflection of the Jog dial causes tuning in 10 Hz per step, and maximum deflection of the Jog dial causes tuning in (faster) 50 Hz steps.

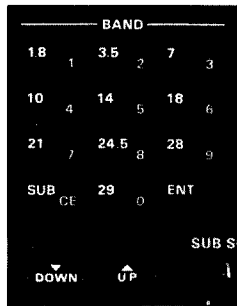
The rate of Shuttle Jog scanning can be varied via Menu Item 1-1, wherein the rate can be varied from a minimum speed of 10 steps per second to a maximum of 1000 steps per second.



(B) Band Selection Keys and VFO Registers

The front panel keypad allows one-touch band change. For example, by pressing the [21] key, the operator commands the transceiver to return to the last frequency utilized on the 21 MHz band.

The Band Stacking VFO register concept allows the owner to store two favorite frequencies in VFO registers for each band. In the above example, the user might have most recently been on 21.050 MHz CW; another press of the [21] key will bring the second 21 MHz VFO into operation, perhaps on 21.295 MHz USB. This may be done for each amateur band.



Unlike poorly-thought-out competitors, the FT-1000MP's VFO (and Memory) registers store not only frequency, but (A) the operating mode, (B) the IF bandwidth, (C) the Clarifier (RIT) offset, if any, and (D) the Automatic Antenna Tuner settings, if used.

(C) Direct Keypad Frequency Entry

A desired operating frequency may be entered directly from the keypad. Just press [ENT] followed by the frequency. To accomplish direct frequency entry for the Sub VFO, simply press [SUB] [ENT] then the desired frequency (and mode, if a change is needed).

(D) MEM/VFO CH Control

The [VFO/M CH] knob on the front panel serves a dual function. Its default function is to select memory channels. However, via Menu Item 1-5, this knob may be converted into a convenient "channelized" frequency selection knob.

For quick QSY up or down a band, you may wish to select 5 kHz steps. For broadcast listening, 1 kHz steps may be more appropriate. And for FM work on 10 meters, you may wish to choose 10 kHz per step. Via Menu, the step size may be chosen in 1 kHz increments within the range of 1 ~ 100 kHz per step.



(E) Versatile Memory Functions

The FT-1000MP provides 99 channels of regular memory plus 9 channels for storing band limits or other tuning/scanning limits, as well as five QMB (Quick Memory Bank) registers for quick recall. All memory registers can store frequency, mode, IF Filter bandwidth, antenna tuner settings, and Clarifier (RIT) offset, if any.

Memory contents can be checked quickly, on a "scratchpad" basis without interrupting current-frequency operation, by rotation of the [MEM/VFO CH] knob during VFO operation.

Fig.8-1 MEMORY SYSTEM

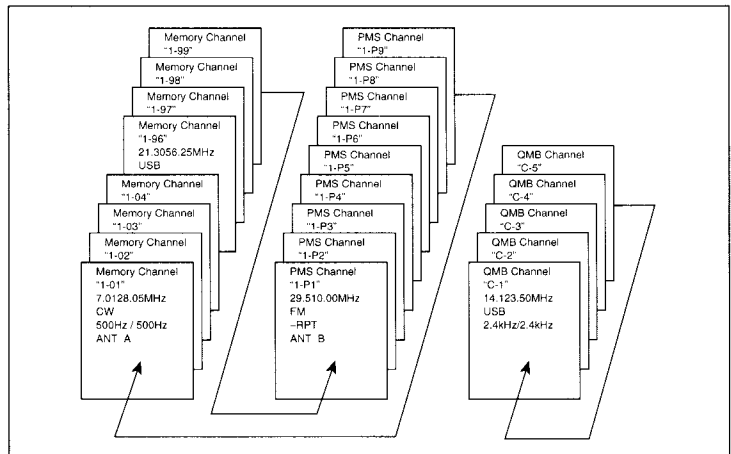


Fig.8-2 MEMORY GROUPING EXAMPLES(Menu Item 0-1/0-2/0-3/0-4/0-5)

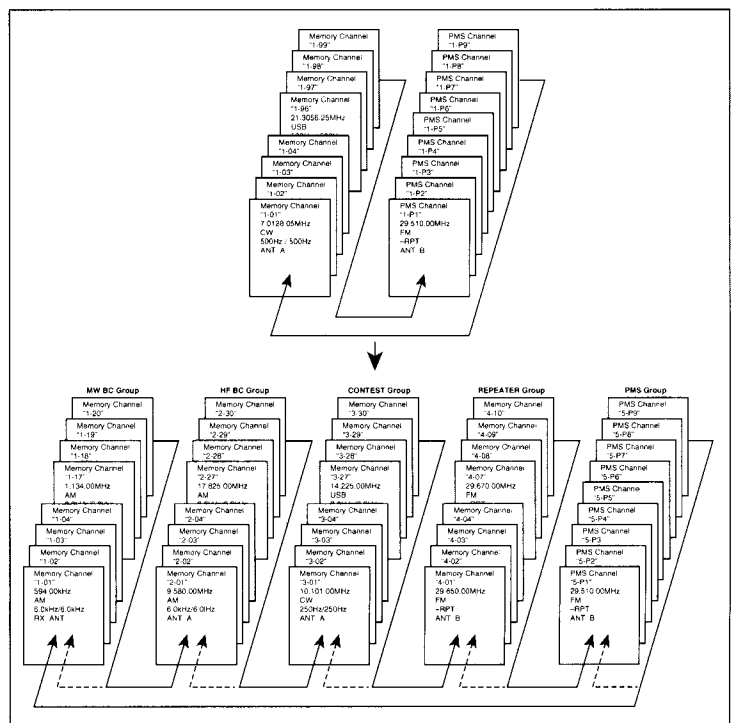
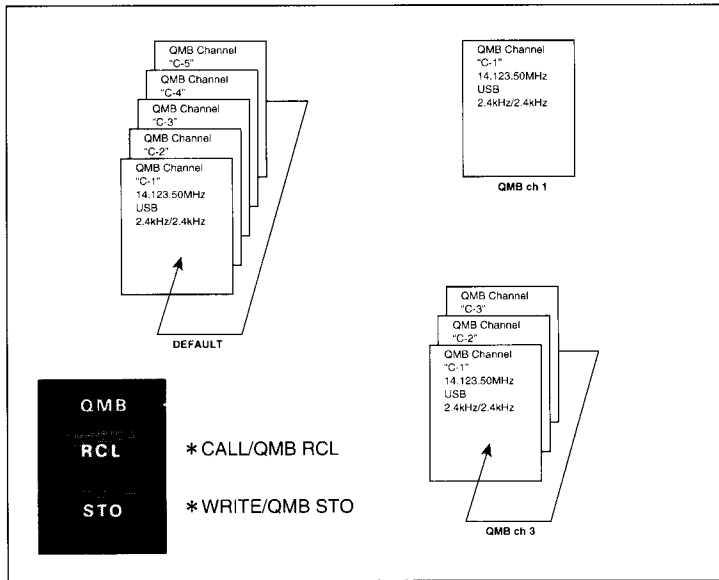


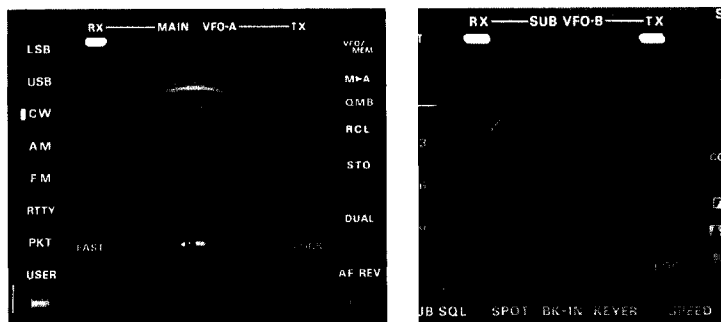
Fig.4-3 QMB MEMORY (MAX 5ch) (Menu Item 0-6)



(F) VFO Selection Switches/LEDs

New on the FT-1000MP is an efficient, easy-to-recognize selection technique for selecting the Main and/or Sub VFOs for transmit or receive operation.

Above the Main and Sub VFO tuning dials are two LED/Switch combinations, each pair being labeled "RX" (Green), and "TX" (Red). By pushing these LED/Switches, selection of the Main and/or Sub VFOs for Receive (RX) operation is possible; if both LEDs glow green, then Dual Receive operation is activated. Only one VFO may, of course, be selected for Transmit (TX), operation. This technique is simple and intuitive, a valuable consideration during long operating sessions when operator fatigue is always a factor.



(G) Quick Split Feature

In order to pre-set a TX/RX split (so as to save time in a DX pile-up), Menu Item 1-6 allow you to set an automatic split anywhere from -100 kHz to +100 kHz between the Main and Sub VFOs (in 1 kHz increments). No matter where the Sub VFO is set, with Quick Split activated, a press of the [SPLIT] key will move the Sub VFO to the same band as the Main VFO occupies, with the exact frequency separated by the amount of the pre-programmed split (the default is "UP 5 kHz"). Transmit frequency command also is transferred to the Sub VFO, of course, at the same time.

(H) Carrier-Controlled Slow Scan

When activated, this feature slows scanning to a very slow speed while the scanner tunes across a CW or SSB signal, allowing the operator plenty of time to stop the scan, if desired.

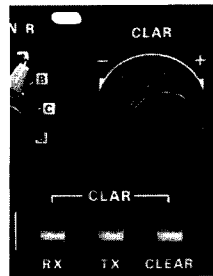
(I) VFO Tracking

By pressing and holding in the LOCK key while turning the Main Dial, both VFOs will tune in a synchronized manner, in the same steps and at the same tuning rate.

(J) Clarifier

Receiver or transmitter offset tuning from the Main Dial frequency is provided via the "Clarifier" control, which utilizes the same type of precise magnetic rotary encoder as does the Main Dial. As on the Main Dial, Clarifier tuning steps as fine as 0.625 Hz/step can be selected.

The Clarifier maintains its programmed offset as you tune around the band, and the offset can be disabled (but remain programmed for later use) by pushing the [RX] and/or [TX] Clarifier key(s).



(K) Remote Control Terminal

If the Contest Memory Keyer feature is not in use, the "REMOTE" jack on the rear panel may be used to control a number of functions via the optional FH-1 keypad. See the chart below for the list of available functions.

Table 8-1 Remote Control Feature (Menu Selection 7-9)

| Key # | Main VFO-A | Sub VFO-B | Memory Control |
|-------|------------|-----------|----------------|
| 1 | 1.8 1 | 1.8 1 | VFO MEM |
| 2 | 3.5 2 | 3.5 2 | A-B |
| 3 | 7 3 | 7 3 | A-B |
| 4 | 10 4 | 10 4 | SPLIT |
| 5 | 14 5 | 14 5 | M-A |
| 6 | 18 6 | 18 6 | M CK |
| 7 | 21 7 | 21 7 | A-M |
| 8 | 24.5 8 | 24.5 8 | RCL |
| 9 | 28 9 | 28 9 | STO |
| 10 | 29 0 | 29 0 | DUAL |
| 11 | SUB CE | SUB CE | M CH UP |
| 12 | ENT | ENT | M CH DWN |

9. Operating Flexibility Example: Two-Operator DX-pedition Setup

The many features of the FT-1000MP have been described in some detail in the preceding pages. The following section will describe the degree of flexibility that is available to DX-pedition operators when dealing with a huge CW pile-up as they operate from a “Most Wanted” location.

The VKØDD operation is just getting under way. The 20-meter Yagis are securely installed: one is pointed at Europe, the other at Japan and North America. Fed with equal lengths of coax, they provide a high-performance “power split” capability designed to saturate the three biggest amateur population centers. A multiband vertical antenna is also in place, to be used as a listening or emergency antenna.

Emergency redundancy is important on an expedition, as the team has already learned. During the landing operation, the cases carrying the laptop computers washed overboard, and all logging/keying will have to be done manually. Fortunately, the team was prepared for this possibility.

In the tent, the operating table is now set up with the FT-1000MP as its centerpiece. The DX-pedition team has configured the FT-1000MP with a number of devices to allow the two 20-meter operators--Dan and Diane--to exploit the pile-up in the most efficient manner:

- ① Two headphones have been wired so as to route Main Receiver audio to Diane, the right-side operator, and Sub Receiver audio to Dan, the left-side operator.
- ② The Yagi array is connected to the “Antenna A” TX/RX jack on the rear panel of the FT-1000MP.
- ③ The vertical antenna is connected via a two-position coaxial switch. In the “normal” position, the vertical is connected to the Receive Antenna input jack of the FT-1000MP; in its second position, the vertical is routed to the “Antenna B” TX/RX antenna jack of the transceiver.
- ④ Two iambic keyer paddles are connected to the transceiver, one each to the front and rear “KEY” jacks.
- ⑤ A two-conductor 3.5 mm “Y” connector is plugged into the rear-panel “REMOTE” jack. One branch of this splitter is connected to an FH-1 Remote Control Keypad, situated at Dan's position; the other branch is connected to a small home-built keypad with two switches on it, labeled “5NN” and “VKØDD.” This mini-keypad is used by the second operator to allow sending of the most commonly-needed messages.

In Menu, Dan dials up item 4-5, and sets the EDSP CW BPF to 120 Hz, and sets item 7-0 (Electronic Keyer Mode) to “Iambic 2.” Dan and Diane sit down to their respective positions, and Dan sets the FT-1000MP's VFOs up for operation. The Main VFO is set to 14.024.00 kHz in 250 Hz bandwidth, and its [LOCK] button is pushed so they won't move off frequency accidentally. Both the Green “RX” and Orange “TX” LEDs for the Main VFO are illuminated, indicating that both receive and transmit control are available on Main VFO-A. The Sub VFO-B is set to 14.030.00 MHz in 500 Hz bandwidth, and the Sub Receiver's Green “RX” LED/Switch is pushed, activating Dual Receive. Diane pushes the [RX CLAR] button, activating the

RIT, and adjusts it for a receive frequency on the Main VFO-A of 14.025.00, 1 kHz up from the transmit frequency. Dan pushes the [BK-IN] and [VOX] keys. They're ready.

The operating setup, as configured, now allows the following scenario to unfold.

- Either operator has his or her own keyer paddle, with which to work someone without interfering with the other operator.
- Dan, the left operator, receives and tunes using the SUB Receiver dial. Dan is responsible for watching the range 14.030 ~ 14.035 MHz.
- Diane, the right operator, receives and tunes using the MAIN Receiver's “RX Clarifier” (RIT) knob. Diane is responsible for watching the range 14.025 ~ 14.030 MHz. Although the CLAR knob is somewhat small, the ultra-fine 0.625 Hz steps used on the RIT mean that the tuning rate will be slow enough to separate signals easily, especially using the 250 Hz IF bandwidth plus the 120 Hz EDSP filter of the Main Receiver.

Dan sends the first transmission: “CQ CQ CQ DE VKØDD VKØDD QSX UP K.” The two operators sweep across their ranges, and Dan finds the first caller, to whom he replies, “VU2RM 5NN” by sending VU2RM's call manually, then pressing the [1] key on the FH-1, which was programmed with the simple signal report “5NN” (599). VU2RM replies with “5NN TU DE VU2RM,” and Dan replies by simply sending “TU VKØDD UP.”

Now the pile-up erupts with thousands of stations. Diane gets a partial call on 14.026.9, to whom she sends “PA? 5NN.” WØPA replies with a 599 report, to whom Diane acknowledges with “WØPA CFM TU;” while Diane was listening to WØPA on the Main Receiver, though, Dan found PA3ABM on 14.033.9 on the Sub receiver, who thought he was being called by VKØDD. Without sending a “QRZ,” Dan immediately sends “PA3ABM 5NN” to work the Dutch station. And while Dan is working PA3ABM, Diane comes across PAØLOU, who also thought he was the “PA” station originally being called by VKØDD.

By now, the pile-up is becoming chaotic, as stations are beginning to figure out the “leap-frog” operating technique being utilized by Dan and Diane. Since VKØDD is operating in the “Split” mode, though, there is no QRM on their own transmitting frequency. While Dan is confirming a callsign on the Sub Receiver, Diane is pulling out a partial call on the Main Receiver. Their transmitting sequences become totally uninterrupted:

(Diane) “PAØLOU TU (Dan) W6RJ 5NN”
(W6RJ) “VKØDD TU 5NN W6RJ”
(Dan) “TU (Diane) RW9AR 5NN”
(RW9AR) “R 5NN DSW”
(Diane) “TU (Dan) JA1YOE 5NN”
(JA1YOE) “TU 5NN BK”
(Dan) “TU (Diane) G3KMA 5NN”
(G3KMA) “5NN TKS NEW IOTA”
(Diane) “GL ROGER (Dan) W1CW 5NN” . . .

By virtue of having the completely independent receivers, dual key jacks, and the split Remote Keypad setup, the two operators have been able to take advantage of the “Constant Calling” syndrome

common in DX pile-ups by spreading the pile-up out and never calling "CQ" or "QRZ." Four hours into the operation, when Dan dashes outside for physical relief, he discovers to his astonishment that more than 1,050 QSOs are in the log, double the typical DX-pedition rate, thanks to their operating efficiencies and the outstanding selectivity of the FT-1000MP's receiver.

Pushing the [RX ANT] switch allows the team quickly to work 50 South American stations who are outside the main lobes of the two Yagis. When the VKØDD 40-meter station comes on the air, the 20-meter station experiences no interference, thanks to the HPF and BPF filters in the front end. And when two laptop computers are salvaged and made operational the second day of the expedition, their keying interfaces are connected in place of the two keyer paddles (and the internal electronic keyer turned off), allowing networked computer logging and keying of the transceiver, thus reducing operator fatigue. The ten-day operation concluded with over 78,000 QSOs logged by

the eleven operators, who put VKØDD on the air from the Isle of Dundee, a small volcanic crag in the Australian Antarctic that had been buried under ice for thousands of years. The brief eruption of Mount Dundee had melted the surrounding ice, creating yet another DX-pedition opportunity for Yaesu, The Choice of the World's Top DXers.

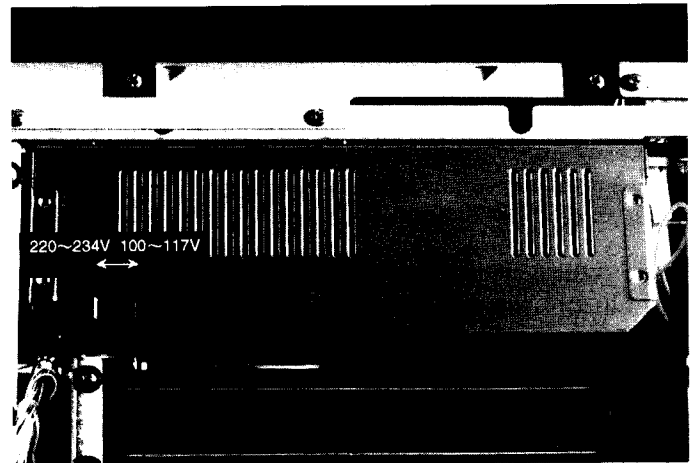
Although the above story is fictional, it accurately depicts the installation and operating flexibility provided by the FT-1000MP. For multioperator DX-pedition or contest work, or for maximum-efficiency single-operator efforts, the FT-1000MP is designed to perform and excel under the most demanding conditions.

10. Low Noise Switching Regulator Power Supply

Except in the case of the FT-1000MP/DC, the FT-1000MP is equipped with a low-noise, highly efficient switching-regulator power supply.

Eliminating the need for a separate power supply unit elsewhere in the station, the switching-regulator AC power supply incorporated into the FT-1000MP features light weight along with sufficient capacity to stand up to heavy-duty operational requirements of contest or DX-pedition operators.

Additionally, the power supply unit is very forgiving of input voltage variations, accepting inputs of 100~125V AC or 200~240V AC, with easy switching from low to high input voltage ranges. In the event that only DC power is available, the optional DC cable (supplied with the FT-1000MP/DC) may be used for 13.5V DC operation.



11. Menu Customization of Transceiver Features

The Menu System of the FT-1000MP allows extensive capability for the operator to customize many aspects of transceiver configuration, so as to provide the most owner-friendly amateur radio apparatus ever created.

(A) Menu Mode

A total of 81 Menu functions are available, pursuant to the chart below. The Menu mode is activated by pushing the [FAST] and [ENT] keys simultaneously; thereafter, the [VFO/M CH] control, the Main Dial, and (for some functions) the Sub Dial are rotated to select the desired Menu item and/or settings.



(D) RF Preamplifiers and Intercept Point Optimization (IPO)

Three separate RF preamplifiers are provided in the FT-1000MP:

• Wideband Preamplifier

This constant-gain, broadband preamp uses four junction FETs in a parallel, push-pull arrangement identical to the circuit utilized in the FT-1000D.

• Low-Band Preamplifier

This preamp, optimized for operation in 1.8 ~ 7.5 MHz, features low noise figure but low gain, along with extra selectivity for improved strong-signal handling capability. This preamp utilizes a single JFET in a source-follower configuration.

• High-Band Preamplifier

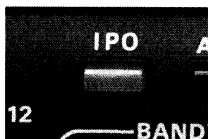
This high-gain, very low noise figure preamp utilizes a 3SK131 MOS FET in a common-source configuration so as to optimize the system gain and noise figure for the high bands, where lower noise figure is desirable.

Table 2-1 RF AMPLIFIER SELECTIONS (Menu Item 8-4)

| AMP Selection | tunEd | | | FLAT |
|---------------|----------------|-----------------|------------------|--------------------------|
| BAND | LOW BAND | MID BAND | HIGH BAND | 0.1MHz~30MHz Wide Amp |
| | 1.800~7.299MHz | 7.300~24.499MHz | 24.500~30.000MHz | |

For most applications, the broadband preamplifier is entirely satisfactory, and it provides excellent performance. The user is, however, encouraged to try the other preamps, which are enabled via the Menu system, to evaluate their suitability for his or her location and antenna system.

For low-band operation, where input preamplification often is not needed, the input RF preamp stage may be bypassed completely by pressing the "IPO" key on the front panel, which provides direct feed to the first mixer without the addition of any stage gain. This has the practical effect of increasing the system noise figure by approximately 7 dB, while improving the 3rd order input intercept by approximately 12 dB.



(E) RF Automatic Gain Control (AGC)

As in the FT-1000D, PIN diodes are used for the RF AGC circuitry in the FT-1000MP. The use of PIN diodes, which increase their attenuation according to the level of AGC voltage, ensures best overall dynamic range of any currently-available component type. The bias circuitry was designed to provide smooth AGC operation without overshoot. The AGC recovery time constant may be manually adjusted from among four settings: Off, Fast, Medium, and Slow, and the FT-1000MP also includes an "Auto-AGC" feature which presets the AGC recovery time constant by operating mode, according to the chart below.

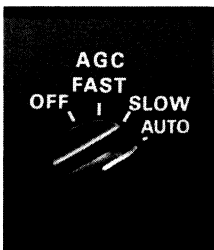


Table 2-2 AUTO AGC MODE CHART

| MODE | AGC (AUTO) |
|-----------|------------|
| LSB | SLOW |
| USB | SLOW |
| CW | FAST |
| AM | FAST |
| FM | FAST |
| RTTY | SLOW |
| PKT (FM) | FAST |
| PKT (LSB) | SLOW |

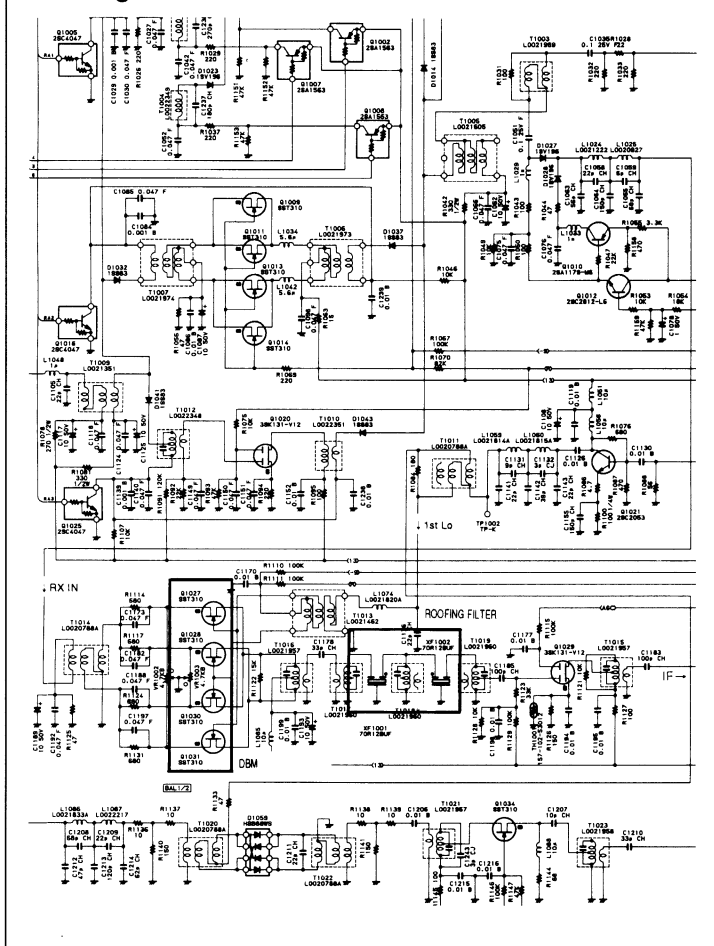
(F) First Mixer and Post-Mixer Filter

Four Siliconix® SST-310 junction FETs are used in a quad doubly-balanced mixer configuration which provides high dynamic range, excellent port-to-port isolation, and minimal spurious responses.

The first mixer produces a first IF of 70.455 MHz. Because of the low noise of the RF stages (the preamplifiers, if used, and the mixer), the IF signal does not require post-mixer RF amplification, and instead is passed immediately through a four-pole "roofing" filter, consisting of a pair of monolithic crystal filters with 12 kHz bandwidth. A post-mixer amplifier is frequently a source of IMD in a receiver, due to the lack of selectivity ahead of it, so the "no-post-mixer-amplifier" design contributes directly to the outstanding IMD performance of the FT-1000MP.

The roofing filter provides early protection for the IF stages to follow, without significant perturbation of the phase of the signal. The design characteristics of the monolithic filters are carefully specified, so as to set a precise delay in the signal for alignment with the blanking pulse of the IF noise blanker. The roofing filter is the first step in a progression of IF filters which protect the later stages from the effects of strong signals present at the antenna jack; by the time the signal reaches the EDSP and audio stages, it will have passed through as many as 20 poles of IF filtering at bandwidths of 12 kHz down to a minimum of 250 Hz. Yaesu's engineers strongly believe that this "hybrid" approach utilizing high-quality IF filters ahead of the DSP system is essential since no transistor, diode, or DSP IC is possessed of "infinite" dynamic range.

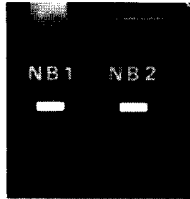
Fig.2-3 RX FRONT END SCHEMATIC DIAGRAM



(G) Noise Blanker Circuitry

Two noise blankers are provided in the FT-1000MP, for coping with different types of noise encountered on the HF bands.

With the demise of the Soviet Union, the notorious "Woodpecker" noise associated with the USSR's over-the-horizon radar systems has essentially vanished (except for sporadic testing). However, the design parameters associated with the "Woodpecker Blanker" circuits developed over the past two decades have proven to be highly effective against many types of commonly-encountered wide-pulse noise sources. In the FT-1000MP, the twin Noise Blankers—NB1 for narrow-duration pulses and NB2 for long-duration pulses—provide the operator with a choice of blanking tools.



The IF Noise Blanker circuitry utilized in the FT-1000MP is fundamentally similar in concept to blanker designs used for many years in Yaesu and other transceivers. In this technique, noise pulses detected in the receiver passband are converted to a DC voltage, which, in turn, controls a "gate" device later in the IF, which places a very short duration "gap" in the IF signal at exactly the point where the noise pulse is present.

This technique has been the only one available for many decades. It can be very effective, but with excessive blanking action it can cause distortion; moreover, if the noise pulse is not well-defined (low amplitude or wide duration), the pulse-detection circuits sometimes cannot "grab ahold" of the pulse, rectify it, and send an effective control signal to the gate device.

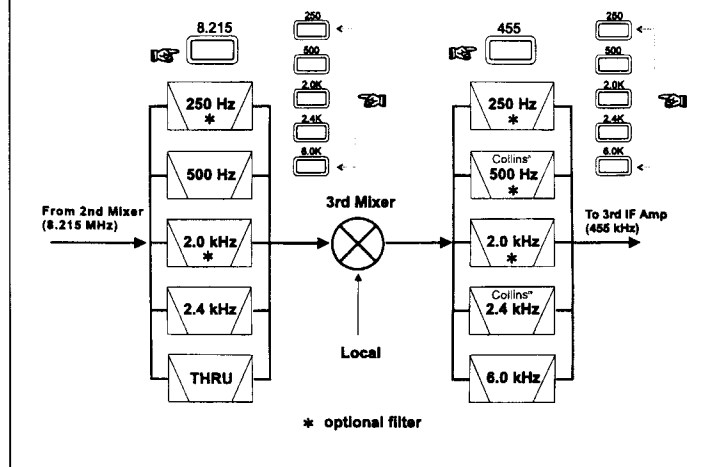
With the introduction of EDSP, however, this traditional analog design can be used in conjunction with the EDSP noise reduction circuits. Unlike the analog noise blanker, which seeks pulses and then blanks them, the EDSP looks for any energy which is not a "desirable" signal, such as voice or CW, and then seeks to eliminate it. In the frequently-encountered situations where poorly-defined pulses or multiple out-of-phase pulses are present, the combination of analog IF and EDSP noise reduction will provide significantly better signal-to-noise ratio than will either technique alone. Moreover, the presence of the EDSP noise reduction allows less aggressive IF noise blanking to be used, so as to minimize distortion effects, with the EDSP Noise Reduction selections performing the "clean up" task that previously could only be accomplished by engaging the IF noise blanker fully (often leading to distortion in the desired signals).

The EDSP Noise Reduction circuitry provides an additional benefit. Its adaptive-filter characteristics cause a "shaping" of the EDSP passband to match the frequency response of the incoming signal. As one tunes across a voice sub-band with Noise Reduction activated, the pitch of the background noise will appear to change every time a new signal is encountered, as the EDSP analyzes the signal and adapts itself to the voice characteristics; a bassy voice will shift the response slightly lower, while a female voice will shift the response higher. The result is greater net noise power reduction, thanks to the adaptive shaping which "form fits" the noise reduction effort around the (current) incoming signal waveform. Re-set time for a new voice pattern encountered as one tunes is, of course, virtually instantaneous thanks to the fast processing time of the EDSP's IC.

(H) IF Main Selectivity Filters

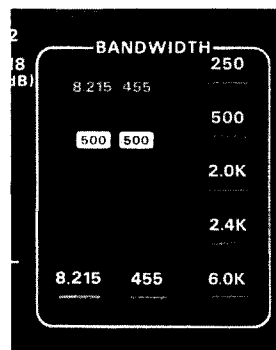
Although the stock 2.4 kHz and 500 Hz IF filters are quite satisfactory for general operation, the FT-1000MP includes provision for the selection of as many as twelve different filters, if all available options are installed in the 8.215 MHz and 455 kHz IFs in the Main and Sub receivers. For world-class contest or DX-pedition use, these filters constitute the most comprehensive and easy-to-use array of IF filters ever assembled in an amateur radio transceiver.

Fig.2-4 Main Receiver (VFO) IF Bandwidth Filter Selections



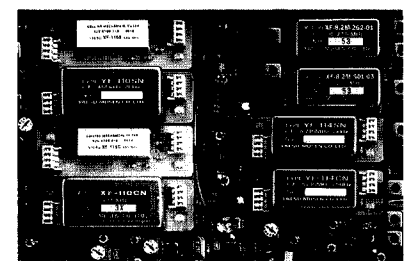
To provide the most flexibility in selecting these filters for the operating circumstances encountered, an ergonomically-designed matrix of seven selectivity-determining switches is used. Two of these determine the IF whose filter is to be changed; the other five determine the bandwidth. If the operator wishes to set a 500 Hz bandwidth for both cascaded filters, the "500" key is pushed once; if, on the other hand, you wish to set the 8.215 MHz IF to 2.0 kHz and the 455 kHz IF to 500 Hz, simply press [8.215]→[2.0K]→[455]→[500]. Filter selections, once completed, are retained in each VFO and memory register (along with mode), so you can set up a 20-meter SSB register with 2.4 kHz bandwidth alongside a 20-meter CW register with 250 Hz bandwidth. Some competing units have no provision for retention of bandwidth information in VFO and memory registers.

The IF filters used in the FT-1000MP are carefully specified, each providing ultimate attenuation of at least 80 dB. Meticulous back-bias of the switching diodes, along with careful mechanical design of the IF Unit's ground plane, provide outstanding isolation between filters, along with negligible bleed-through. The filter stages are gain-balanced, so as to keep receiver gain constant when changing bandwidths.



◀ BANDWIDTH SWITCH

▼ FILTER LAYOUT



A highlight of the IF filter complement is the inclusion of the new-technology Collins® Mechanical Filters into the design of the FT-1000MP. A 455 kHz 2.75 kHz-bandwidth Mechanical Filter is standard equipment, while 455 kHz 500 Hz-bandwidth filters are available options for the Main and Sub receivers. Collins® Mechanical Filters are vastly superior to the usual ceramic filters which are often used at the end of an IF chain for noise reduction, in that they have negligible phase distortion, an extraordinarily flat “nose-on” passband (ripple typically ≤ 0.1 dB), and outstanding ultimate attenuation. The flatness throughout the desired passband means that the bandwidth of the mechanical filter will usually be wider at the -6 dB points than is a ceramic or crystal filter of identical bandwidth specification, yet the -60 dB bandwidth will likely be narrower. This provides better fidelity and more natural reproduction of the operator's voice pattern.

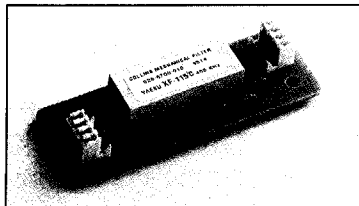
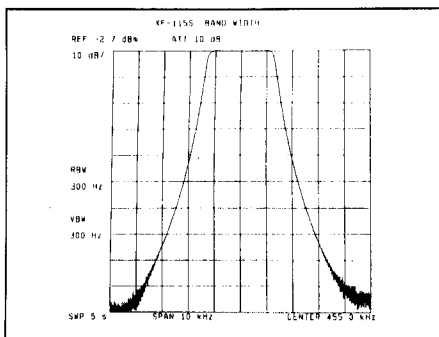


Fig.2-5
Collins® MECHANICAL
FILTER PASSBAND
RESPONSE (SSB FILTER)



(I) IF Amplifiers

The characteristics of the main IF chain in any receiver are critical to the net system performance of the design. The FT-1000MP utilizes the proven design of the FT-1000D, featuring low-noise 3SK131 MOS FET transistors as the main amplification devices. The IF design was executed using a comprehensive and sophisticated computer program which allows careful scrutiny of such critical parameters as gain, noise figure, and dynamic range, and which allows evaluation of the effects on system performance due to temperature and input signal level variations.

In the manufacturing process, this design data is utilized in conjunction with the computer-based alignment protocols of the production line, and each transceiver is individually optimized for specified receiver system gain, ensuring a high level of consistency in finished products as they exit the production line.

(J) (Analog) Detection Circuits

Three analog detection techniques are used to convert the 455 kHz IF signal to audio at the end of the IF chain:

• SSB Product Detector

The μ PC1037H product detector IC provides outstanding thermal stability and balance, addressing common problems found in discrete-diode product detectors.

• AM Detector Circuit

Both envelope detection and synchronous detection are facilitated by the MC13020 AM detector IC. In the synchronous detection mode, a 455 kHz VCO is locked onto the carrier frequency of the received signal by a PLL circuit. Then, by concentrating on the carrier and one sideband during synchronous reception, AM distortion due to phase differences in the upper and lower sidebands is eliminated. If, due to fading, phase lock is lost on the incoming signal, the receiver instantaneously reverts to envelope detection.

• FM Detector Circuit

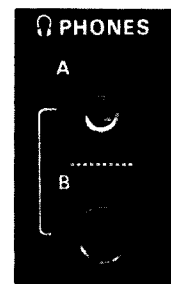
An FM subsystem IC, type MC3372, is used to provide high-quality narrow-band FM reception. The bandwidth of this system, at 6 dB down, is 8 kHz.

(K) Receiver Audio Circuits

The demodulated analog audio signals are passed through an active low-pass filter, the response of which is optimized for the mode (and corresponding IF bandwidth) in use. Particularly on CW, this audio bandwidth optimization ensures that noise figure is not degraded (due to excessively broad audio bandwidth) when a narrow IF filter bandwidth is utilized.

The audio output level to the headphones or speaker is varied by a low-noise voltage-stepping volume control similar to the type used in high-fidelity audio equipment. The design was accomplished so as to minimize noise pickup by eliminating the routing of the audio signal itself to the front panel Volume control, as well as to make the level steps indistinguishable to the operator.

Headphone audio is fed through a dedicated headphone-audio amplifier stage, which provides independent output for the Main and Sub receivers, thus minimizing “suck-out” loss during Dual Receive operation. Either full stereo, monaural, or “mixed” audio (left/right emphasis for Main and Sub audio, but not complete isolation) can be selected. Both 3.5mm and 1/4” stereo headphone plugs may be used, and it is easy, for example, for two operators using two sets of headphones to use the FT-1000MP in a Dual Receive configuration, each operator covering, for example, a different segment of a pile-up during DX-pedition use.



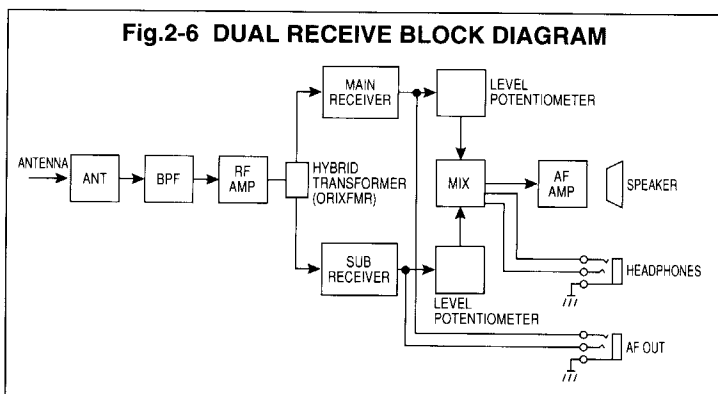
The built-in speaker includes a large magnet for high-quality sound reproduction, even at loud volume levels.

(L) Sophisticated Dual Receive System

The Dual Receive system architecture, widely acclaimed on the FT-1000D, was developed specifically with the DX and contest operator in mind. Utilizing two large tuning knobs, independent Volume and Squelch controls, as well as simple frequency and mode selection with clear displays for each receive frequency, the Dual Receive system makes “Split” operation in DX pile-ups simple and efficient.

For example, the operator may search a pile-up for the station in QSO with the DX, while also listening to the DX station so as to allow precise timing of calls to the DX station. In contest operation, the Dual Receive system allows the operator to “watch” a multiplier on the current band, or it may be used to establish and hold two “CQ” frequencies (for example, at the low end and at the high end of the band) during slow times of a contest; with one touch of the VFO selector, the transmitter will be switched back and forth between the two frequencies; with audio from the two frequencies isolated in stereo headphones, it is easy to determine instantly the VFO on which a response is heard.

New features of the FT-1000MP Dual Receive system are AF Reverse (to compensate for reversed wiring of headphones), the one-touch illuminated VFO selector keys, and VFO tracking.



(M) Independent Sub Receiver Unit

An essential element of the FT-1000MP's Dual Receive system architecture is the Sub Receiver Unit.

The Sub Receiver is a double-conversion superheterodyne design, using up-conversion to a 47 MHz first IF. Because the Sub Receiver is completely independent from the Main Receiver, the AGC circuitry of the Main Receiver does not affect the Sub Receiver (and vice versa), so strong signals on one receiver do not “pump” the other receiver. Moreover, different IF filters may be selected in the two receivers, allowing a DX operator to listen, for example, in a 250 Hz bandwidth on the Main VFO (to isolate the desired DX station) yet listen in 2.4 kHz bandwidth on the Sub Receiver to search through the pileup for an optimum calling frequency.

It also is possible to operate in different modes on the two registers, so the Sub Receiver may be used for monitoring of a 10 MHz DX packet station while the operator tunes elsewhere in the band on CW in a narrower bandwidth. New on the FT-1000MP Sub Receiver is the elimination of mode/filter restrictions for RTTY operation, so it is possible to use a 500 Hz filter on the Sub Receiver for AFSK operation.

Both 6 kHz and 2.4 kHz ceramic filters are utilized as standard equipment in the Sub Receiver, and the optional 500 Hz Collins® Mechanical Filter may be added for improved CW and Data selectivity. Utilizing the newly-developed Direct Digital Synthesis (DDS) IC (described later), tuning steps as fine as 0.625 Hz may be selected, allowing very precise tuning for critical Packet and other Data applications.

On transmit, the Sub Receiver acts as an RF Monitor, allowing the operator to hear actual “on the air” results of bandwidth and other adjustments of the EDSP and/or microphone equalization during voice transmission, as well as the effects of CW timing adjustments in that mode. The DDS automatically slaves the Sub Receiver to the current transmit register's frequency, ensuring zero-offset precision on the RF monitor.

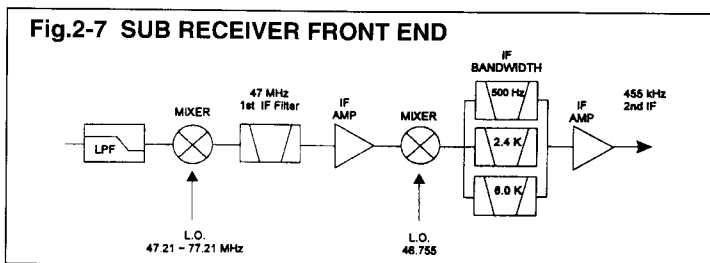
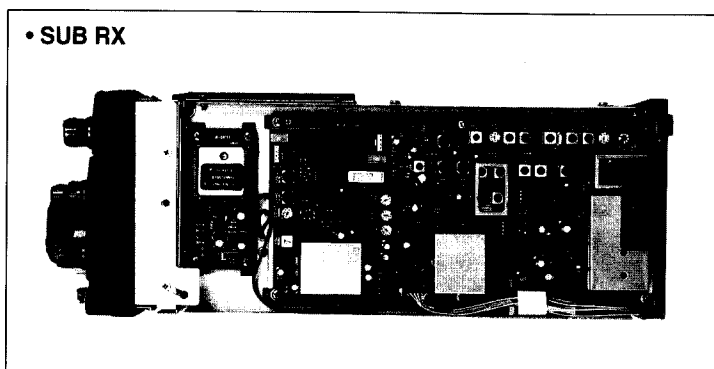


Table 2-3 Sub Receiver AGC Selections (Menu Item 8-7)

| MENU | COMMENT |
|------|------------------------------|
| AUTO | MODE-DEPENDENT AGC SELECTION |
| SLo | SLOW AGC RECOVERY TIME |
| FAST | FAST AGC RECOVERY TIME |



(N) Comprehensive Interference-Removing Features

The FT-1000MP is equipped with the most complete and comprehensive array of interference-removing features every assembled in an amateur radio transceiver. The design philosophy of the FT-1000MP incorporates filtering and other interference-reduction features throughout the receiver signal path, beginning with the High-Pass and Band-Pass filters in the 70 MHz first IF, and culminating with the EDSP filters late in the receiver.

Besides the standard and optional IF crystal, mechanical, and ceramic filters, there are several specialized interference-reduction tools utilized in the FT-1000MP:

① Analog Processing

The IF WIDTH, IF SHIFT, and IF NOTCH filter circuits of the Main Receiver all bring special capabilities to the operator, allowing interference to be combated in different ways.

• IF SHIFT

The IF SHIFT function tunes the signal across the passband of the IF filter electrically without changing the pitch of the signal and without changing the bandwidth of the IF, by shifting the frequencies of two local oscillators simultaneously. This allows either high-side or low-side interference to be rolled off quickly and efficiently.

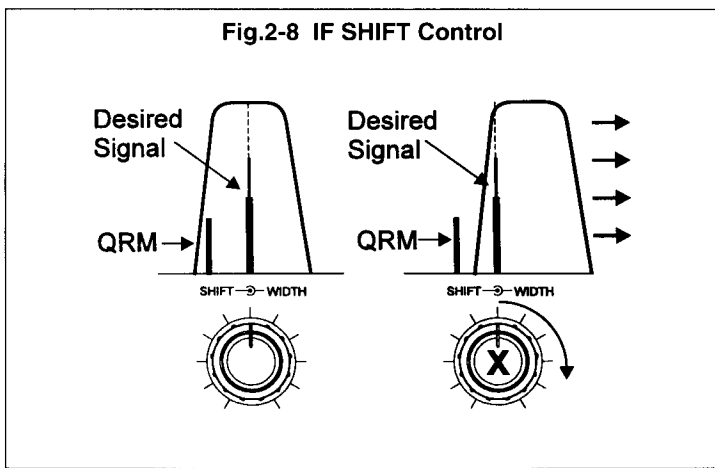
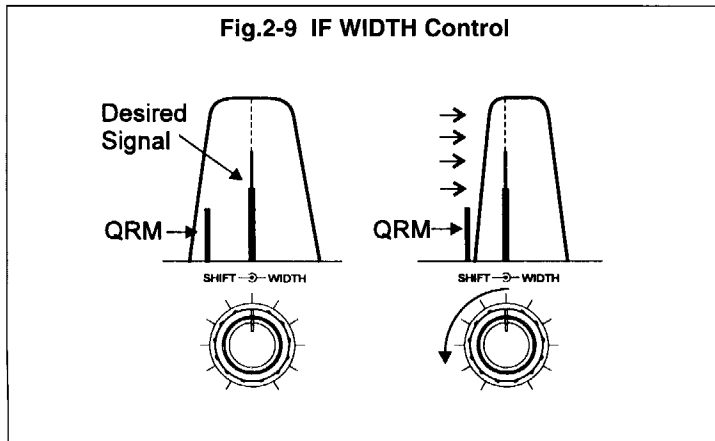


Table 2-4 IF SHIFT/WIDTH Resolution (Menu Item 1-2)

| DISPLAY | 10 (NORMAL) | 20 |
|-----------------|----------------------------|---------------------------------|
| STEP RESOLUTION | 10Hz | 10Hz |
| RECOMMENDED USE | BEST FOR FINE TUNING ON CW | BEST FOR SSB OR WIDE FILTER USE |

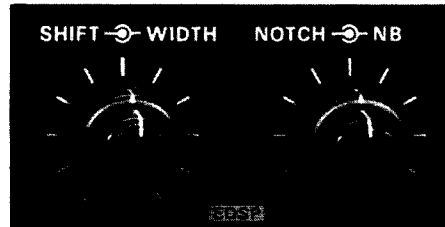
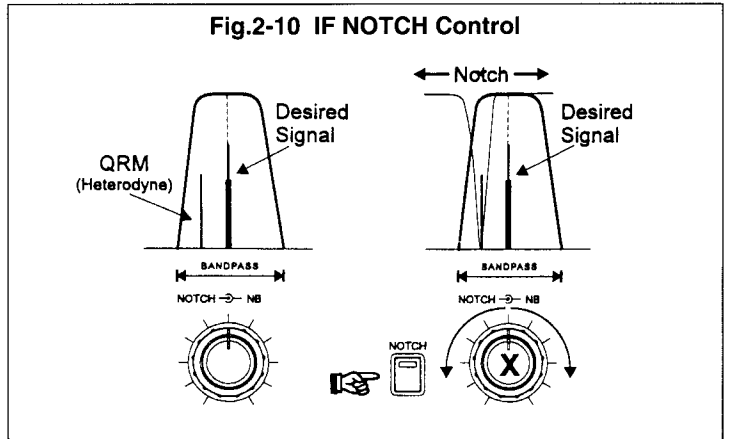
• IF WIDTH

The IF WIDTH function utilizes the cascaded filters in the 8.215 MHz and 455 kHz IFs. By varying the frequencies of the local oscillators for these IFs, the two filters' passbands are "squeezed" against each other, providing variation of the IF bandwidth from about 1.2 kHz to 2.4 kHz in SSB, or 0 Hz to 500 Hz on CW. IF WIDTH function is most effective when full banks of optional IF filters are installed.



• IF NOTCH

The 455 kHz IF includes a high-Q Notch function, which allows the operator to notch out strong carriers interfering with the desired signal. The NOTCH function is particularly spectacular when both the IF NOTCH and EDSP NOTCH filters are engaged simultaneously.



② EDSP Processing

The bandwidth of the Band-Pass Filter in the EDSP (the first counter-clockwise position in the EDSP Contour control) can be set and optimized for each mode. For example, the CW EDSP passband may be set to 120 Hz, while the SSB passband may be set to 2.38 kHz! With very sharp skirt selectivity, the EDSP filters, positioned near the end of the receiver signal path, provide the final "clean-up" of any residual interference, and the EDSP NOTCH function, as mentioned previously, can be used to eliminate any remaining beat notes in the passband.

3. Transmitter Design Highlights

Both analog and digital modulator circuits are provided in the FT-1000MP, along with transmitter gain compensation, the Collins® Mechanical Filter in the 455 kHz IF, and a refined RF Speech Processor. The result is outstanding transmitted signal clarity and pile-up "punch" when you need it most.

(A) Microphone Amplifier Stage

Just as in a receiver design, the earliest stage of the transmit signal path is critical in establishing maximum signal-to-noise ratio and dynamic range on the voice signal. Whether analog or digital modulation is to be used, it must be recognized that the human voice

has a total dynamic range of 90 dB or more in close proximity to a microphone element. Therefore, simple general-purpose microphone amplifier ICs are not adequate for this application.

The FT-1000MP incorporates a low-noise microphone amplifier stage using bipolar transistors, as on the FT-1000D, to obtain the required 90+ dB of Signal-to-Noise ratio on the voice signal. The MIC GAIN control is a voltage-stepping potentiometer similar to that used for receive audio, and it eliminates the possibility of noise pickup on an audio line routed through a front panel potentiometer; instead, the signal path remains on the AF Unit, shielded from noises which might be generated elsewhere in the transceiver.

Careful ALC design, and the application of EDSP microphone equalization, both contribute to the maintenance of high Signal-to-Noise ratio early in the voice signal generation process.

(B) Analog Modulator/Mixer and Transmit IF Stages

A balanced modulator circuit featuring the Yaesu-exclusive μ PC1037H converts the incoming microphone signal (either analog audio or the 10.24 kHz EDSP digital voice signal) to the first transmit IF of 455 kHz. The μ PC1037H has superb thermal stability, outstanding resistance to carrier leakage, and high Signal-to-Noise ratio and dynamic range.

The transmit signal, subsequently mixed first to 70 MHz and thence to the final transmitting frequency, is carefully controlled for gain, so as to ensure that overdrive of the IF or power amplifier stages does not occur, either during thermal changes or with varying output power.

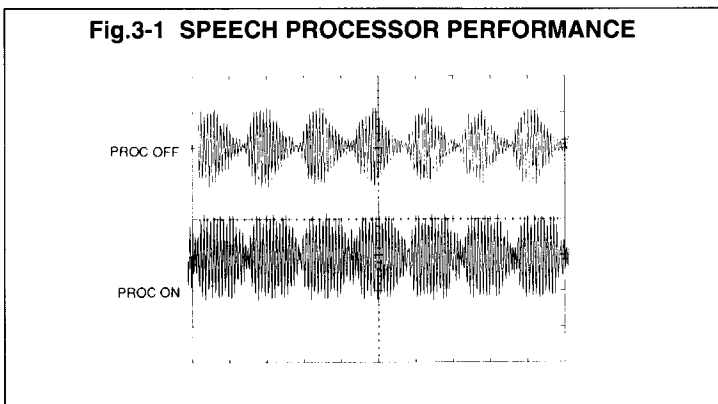
The Collins[®] Mechanical Filter in the 455 kHz IF provides a very flat passband, with negligible ripple which might distort the voice reproduction. Other analog filtering circuits during the transmit signal path ensure a clean signal at RF.

(C) RF Speech Processor

The SSB speech processor is the so-called "RF Clipping" type. During processor operation, the 455 kHz IF signal is compressed via a limiter IC which filters this signal with a low-Q Low-Pass Filter, then mixes the signal to 8.215 MHz where the signal passes through an eight-pole crystal filter and is then amplified. The result is increased "talk power," on an order of magnitude of 6 dB or better.

The RF Speech Processor design is superior to other types, because it provides lower distortion along with a higher increase in talk power. As with all such designs, of course, the drive levels must be carefully adjusted; fortunately, the extensive metering capability of the FT-1000MP makes level adjustment quick and fool-proof.

The combination of the RF Speech Processor, front-panel carrier point adjustment, and the EDSP Microphone Equalizer provide the operator with extensive ability to tailor the response and compression level of the transmitter to his or her voice pattern. This means that less power is wasted in the production of unneeded areas of the modulation envelope, and consequently more available power can be concentrated in the useful frequency components of the operator's voice.

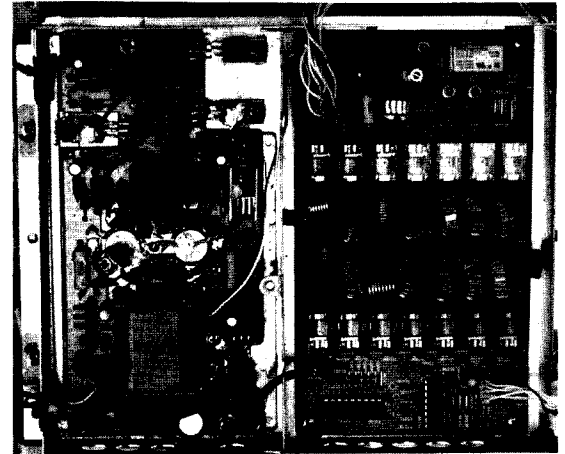


(D) RF Power Amplifier

The push-pull final amplifier stage utilizes bipolar 2SC2879 transistors, which proved to be so reliable in the 200-watt power amplifier for the FT-1000D. At the 100-watt power level, this amplifier design is extremely stable and provides excellent linearity.

The Duct-Flow Cooling System (DFCS) combines a large cross-flow cooling fan and heat sink to provide excellent dissipation of heat generated in the power supply and power amplifier areas. The entire chassis design is formulated around efficient heat transfer and dissipation from the rear, side, and front panels, thus simplifying the routing of cables (since heat buildup is not allowed to occur in any one area).

The operation of the cooling fan is thermostatically controlled by heat sensors in both the power supply and the power amplifier.



● RF POWER AMP + LOW PASS FILTER CIRCUITS

(E) Automatic Antenna Tuner

Using its own 8-bit Central Processing Unit (CPU) for tuner control, the Automatic Antenna Tuner command and control circuitry chooses re-selected fixed inductor values, and drives a variable capacitor, to achieve optimum impedance matching.

The Auto Tuner is equipped with a preset memory for each amateur band, plus general-purpose preset memories for any arbitrary band, yielding a total of 31 of available presets for the antenna tuner. Memory data can be stored every 10.24 kHz, if needed, so as to allow efficient movement around a band once tuner memory data is stored. In any event, eight memories are reserved for a "preset" function, one per band other than the currently-used band, so as to serve as a starting point for operation whenever a band change occurs.

The control circuitry is "smart," in that it anticipates transmission requirements as you move around a band, presetting itself to (A) the impedance-matching data already stored in memory, or (B) the predicted impedance requirements based on your last-used frequency and the direction/magnitude of frequency excursion. In the latter case, although no such "estimate" can be entirely accurate, the presetting dramatically reduces any needed retuning time when transmission eventually occurs.

Extremely fast tuning speeds are possible, thanks to the geared tuning motor and detailed impedance data provided by the LPF (Low-Pass Filter) Unit's directional coupler. The tuning circuits have been designed using high values of capacitance, so as to minimize losses through coils, and the high resolution and electric braking on the variable capacitor motor yield imperceptible overshoot or undershoot in the tuning alignment.

The antenna tuner also can sense and report a catastrophic antenna failure or erroneous antenna selection (e.g. the operator mistakenly attempts to use a 40-meter Yagi on 20 meters), and will suspend antenna tuning in such instances.

Ideal for smoothing out impedance variations across an entire amateur band, the Automatic Antenna Tuner in the FT-1000MP is the fastest, most sophisticated total design package ever incorporated in an Auto-Tuner in an amateur radio transceiver to date.

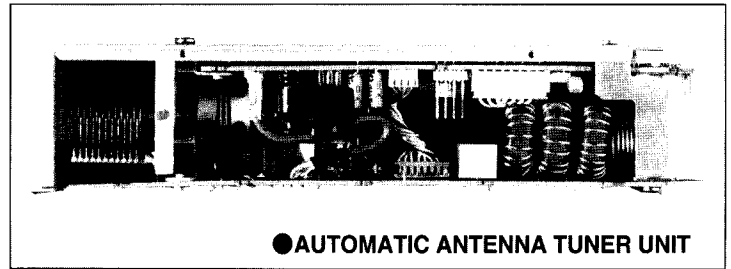
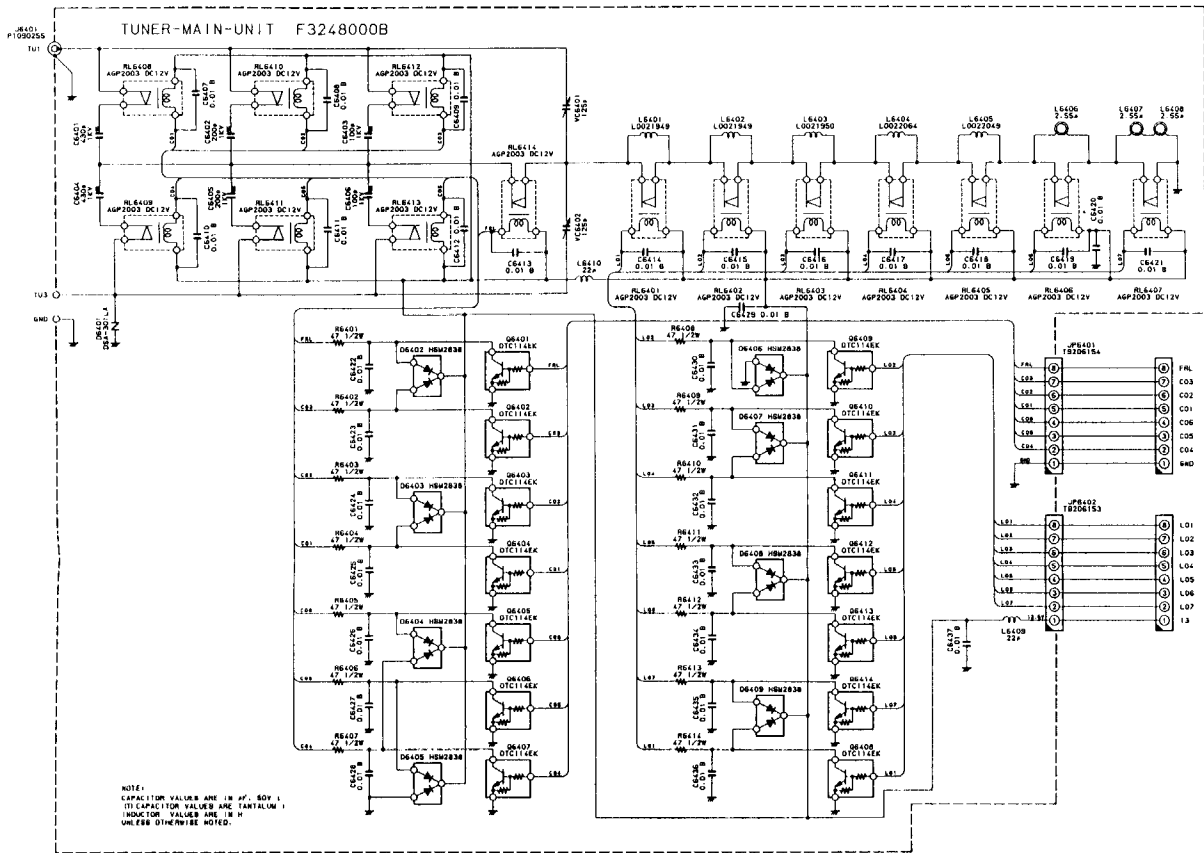


Fig.3-2 AUTOMATIC ANTENNA TUNER SCHEMATIC DIAGRAM



4. Local Oscillator Design Features

(A) Single-Crystal-Reference Main Oscillator System

With all the attention given to establishing and maintaining high Signal-to-Noise ratio in the FT-1000MP, as described earlier, it is clear that the local oscillator structure of the transceiver must be extraordinarily clean, as any noise-generating deficiencies will be quickly noticed by the operator. Moreover, with so many interference-fighting circuits in use, the possibility of spurious beats between oscillators is a significant challenge to engineers. To conquer these potential adversities, Yaesu's engineers incorporated a unique single-loop PLL structure, utilizing a high-stability master reference oscillator and low-noise, high-resolution Direct Digital Synthesizer (DDS).

This method has produced a local oscillator structure which provides exceptionally fast lock-up time, high Carrier-to-Noise (C/N) ratio (for both the VCO and the new local oscillator output), and outstanding frequency resolution. Yaesu's engineers optimized the design around the often-conflicting objectives of (A) reducing phase noise from strong signals separated 20~50 kHz or more from the desired signal, (B) reducing phase noise from close-in

signals (separated by 1 kHz or less), (C) reducing the magnitude of discrete spurious signals (as opposed to broadband noise), (D) reducing synthesizer noise on the high bands, where noise figure is critical, and (E) reducing synthesizer noise on the low bands, where noise figure is not so critical but where high signal levels can cause serious synthesizer-noise problems.

The result is an oscillator system which will sustain the input from a broadband front end amplification system, does not fill a 250 Hz or 500 Hz low-noise bandwidth with rushing noise from a CW carrier, and yet one which provides transmit / receive turnaround times fast enough for the most demanding data applications.

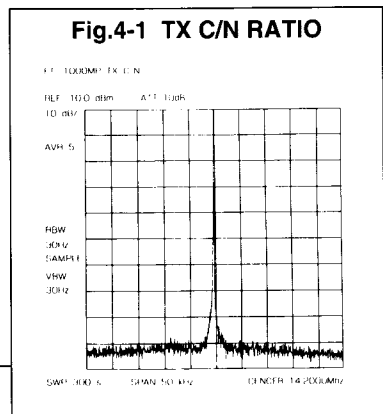


Fig.4-2 (1) LOCAL OSCILLATOR BLOCK DIAGRAM

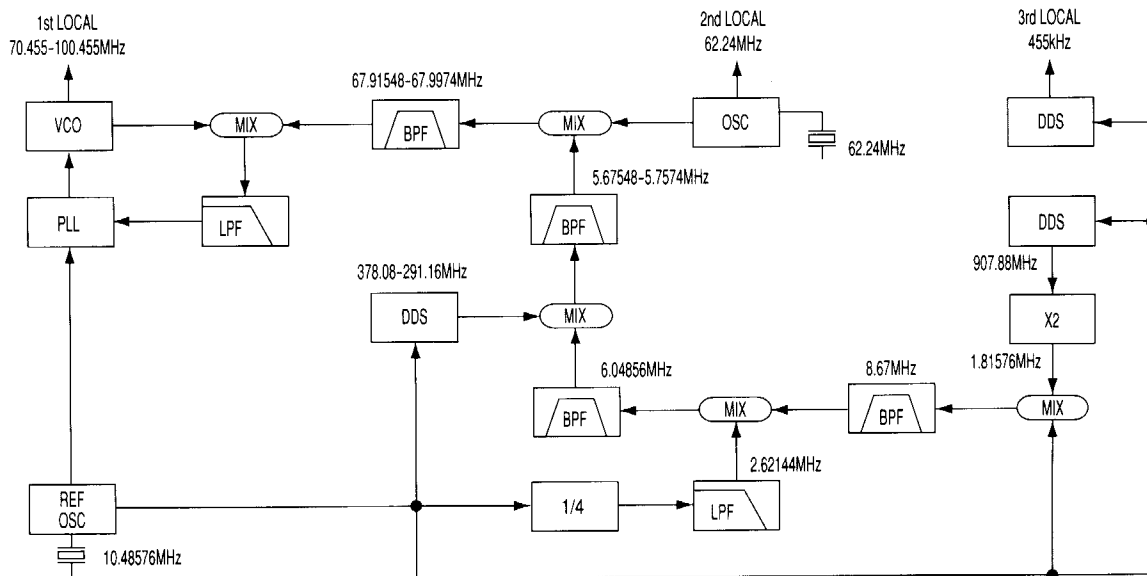
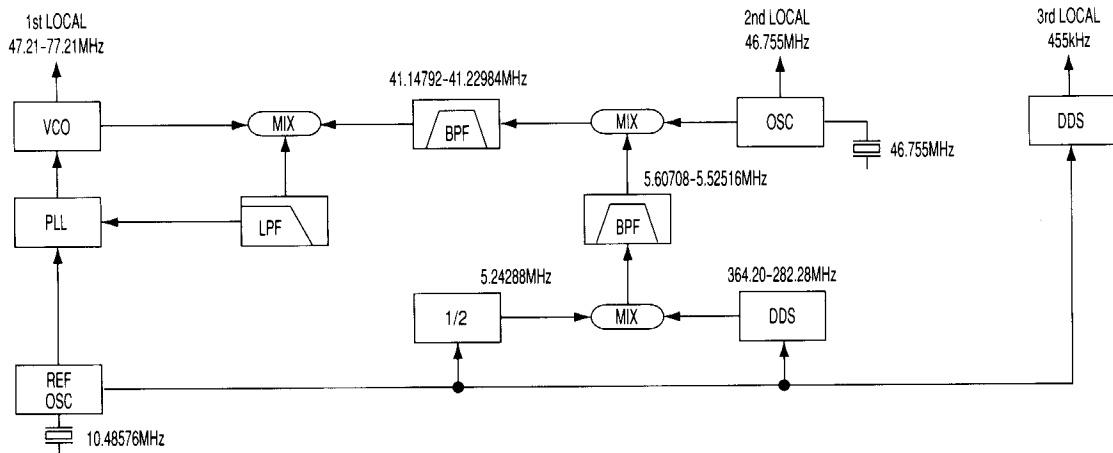


Fig.4-2 (2) SUB RECEIVER LOCAL OSCILLATOR BLOCK DIAGRAM



All-Mode HF Transceiver FT-1000MP



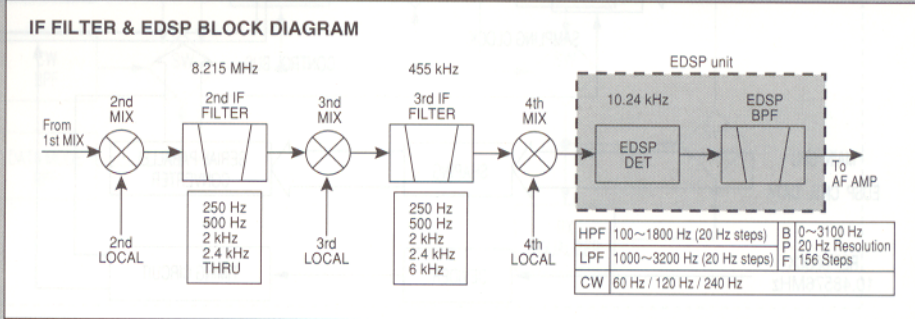
The year was 1956. Electronic communication throughout the world was on the threshold of significant and remarkable change. Intrigued by the development of single sideband radio theory, a young engineer and amateur radio experimenter painstakingly assembled an SSB transmitter. Word of his successful efforts spread quickly among his friends, and soon radio amateurs from all over the country were requesting transmitters just like it. Thus was born the first invention of JA1MP, founder of Yaesu. Though his key is now silent, in tribute to his leadership and exceptional contributions to the radio art, the FT-1000MP carries the memory of his call sign.

An HF Masterpiece, Combining the Best of Digital and RF design technology. The FT-1000MP.



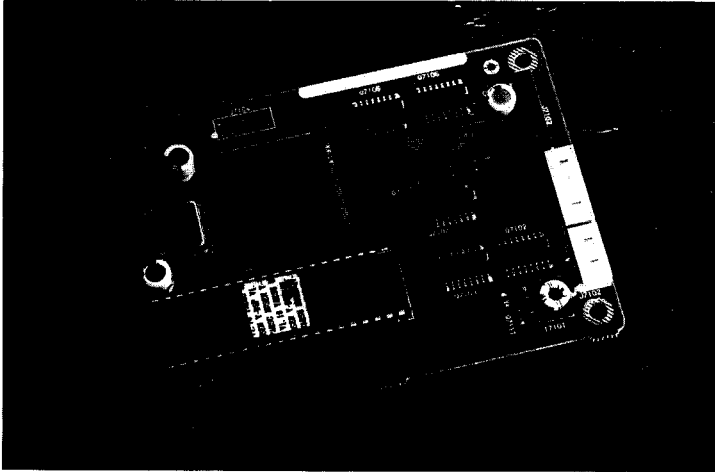
The FT-1000MP introduces the Yaesu exclusive Enhanced Digital Signal Processing system to the world of HF operating. Operational both in receive and transmit modes, EDSP provides 4 random-noise reduction protocols, audio enhancement with 4 voice response equalization programs for both RX and TX, and an automatic notch filter which identifies and eliminates multiple interfering carriers or heterodynes. Selectable contours of the EDSP bandpass filtering offer low, mid, and high-range roll-off responses, allowing the operator to cope with changing interference conditions. Improved signal-to-noise ratio, razor-sharp selectivity curves, and outstanding transmitted signal clarity are yours with the exclusive EDSP system.

ENHANCED
EDSP DIGITAL SIGNAL PROCESSOR



1. EDSP (Enhanced Digital Signal Processor)

The EDSP system's design is constructed around the latest high-performance NEC® DSP device, the μ PD77016. The FT-1000MP overall architecture blends this leading-edge technology with proven analog filtering techniques to eliminate areas of deficiency in traditional designs, including filter bleed-through, phase distortion, inappropriate frequency response, carrier leakage, and the like.



(A) Fundamental EDSP Architecture

The analog processing circuits of the EDSP Unit are constructed utilizing a two-channel Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC) technique. Therefore, the receive and transmit circuits are completely independent, and can be individually optimized for the differing requirements on the transmit and receive modes. To ensure a high level of EDSP performance and consistency, low-noise Op-Amps and precision film capacitors are used in all EDSP analog filters.

The discussion below will detail the highlights of the EDSP signal flow.

①Receiver

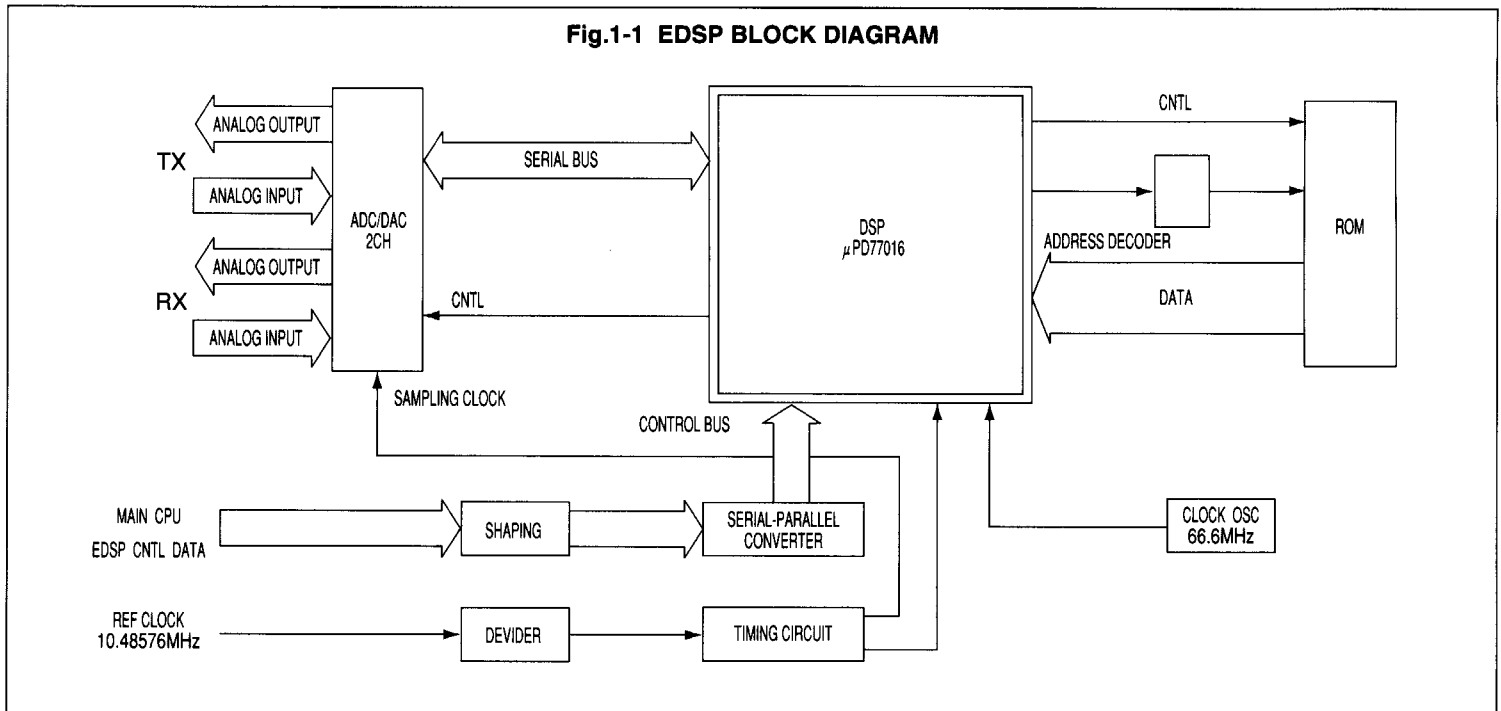
The signals which appear at the input of the EDSP circuitry will vary in composition, depending on the demodulation technique selected by the operator. If analog demodulation is selected, the analog (demodulated) audio signal is applied to the EDSP for processing; in the case of digital demodulation, a 10.24 kHz digitized IF signal is applied. Figure 1-2 shows the Functional Block Diagram for the EDSP.

The input signal passes through a buffer circuit, consisting of a low-noise op-amp, and then is connected to the difference input of the Analog-to Digital Converter (ADC) using a difference-converting circuit provided by the inverting/non-inverting function of the same low-noise op-amp. This circuit is specially designed to minimize the phase difference between inverted and non-inverted input signals.

Since an 18.6 kHz anti-aliasing (decimation filter) circuit is installed in the ADC, only a simple filter which eliminates signals near the over-sampling frequency is needed prior to the ADC.

The ADC features 16-bit resolution for low distortion, utilizing 4th-order $\Delta\Sigma$ conversion with 64 times over-sampling. The 40.96 kHz clock pulse for sampling is obtained by dividing the 10.48576 MHz master reference oscillator by 256, resulting in a very stable clock signal. Due to the 64x over-sampling, of course, the actual sampling frequency is $64 \times 40.96 \text{ kHz} = 2.62144 \text{ MHz}$. The sampled data is processed in the DSP-D Unit; each filter utilized in the processing effort utilizes an FIR filter structure, so there is less degradation in signal quality, thanks to the phase-linear characteristics of the FIR filters. This characteristic also provides remarkably sharp skirt selectivity and narrow bandwidths (down to 60 Hz) in the CW mode, with virtually undetectable ringing.

Fig.1-1 EDSP BLOCK DIAGRAM



Digital demodulation can be selected by the operator, enabling a proprietary Yaesu digital demodulation technique designed to eliminate the interference problems commonly encountered with the usual phase-shift network (PSN) technique. If digital demodulation is selected, a preliminary bandwidth of 100~3100 Hz or 300~2800 Hz for SSB, and 300~1400 Hz for CW, is established in the demodulator itself. Whether analog or digital demodulation is selected, however, the main EDSP algorithm allows very precise high- and low-cut filters to be combined to produce a bandpass response, with 20 Hz resolution, for SSB and CW. On CW, the bandpass filter choices available are 60 Hz, 120 Hz, and 240 Hz, with the center frequency of the filter being determined by the setting of the front panel PITCH control, which also shifts the IF passband and transmit carrier in sync with the center frequency of the (very narrow) CW BPF. Dedicated filters are also provided for data communications modes like Packet.

After bandwidth processing, the signals pass to the "Auto-Notch" block where, if enabled, the EDSP Auto-Notch filter removes carriers from the receiver passband. The Auto-Notch filter takes advantage of the fact that pure carriers are highly "autocorrelated" (highly repetitive in time-domain characteristics) as opposed to noise (which has essentially zero autocorrelation) and speech (which has only moderate autocorrelation). Less-well-autocorrelated carriers may be notched out using the manual IF notch, and the combination of the IF notch and the EDSP Auto-Notch is frequently the most formidable weapon against undesired carriers.

Next comes the Noise Reducer block, in which four different noise-reduction algorithms are utilized which compare the periodicity of the IF passbands components--signals and noise--and targets the less-correlated signals by the method of least squares. The four noise reduction protocols are adaptive filters

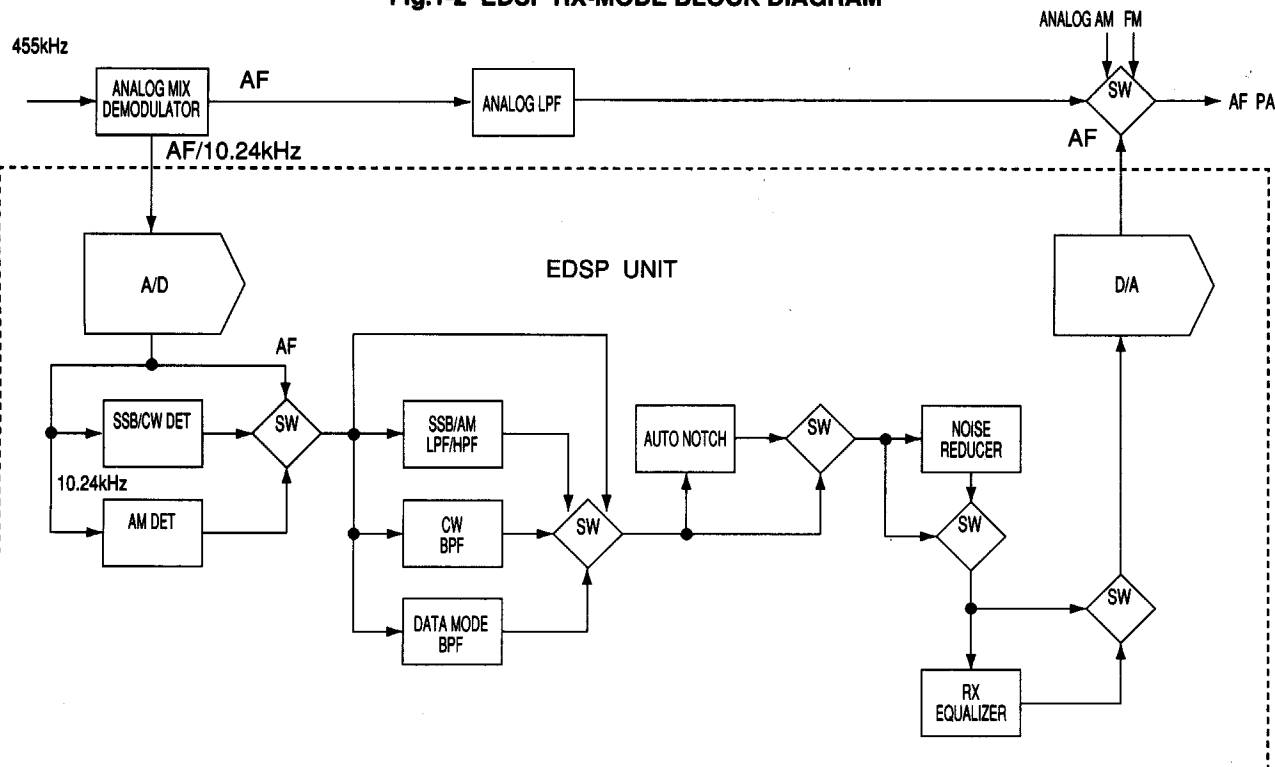
which "form fit" the incoming signal, while having instantaneous reaction time so as to cause minimal distortion of the desired signal, particularly on voice modes.

Finally, the intelligence recovery of incoming voice signals can be enhanced by utilization of the "CONTOUR" feature, which provides peaked low-pass, peaked high-pass, and double-peak (bass and treble peaking) responses to help to align the late-stage response of the receiver to the exact voice characteristics of the operator on the other end of the communications circuit.

Although the bandpass contour and peaked filters just mentioned cannot be used together (in combination), all other filters may be used together (i.e. Aut notch and Noise Reducer plus peaked high-pass filter).

After all the digital processing is completed, the 10.24 kHz EDSP IF signal is converted back to analog audio by the Digital-to-Analog Converter (DAC). The DAC, like the ADC, uses a 4th-order $\Delta\Sigma$ process and 64x over-sampling to obtain the analog signal. Since an 8-pole interpolation filter and 2nd-order analog low-pass filter are installed in the DAC, no additional smoothing filter is needed. The output circuit of the DAC also functions as a low-pass filter which removes quantization noise outside the desired passband, so output signals have excellent signal-to-noise ratio and tone quality.

Fig.1-2 EDSP RX-MODE BLOCK DIAGRAM



② Transmitter

The EDSP architecture on the transmit side of the FT-1000MP is very similar to that of the receiver side. Both digital and analog modulators are provided, and the digital processing features 16-bit resolution, and 64x over-sampling. Great care has been taken to ensure that dynamic range in excess of 90 dB is maintained, since the human voice/microphone combination can easily exceed 90 dB S/N during "close talking" of the microphone.

After amplification of the voice signal by the microphone amplifier, the signal may pass along a "traditional" analog path, or it may be digitized for EDSP manipulation. In the latter case, the signal may be passed through the "Microphone Equalizer" circuit, which mirrors the functional concept of the "Contour" feature on receive. The equalization algorithms were designed to emulate the capabilities of studio broadcast microphones using different factors of equalization, and both the MH-31B8 Hand Microphone and the new MD-100A8X Desk Microphone were used during the design process. A "bypass" path is also available, if microphone equalization is not desired.

After equalization, if used, the signal may be delivered to the digital modulator (except in the non-linear FM mode, which bypasses the digital modulator). Both opposite sideband rejection and transmit signal-to-noise ratio have been enhanced by Yaesu's proprietary digital modulator, and are particularly superior on the FT-1000MP when compared to competing PSN circuits.

The output from the digital modulator is a 10.24 kHz IF signal, which subsequently is converted to an analog signal by the DAC.

(B) Key Features and Benefits of EDSP

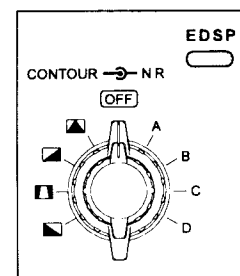
① EDSP Noise Reduction

In the HF region, the input signal voltage presented to the receiver contains not only the desired signals but a wide variety of

undesired noises. These noises, which can be cosmic, atmospheric, or man-made, are impossible to eliminate using traditional analog techniques, because the signal characteristics of the noises are so varied.

For decades, noise blanker technology worked entirely within the "time domain," whereby both noise and desired signals were evaluated as to their strength versus time, and a blanking pulse was injected into the signal path at the point where the noise pulse was to be found. As a result of this technique, desired information was often lost; severe distortion of the desired signal was a frequent by-product of this technique.

The FT-1000MP's EDSP Noise Reduction circuitry came about as a result of thousands of hours of design work followed by hundreds of on-the-air bench tests and field reports which evaluated and verified the real-world performance of laboratory designs. The four Noise Reduction parameters which were ultimately incorporated in the FT-1000MP each bring a unique correlation technique to bear against the prevailing noise encountered; accordingly, unlike many traditional IF "Noise Blankers" in use today, the (A) ~ (D) selections do not represent a "level" control per se, but rather a different evaluation of the noise and a unique attack pattern thereupon. Because of the precision possible due to the digitizing process, only the offending noise is targeted for elimination; moreover, the EDSP Noise Reduction circuitry targets the unique characteristics of noise as opposed to the "known" characteristics of voice or data signals (including CW), and is not sensitive to relative signal-to-noise ratio as it attacks noise present in the receiver passband.



The Noise Reduction circuitry works in concert with the EDSP Bandpass filters, and can be particularly effective in voice or data modes when used in conjunction with the Contour functions to maximize net signal-to-noise ratio.

Fig.1-3 EDSP TX-MODE BLOCK DIAGRAM

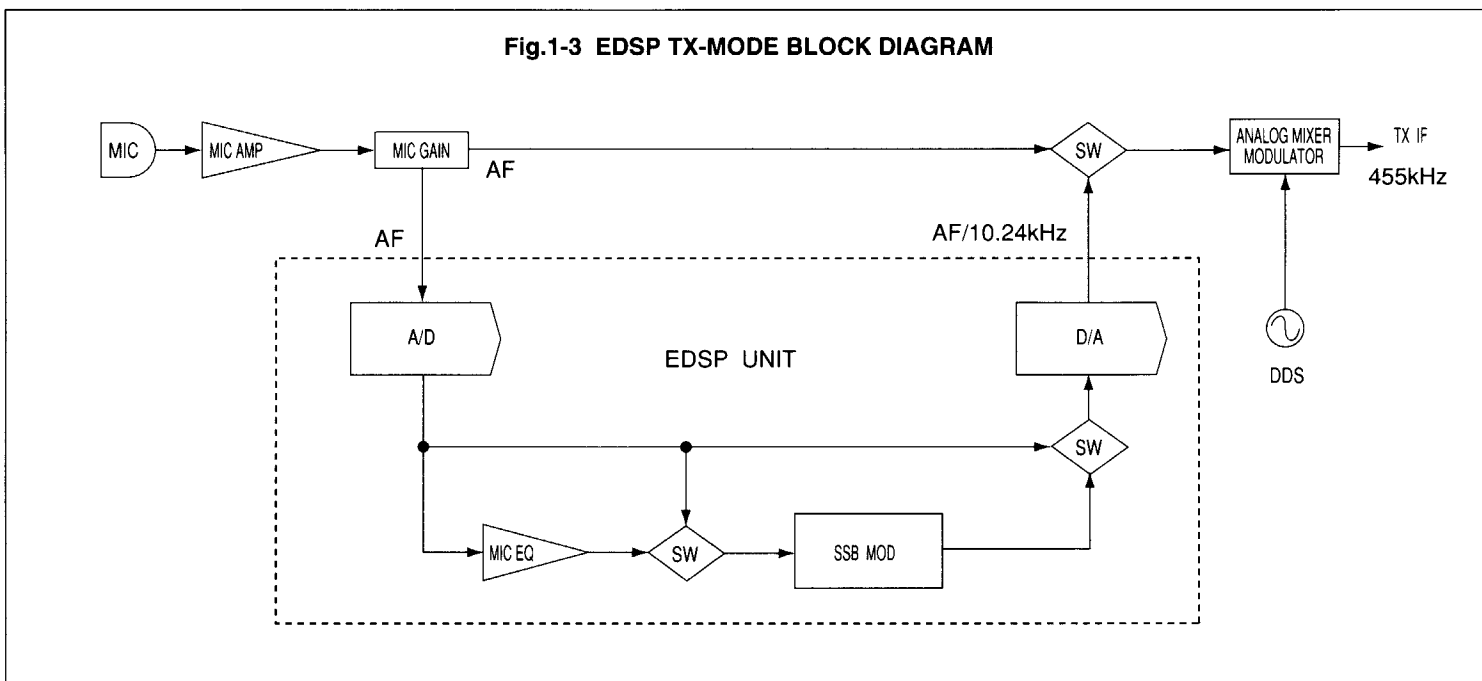
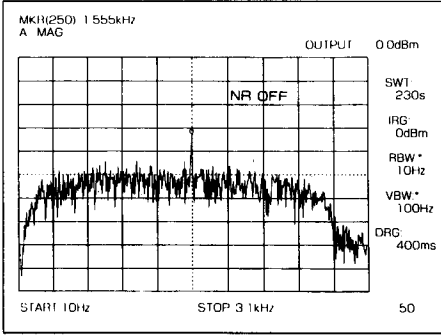
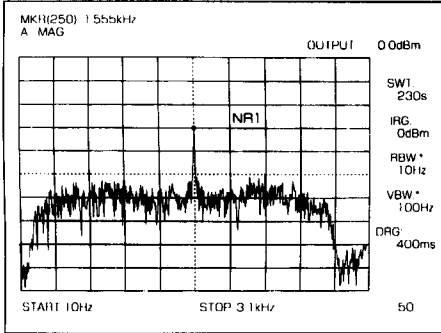


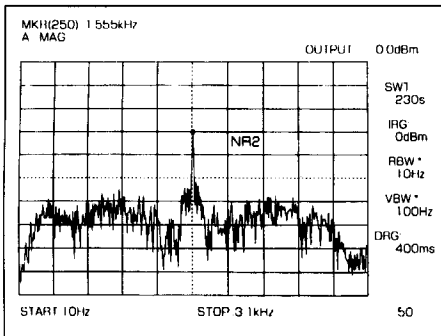
Fig.1-4 NOISE REDUCER PATTERNS



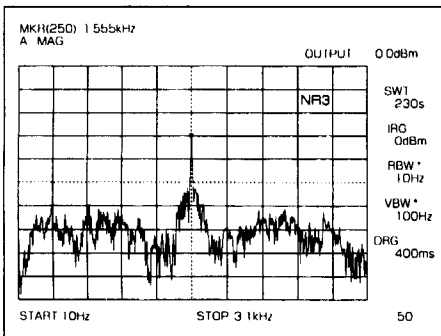
① NR OFF



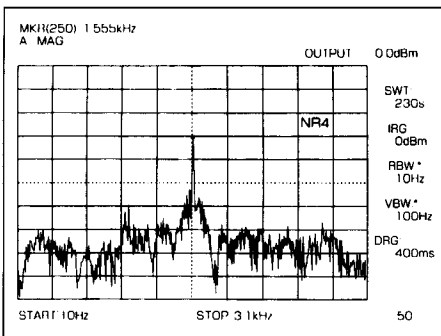
② NR A



③ NR B



④ NR C



④ NR D

② EDSP Contour Function

The new "Contour" feature pioneered by Yaesu in the FT-1000MP is the evolution of the highly-acclaimed digital filter utilized in the FT-990. On receive, this filter allows the operator to match the EDSP filtering pattern to that of the incoming signal (for example, a female voice versus a male voice), with the selection being performed via a front panel switch. On transmit, the EDSP contours allow the transmitter's response to be matched to the voice pattern of the operator, with the selection being made via the Menu system (since the operator's voice presumably does not change).

Table 1-1 EDSP CONTOUR Selections

| | | |
|---|----------------|---------------------------|
| ▲ | BPF(Band-Pass) | QRM rejection |
| ▣ | LCF(Low-Cut) | high-freq. emphasis |
| ▢ | MCF(Mid-Cut) | high & low freq. emphasis |
| ▤ | HCF(High-Cut) | low-freq. emphasis |

Table 1-2 EDSP BPF Selection & Parameters (Menu Selection 4-5)

| | | | |
|---------|-----------|---------------------|------------|
| SSB | High Cut | 1000~3200Hz | 3200Hz |
| | Low Cut | 100~1800Hz | 100Hz |
| CW | Bandwidth | 60/120/240Hz | 240 Hz(BW) |
| AM | High Cut | 1000~3200Hz | 3200Hz |
| | Low Cut | 100~1800Hz | 100Hz |
| DIGITAL | PKT | 800~2500Hz, preset | |
| | SSTV | 1000~2500Hz, preset | |
| | FAX | 1300~2500Hz, preset | |

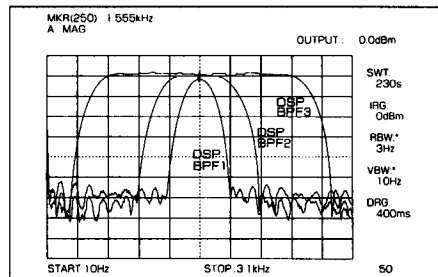


Fig.1-5 (1) SSB BPF PATTERNS

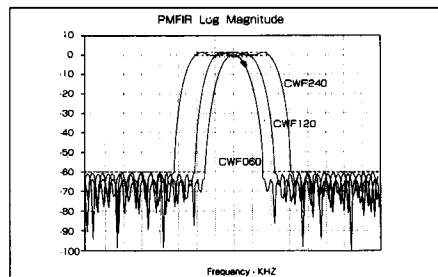


Fig.1-5 (2) CW BPF PATTERNS

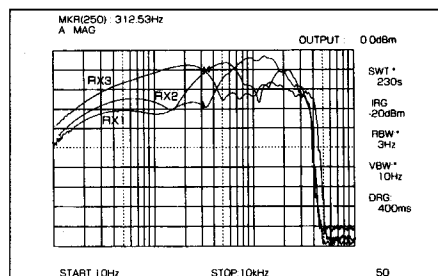
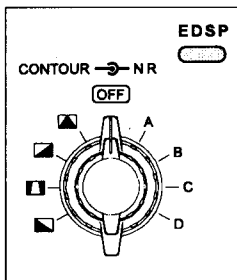


Fig.1-6 CONTOUR PATTERNS

For digital modes such as RTTY and packet, the cutoff frequency is shifted to correspond to the higher (demodulated) audio frequencies used by digital modem units. On CW, the bandpass response can be varied from 240 Hz maximum bandwidth to 60 Hz minimum bandwidth, the latter of which presents some interesting and exciting possibilities when used for VHF/UHF weak signal work such as EME (with a transverter).



Because of the wide variety of IF filter combinations available on the FT-1000MP, the EDSP contour filters provide a unique benefit to the operator, in that they “massage” the signal passband late in the receiver stage so as to enhance intelligence recovery in a way that simple bandpass filters (found in competing units) cannot. The IF filters create the most narrow bandwidth consistent with the mode in use, thereby protecting the IF amplifiers from strong signal encroachment, and then the EDSP contour filters can be utilized to “form fit” the signal inside the IF passband, thus enhancing signal-to-noise ratio.

③ Improved Signal Quality Through Digital Modulation and Demodulation

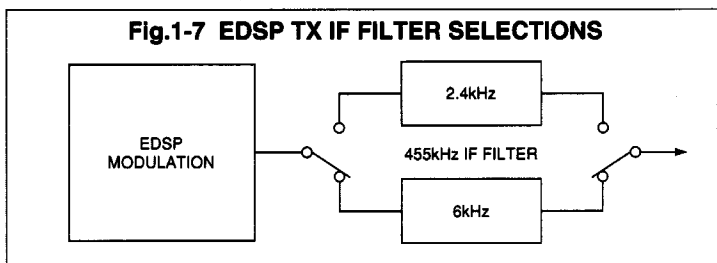
Digital Signal Processing brings the potential of an undistorted voice signal waveform, with no spurious products outside the desired passband. Unfortunately, earlier digital modulation schemes have suffered from poor signal-to-noise ratio as compared to analog modulators. New techniques applied in the FT-1000MP, however, have broken through this barrier, producing a digital modulator with signal-to-noise performance equal to or better than the best analog modulator circuits.

Because the EDSP-modulated signal contains no out-of-band products, it makes possible the use of a 6 kHz IF filter in the transmit signal path, thereby allowing the possibility of utilization of slightly wider bandwidths (100-3100 Hz maximum) where higher fidelity is desired. The bandwidth may be adjusted, through menu settings for a low-frequency roll-off at 100, 150, 200, or 300 Hz, depending on your application.

Table 1-3 EDSP Modulation and Demodulation (Menu Selection 7-7)

| | |
|----------|---|
| SSB (Rx) | OFF 100-3100Hz 300-2800Hz |
| SSB (Tx) | OFF 100-3100Hz 150-2800Hz 200-3100Hz 300-3100Hz |
| CW (Rx) | OFF ON (100-3100Hz) |
| AM (Rx) | OFF ON (70-3800Hz) |

Fig.1-7 EDSP TX IF FILTER SELECTIONS



④ EDSP Microphone Equalizer

Whether or not the Digital Modulator is engaged, the FT-1000MP provides a microphone equalizer through EDSP, allowing customization of the transmitter's early-stage frequency response to match the operator's voice.

Similar in concept to the four-position Contour circuitry used in the receive mode, the microphone equalizer provides four responses, set through the menu system, which each serve a unique function, as outlined in the table below.

These settings are established via the Menu system, so as to prevent the front-panel Contour control (which is frequently adjusted so as to compensate for differing incoming voice characteristics) from affecting the transmitter setting (which should not change just because a different sounding incoming signal is being received).

Table 1-4 EDSP Transmitter Equalizer Selections (via Menu Item 4-4)

| | | |
|-----|------------------------------------|--------------------------------|
| OFF | Microphone Equalizer Disabled | |
| 1 | Equalizer On: Bandpass response | Natural-sounding flat passband |
| 2 | Equalizer On: Low-Cut Response | For DX pile-up or contest use |
| 3 | Equalizer On: Bass-Enhancement | For ragchew use |
| 4 | Equalizer On: Mid-High Enhancement | Emulates Crystal Microphone |

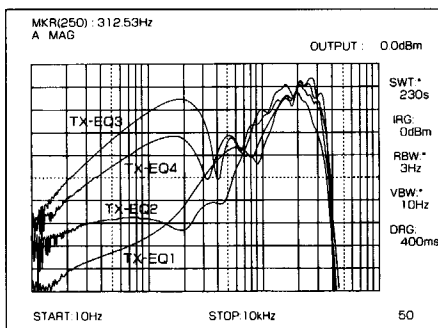


Fig.1-8 TX EQUALIZER

⑤ EDSP Digital Auto-Notch Filter

The FT-1000MP's Notch Filter combo provides a perfect example of the blending of analog and digital technology which yields a product superior to an analog-only or DSP-only design.

The FT-1000MP provides both an analog IF notch filter, manually tuned, and a seeking automatic EDSP notch filter. The Auto-Notch is theoretically capable of eliminating an infinite number of undesired carriers, and it should be disabled whenever CW operation is in progress(!). Through the Menu system, several combinations of these notching circuits may be activated, per the table below.

Table 1-5 Notch Filter Selections (Menu Item 2-9) when NOTCH Key is Activated

| | |
|--------|---|
| MANUAL | IF Notch, adjusted via manual “Notch” knob |
| AUTO | Auto-Notch (If EDSP is Off, IF Notch is activated as above) |
| SELECT | EDSP Auto-Notch plus IF (manual) Notch are active |

The "Select" mode is usually the preferred setting, as the IF Notch can be used to take out loud, wide carriers with the EDSP Auto-Notch doing a "clean-up" job on remaining "birdies."

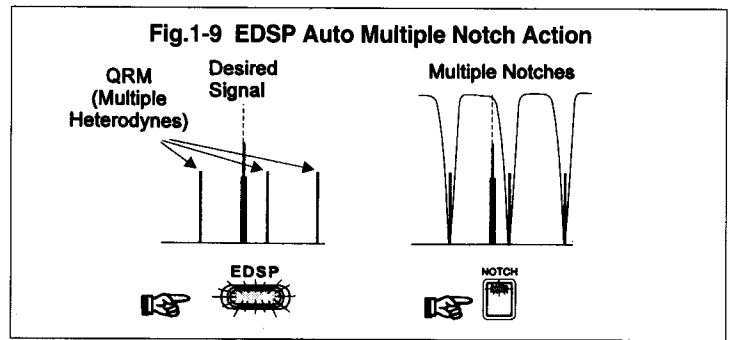
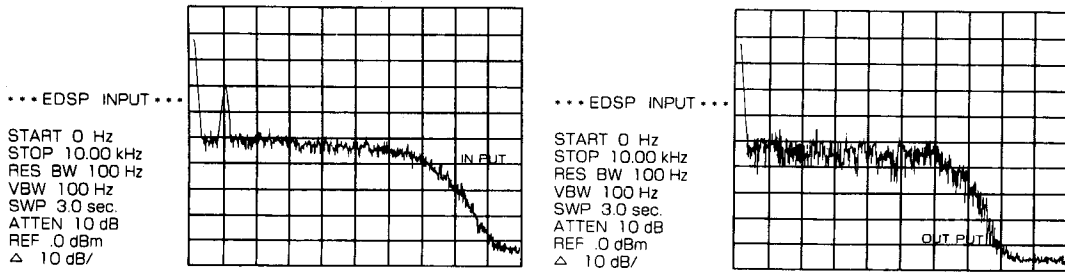


Fig.1-10 DIGITAL NOTCH FILTER



2. FT-1000MP Receiver Design Highlights

Building on the success of the highly-acclaimed receiver design architecture of the FT-1000D, the FT-1000MP retains the fundamental design philosophy while adding significant enhancements to improve both signal-to-noise ratio and strong-signal handling capability.

Design Philosophy

Because the front end of a receiver is typically the most critical in terms of immunity from intermodulation distortion (IMD), special emphasis was placed on front end filtering and intercept performance in the development of the FT-1000MP.

The front end of the FT-1000MP includes a wide variety of input filters to protect the active devices which follow. These include low-pass filters, high-pass filters, and band-pass filters, the latter of which are selected using PIN diodes, which have superior rejection of 2nd-order IMD.

Following the input filters are three input preamplifiers which may be selected for special applications, or bypassed for even higher input intercept. Following the input RF stage is the first mixer, a doubly-balanced circuit using four Siliconix® SST-310 FETs in an up-conversion design which produces a first IF of 70.455 MHz. The up-conversion technique significantly improves image rejection, and is identical to the design utilized in the FT-1000D.

A monolithic crystal roofing filter follows the first mixer, setting the early-IF bandwidth which subsequently is narrowed as the signal works its way through the receiver circuits to the speaker.

A discussion of the individual circuit highlights follows, corresponding to the signal flow through the receiver system.

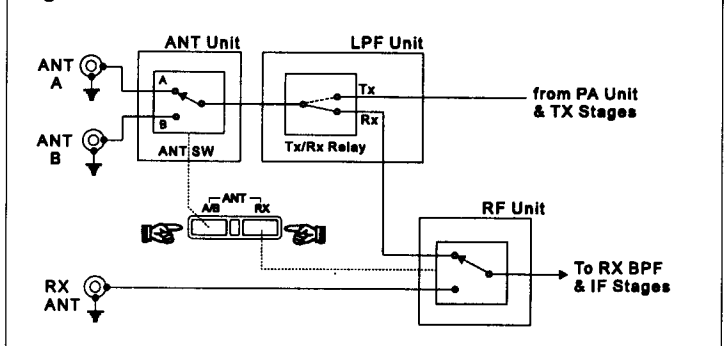
(A) Antenna Selection and Switching

The FT-1000MP provides two SO-239 ("M") female connectors on the rear panel, with "A/B" selection via a front panel switch. Although multiple antenna jacks are occasionally seen in other transceivers, they frequently suffer from poor isolation, leading to signal bleed-through from the antenna(s) not in use. In the FT-1000MP, the unused antenna jack is shorted to ground to ensure total isolation.

A separate receive-only "RX ANTENNA" access path is provided via a pair of RCA connectors. These allow special receiving filters or preamplifiers to be inserted into the receive line, or they allow attachment of a receive-only antenna such as a loop or Beverage antenna for low-band reception.

A surge suppresser is included on the antenna input line, so as to suppress static "spikes" which could damage the input diodes and/or transistors.

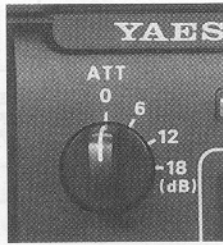
Fig.2-1 Antenna Selection



(B) Front-end Attenuator

A three-step attenuator is provided which will reduce the input signal by one S-Unit per step (6/12/18 dB) during conditions of very high noise or strong local signal levels, where high gain is not needed.

The 6 dB steps, being more gradual than traditional 10 dB or 20 dB attenuation steps, allow more reasonable tailoring of the system noise figure than the larger steps, which frequently are so large that the incoming signal and noise disappear.



See the discussion below regarding the Intercept Point Optimization front-end selection, another tool in improving receiver strong-signal-handling performance.

(C) Input High-Pass and Band-Pass Filtering

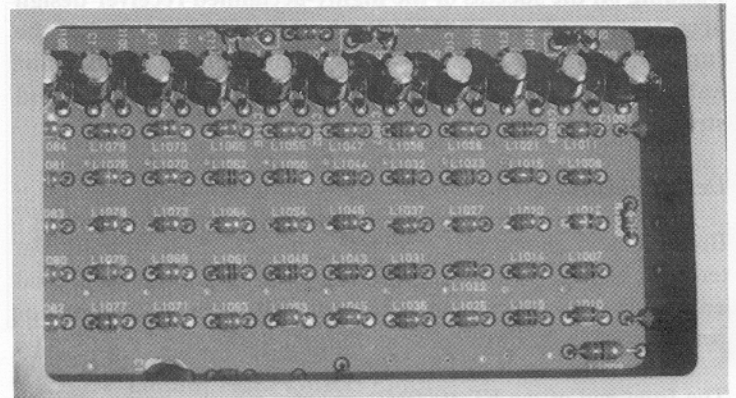
An ever-increasing challenge in amateur radio HF receiver design is the proliferation of broadband antennas such as log-periodic beams and large loops which have little or no RF selectivity. These antenna types, utilized by amateurs understandably seeking to operate on as many of the nine authorized HF bands as economically as possible, have grown in popularity as the 10, 18, and 24 MHz bands have become widely used throughout the world. They provide little RF protection for a receiver, unlike a monoband antenna such as a Yagi (which acts as a sort of bandpass filter), and with 7 MHz broadcast signals becoming more powerful each year, the opportunities for 2nd-order intermodulation have increased dramatically.

Second-order IMD results when, for example, two broadcast stations on the 40-meter band (e.g. at 7.100 MHz and 7.200 MHz) combine to produce a spurious IMD response, generated inside the receiver, at 14.300 MHz, or where a local broadcast station at 850 kHz mixes with another at 1000 kHz to produce an IMD response at 1.850 MHz (i.e., $f_1 + f_2$). Second-order IMD can be produced by non-linear operation in any active device such as a diode or transistor, much like 3rd-order IMD (where, for example, signals at 14.200 and 14.220 MHz produces 3rd IMD responses at 14.180 and 14.240 MHz ($2f_2 - f_1$ or $2f_1 - f_2$)).

The FT-1000MP utilizes several tools in the battle against 2nd-order IMD. The first line of defense is a series of High-Pass Filters (HPF), which allow all frequencies above its cut-off frequency to pass unimpeded, but which severely attenuate signals below the cut-off frequency. These filters, for example, roll off any signals below 2.8 MHz when you are operating on 80 meters, roll off all signals below 5.6 MHz when you operate on 40 meters, etc., and they are selected via mechanical relays, not diodes, so as to protect the switching diodes which follow from having strong, unfiltered signals impinging on their junctions, possibly causing IMD. Attenuation at half-frequency is at least 36 dB. Additionally, there is a low-pass filter which rolls off signals above 4.2 MHz during operation on 80 meters and lower.

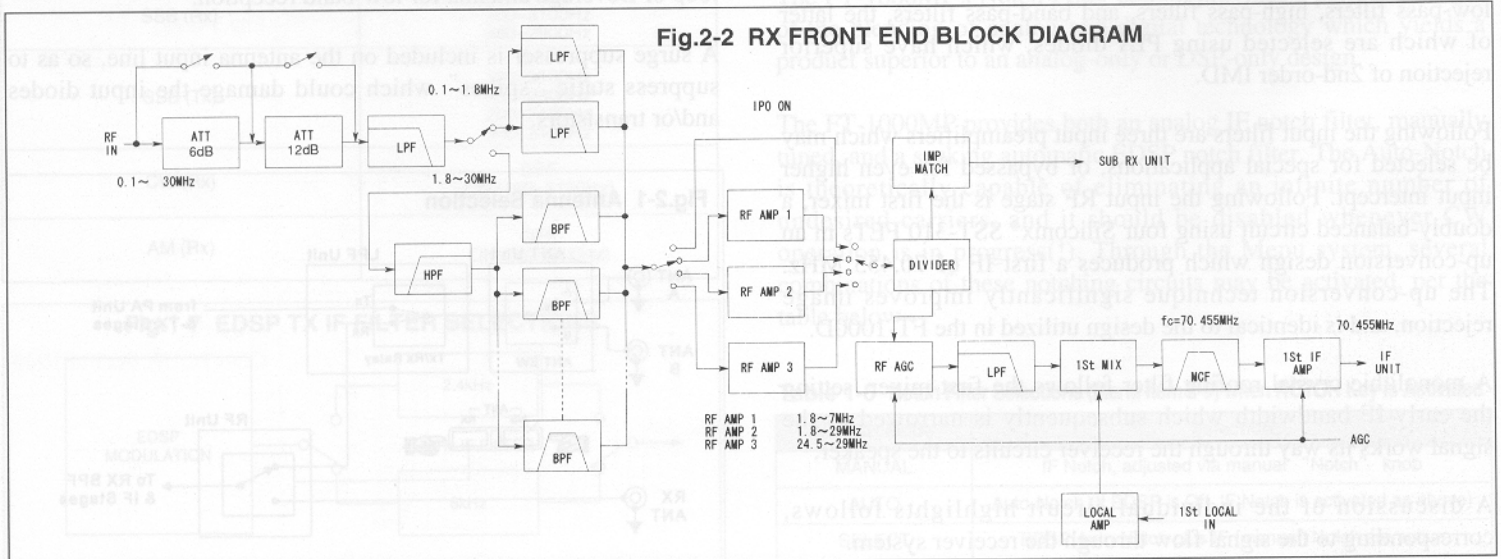
Once the HPF networks have rolled off any stations operating at half-frequency, the RF signal passes through a bank of eleven Band-Pass Filters (BPF), which serve as the main RF selectivity elements. These networks form a "shell" around the current band of operation, further protecting the RF amplifier and first mixer from (unneeded) out-of-band signals which might produce IMD. The BPFs are selected using PIN diodes with long minority carrier lifetimes, such diodes being especially resistant to 2nd order IMD.

The net result of the extensive RF filtering in the FT-1000MP is a 2nd-order intercept performance level which typically is 20 dB stronger than any other amateur transceiver available on the market today (typically +85 dBm or better). The FT-1000MP is outstanding in a wide variety of strong-signal environments, including multi-multi contest stations, Field Day installations, and multi-transmitter DX-peditions.



● BPF UNIT

Fig.2-2 RX FRONT END BLOCK DIAGRAM



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