HF 200 W ALL MODE TRANSCEIVER

MARK-V FT-1000MP

TECHNICAL OVERVIEW

200 W 50 MHz Transverter
FTV-1000

HF/50 MHz 1 kW Linear Amplifier
VL-1000

YAESU
Choice of the World's top DX'ers℠

CONTENTS

THE RADIO OF THE MILLENNIUM.
WHEN THE HISTORY OF 21ST CENTURY AMATEUR RADIO IS WRITTEN, THE FIRST CHAPTER WILL BE ABOUT YAESU'S GREATEST-EVER TRANSCEIVER:

HF 200 W ALL MODE TRANSCEIVER

MARK-V FT-1000MP

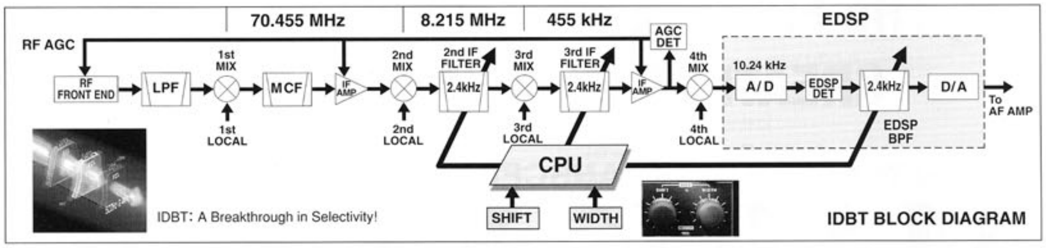
With more DX and contest activity in Amateur Radio than ever, you face the challenges of crowded bands and huge pile-ups every day. The MARK-V FT-1000MP, pushing the envelope in modern HF design, is an elite-class operator's Dream Machine, crafted with care from the smallest chip resistor to the largest chassis assembly.

The Technical Overview for the MARK-V FT-1000MP provides details of the design philosophy and circuit complexity, in the hope that you will enjoy your MARK-V FT-1000MP experience even more. And if you haven't yet invested in a MARK-V, the pages that follow will tell you why you should!

The MARK-V FT-1000MP, the HF transceiver for the 21st Century, is the radio of choice for elite-class DX and contest operators. The MARK-V includes five major enhancements to the FT-1000MP platform, yielding world-best performance.

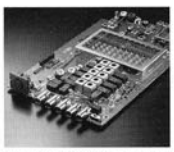
I IDBT: Interlocked Digital Bandwidth Tracking System (Page 8)

Locking the Analog IF and DSP bandwidths together on SSB, the total selectivity in the MARK-V FT-1000MP is razor-sharp and effortless in operation.

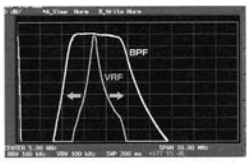


II VRF: Variable RF Front-End Filter (Page 3)

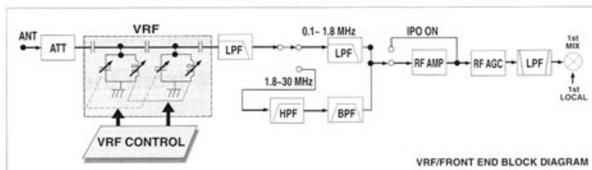
The world-renowned receiver front-end performance of the FT-1000MP has been enhanced by the addition of the VRF system, a high-rejection Preselector for the 160 - 20 meter bands.



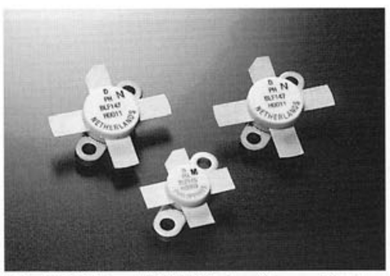
VRF components include high-Q coils and quality, sealed relays.



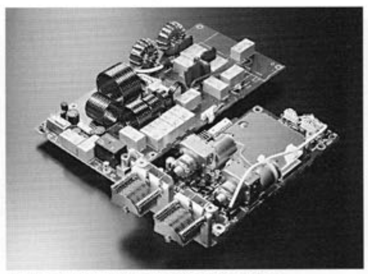
VRF Selectivity Performance (3.5 MHz)



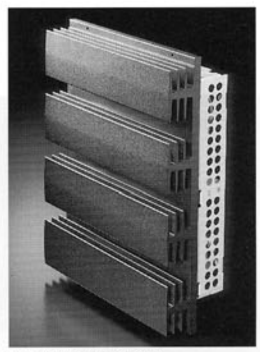
III Industry-Leading 200 W PEP Power Output (Page 15)



Philips BLF147 Power MOS FET final amplifiers are driven by a BLF145 MOS FET driver stage.

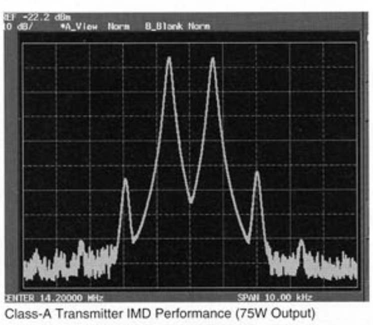


High-speed 200 W Automatic Antenna Tuner

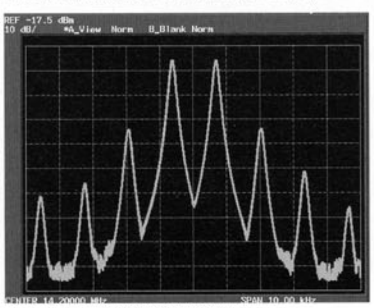


T-configuration Heat Sink

IV Yaesu-exclusive Class A Bias Selection (Page 15)



Class-A Transmitter IMD Performance (75W Output)



Typical Class-AB IMD at 200 W Output

V Enhanced Shuttle Jog Tuning Dial and Enhanced Ergonomics (Page 27)

VRF and IDBT Switches are located on Shuttle Jog Dial for ease of operation.

Large, easy-access knobs with rubber rings provide operating convenience.

1. Building on the Receiver Heritage of the FT-1000/FT-1000MP

When it comes to elite-class HF transceivers, both DXers and Contesters alike have made the FT-1000, FT-1000D, and FT-1000MP transceivers the radios of choice for over a decade. The FT-1000-series transceivers have become legendary for their ability to dig deep into a QRM-filled band, dealing with noise, fading, and interference with an effectiveness unmatched in competing transceivers.

Elite-class DXers and Contesters, utilizing large antenna systems which produce large signal inputs to the receiver front end, cannot accept compromise in receiver design. The 11-section bandpass filter system, retained from the FT-1000MP, provides outstanding rejection of out-of-band signals, an important capability in multi-operator contest applications. In the MARK-V, the front end has been made even more bullet-proof by the addition of the VRF (Variable RF Front End Filter), a manually-variable Preselector filter designed to protect the bandpass filter (BPF) switching diodes while narrowing the RF selectivity inside the BPF passband. Operational on the 160 - 20 meter Amateur bands, where signal voltages are greatest, the VRF significantly enhances the 2nd-order intermodulation performance in the MARK-V FT-1000MP.

A host of front-end gain-distribution adjustments are available via the front panel. Besides the front end Attenuator, which is adjustable in 6 dB steps, there are three RF preamplifier selections, plus the "IPO" (Intercept Point Optimization) selection which bypasses the preamplifiers, providing direct feed to the first mixer.

The first mixer consists of four Siliconix® SST-310 FETs in an up-conversion design which produces a first IF of 70.455 MHz. This up-conversion technique significantly improves image rejection (typically approaching 100 dB), and the high-level mixer contributes to a two-tone dynamic range in the 100 dB range (IPO on).

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

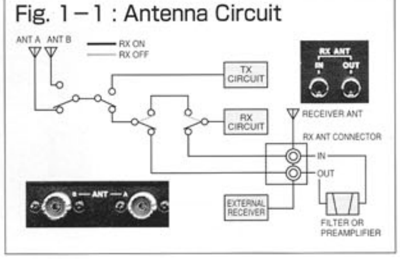
1. Front-end Processor

(A) Antenna Selection and Switching

The MARK-V 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.

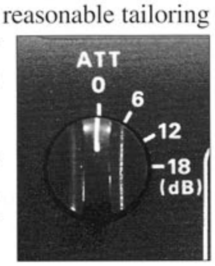
Fig. 1 – 1 : Antenna Circuit



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.

(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.

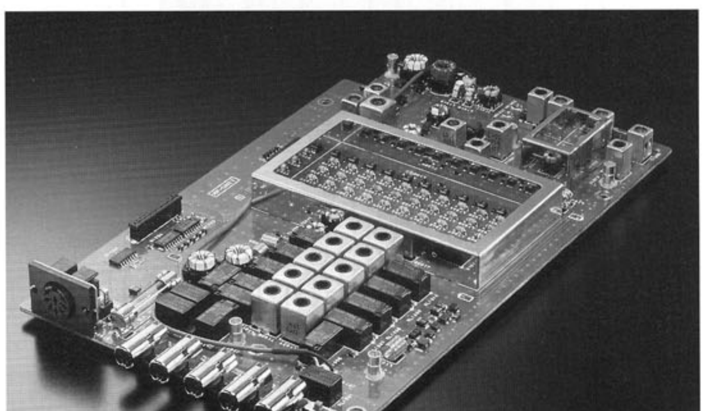


See the discussion below regarding the Intercept Point Optimization front-end selection, another tool in improving receiver strong-signal-handling performance.

(C) All-New VRF (Variable RF Front-End Filter)

The FT-1000MP series of transceivers has long been preferred by DX and Contest operators, and especially by low-band and DX-pedition operators, many of whom operate in a multi-transmitter environment which can present difficult challenges due to the close proximity of antennas to each other. Seeking to extend the already-excellent out-of-band rejection of the FT-1000MP, Yaesu's engineers have introduced a front-end Preselector filter in the MARK-V, operating on the bands at 14 MHz and lower in frequency.

The VRF concept is the first stage in a multiple-platform design philosophy which has been crafted to provide the greatest survivability under the "electronic warfare" conditions which exist on the crowded Amateur bands during contest conditions. Each stage of the MARK-V receiver works in concert with the preceding and following stages, so as to provide the best net system performance available in the Amateur market today.



●RF UNIT High-quality, high-Q coils and sealed relays of VRF in foreground

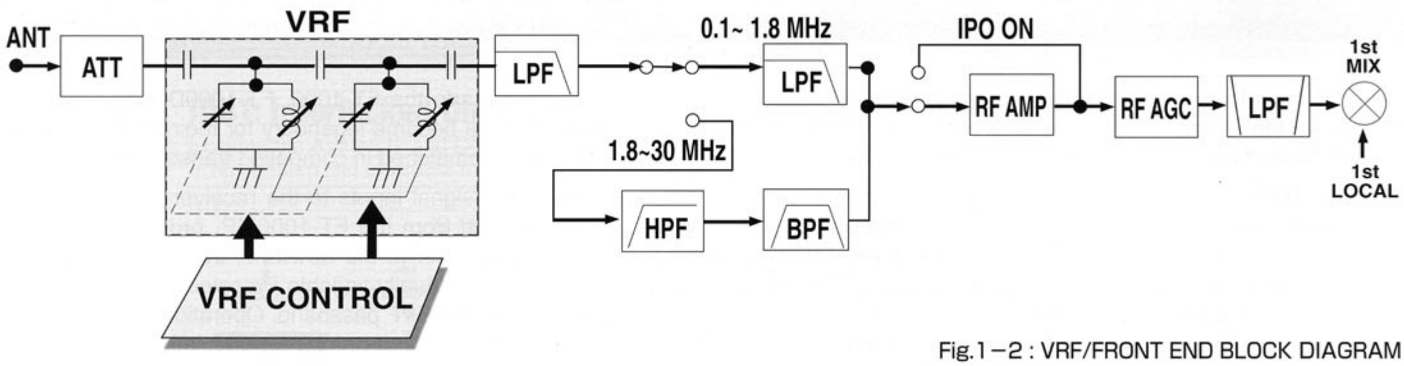


Fig.1－2 : VRF/FRONT END BLOCK DIAGRAM

Some "all digital" receiver systems, which use a silicon chip claiming a "140 dB dynamic range" in the front end, claim to provide superior results. yet these ICs cannot provide this level of dynamic range in a high-level, multi-signal environment. What's more, these chips are followed by an IF system incapable of providing even 100 dB of dynamic range, so the net system performance ultimately turns out to be inferior. Making matters worse, any DSP "artifacts" created in the front end are amplified in the IF, and the net result is a receiver that cannot survive in a crowded RF environment.

The MARK-V is very different. The VRF is a unique tool, used for decades in receiver design to protect the early stages of receivers. Containing no active devices like transistors or diodes, it does not contribute IMD (Intermodulation Distortion) itself; the resurrection of the preselector concept in the MARK-V invokes a new level of receiver performance, due to three main benefits:

(1) The switching diodes in the input bandpass filters are now protected against strong out-of-band signals;
(2) RF Preamp and mixer performance are enhanced due to reduced feed-through of out-of-band signals to those stages; and
(3) The RF preamp and mixer stages are not processing IMD created in the BPF diodes and other early receiver stages.

Fig.1－3 : VRF ACTION

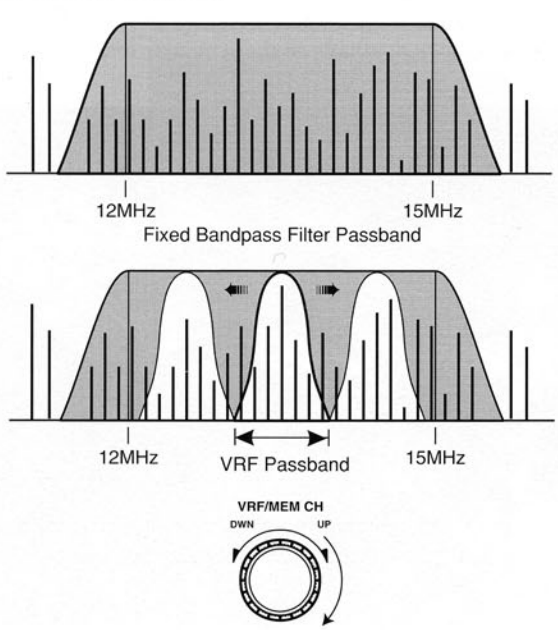


Fig.1－4 : VRF CIRCUIT

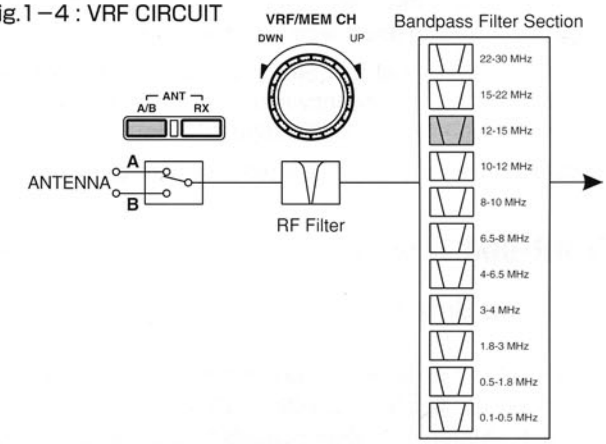
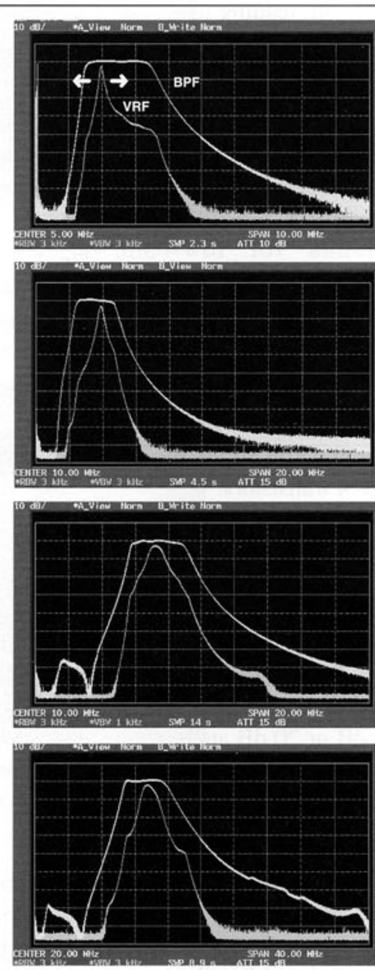


Fig.1－5 : VRF PATTERNS



VRF Pattern (1.9 MHz)

VRF Pattern (3.5 MHz)

VRF Pattern (7 MHz)

VRF Pattern (14 MHz)

The VRF system, without any active devices of its own and ahead of all active devices in the receiver section, provides an IMD-free protection system for all components in the front end: not just the RF amplifiers and first mixer, but the switching components in the bandpass filters ahead of the preamps and mixer. In a practical sense, the effect is identical to that of putting a 20 - 30 dB attenuator in the receiver path outside the passband of the VRF. The result is an immunity from problems caused by out-of-band energy that is unmatched in the industry.

A primary objective of the VRF system is to improve the 2nd-order IMD performance. 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., f1 + f2). 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 (2f2 - f1 or 2f1 - f2).

Large-area, high-quality components must be used in any effective preselector circuitry, if the Q of the circuit is to be preserved. The MARK-V's VRF uses 10 mm x 10 mm coils, plus sealed, high-quality relays, and the system is designed to sustain surge voltages of up to 2000V. Through the use of quality parts, the effectiveness of the VRF design is assured.

The VRF system is activated using the VRF on/off switch, located on the Shuttle Jog dial ring. The VRF is preset for the band on which you are operating, and as the VRF/MEM CH control is rotated, the ten relays select different combinations of coils and capacitors so as to optimize the frequency setting of the VRF. The manual adjustment capability allows the operator to adjust the peak response of the VRF away from interference which may be occurring on-site: in a 7 MHz CW Field Day installation, for example, peaking the VRF at about 6.85 MHz will reduce the interference potential from the Phone station operating around 7.25 MHz.

And if quick QSY is needed when the bands aren't so active, a single touch of the VRF switch on the Shuttle Jog ring will turn the VRF system off, providing direct input to the bandpass filters ahead of the RF amplifiers and mixer. Even with the VRF off, performance is only "degraded" to the exceptionally-good level provided by the original FT-1000MP!

Fig.1－6 : VRF ACTION

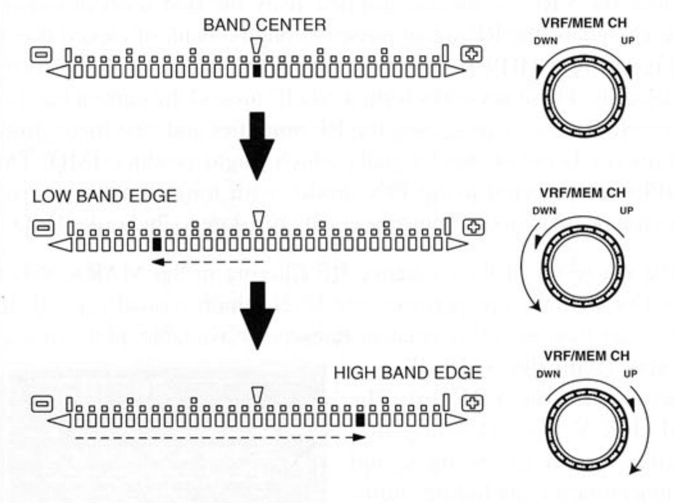
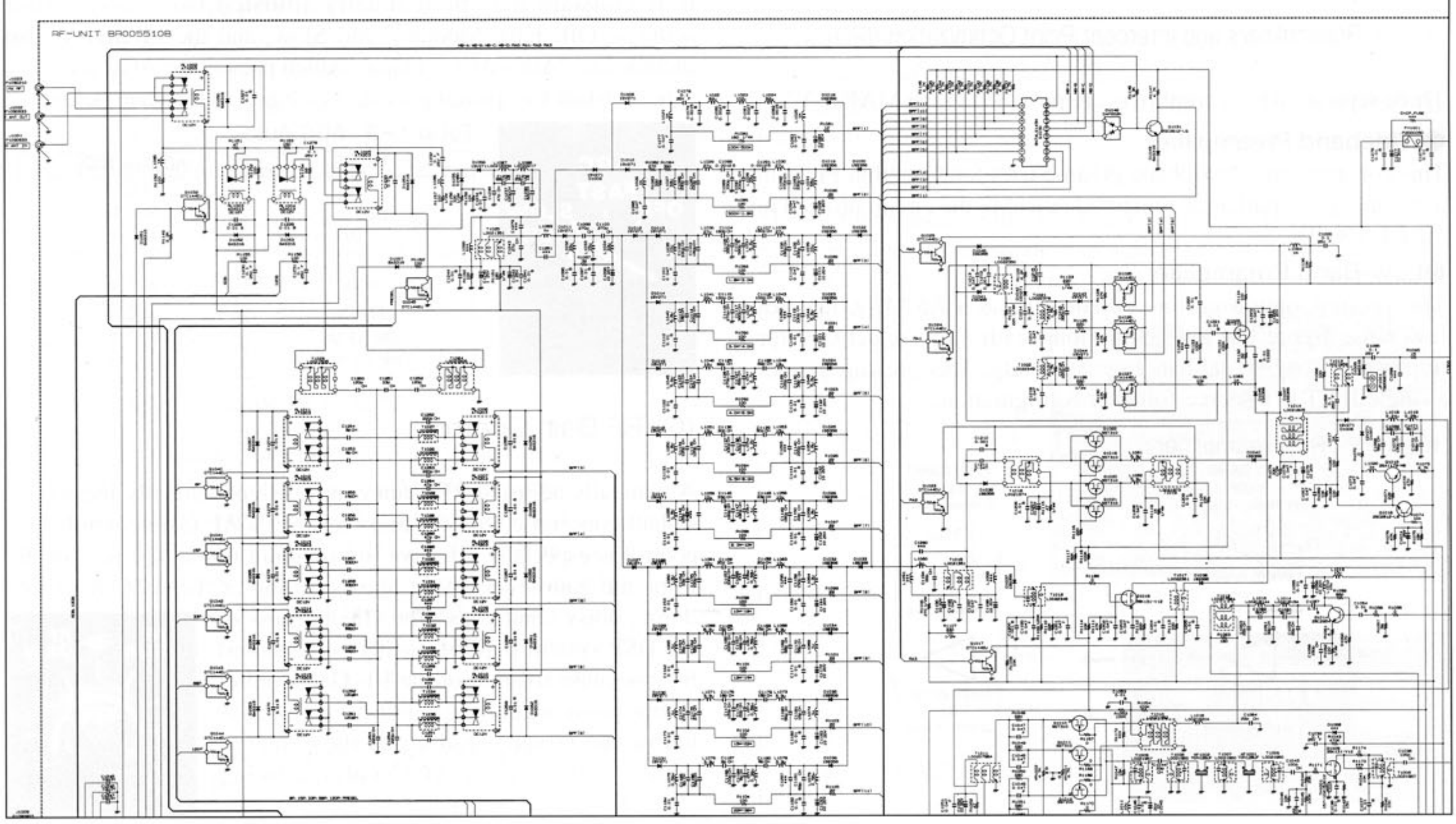


Fig.1－7 : VRF / BPF CIRCUIT

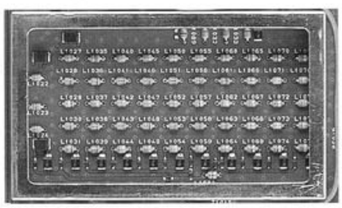


(D) Input High-Pass and Band-Pass Filtering

An ever-increasing challenge in amateur radio HF receiver design is the proliferation of broadbanded 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. The VRF circuitry is the first line of defense against 2nd-order IMD, but only the first.

Once the VRF circuit has stripped away the first level of out-of-band signals, 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 MARK-V is a 2nd-order intercept performance level which typically is 20 dB stronger than any other amateur transceiver available on the market today (typically +110 dBm or better with the VRF on). The MARK-V 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

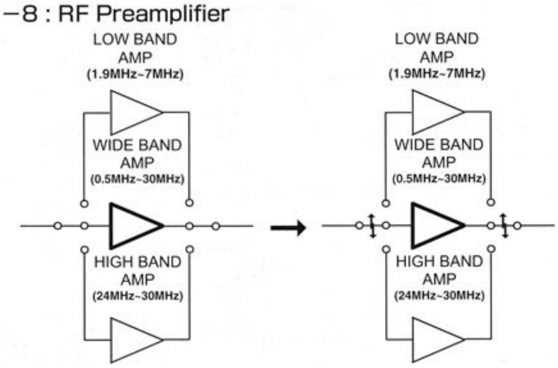
(E) RF Preamplifiers and Intercept Point Optimization (IPO)

Three separate RF preamplifiers are provided in the MARK-V:

●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.

Fig.1－8 : RF Preamplifier



●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 1－1 : RF AMP Selection (Menu Item 8－4)

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

●IPO (Intercept Point Optimization)
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.

(F) RF Automatic Gain Control (AGC)

As in the FT-1000D, PIN diodes are used for the RF AGC circuitry in the MARK-V 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 MARK-V also includes an "Auto-AGC" feature which presets the AGC recovery time constant by operating mode, according to the chart below.

Table 1－2 : AGC Auto

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

(G) RF Gain Control

A manually-adjusted RF Gain control is conveniently located on a shaft concentric with the main receiver's AF Gain control. This control is especially effective in providing fine adjustment of the front-end gain level, and it allows setting of the AGC threshold during noisy conditions. The effectiveness of the DSP system may frequently be enhanced by clockwise rotation of the RF Gain control to the point where the band noise level is below the (fixed) reading of the S-meter, which indicates the AGC voltage being applied to reduce the gain of the RF/IF stages.

2. Hybrid Analog- and Digital-Domain IF System

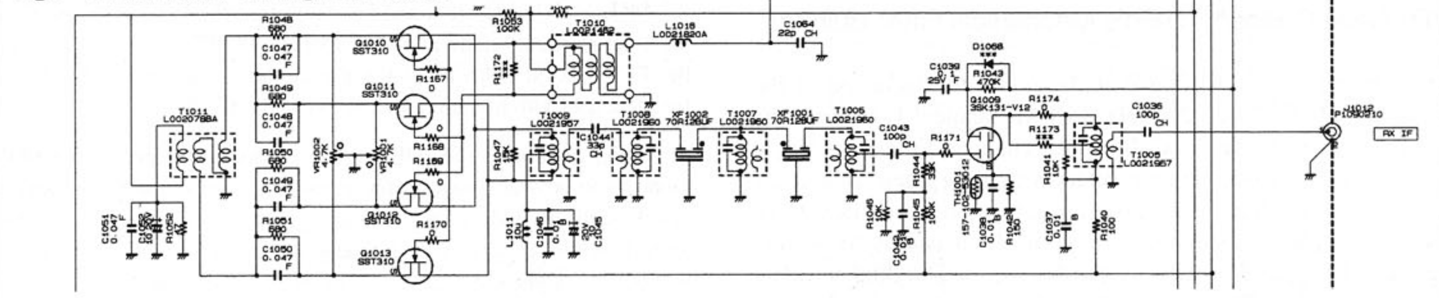
(A) First Mixer and Post-Mixer Filter

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 MARK-V 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.1－9 : 1st Mixer / Roofing Filter Circuit



(B) IF Amplifiers

The characteristics of the main IF chain in any receiver are critical to the net system performance of the design. The MARK-V utilizes the proven design of the FT-1000MP, 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.

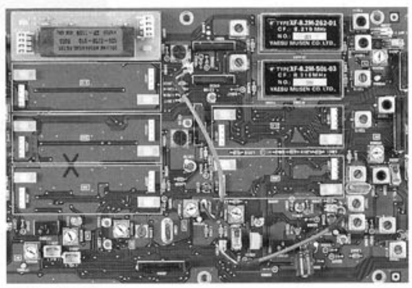
In the manufacturing process, this design data is utilized in conjunction with the computer-based alignment protocols of the production line, and each transceiver is individually optimized for specified receiver system gain, ensuring a high level of consistency in finished products as they exit the production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

(C) IF Main Selectivity Filters

Although the stock 2.4 kHz and 500 Hz IF filters are quite satisfactory for general operation, the MARK-V 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. The interference-rejection capabil-ities of these cascaded filters are truly formidable.

To provide the quickest access to the wide range of IF filters available, the MARK-V provides a simple, three-button filter selection scheme, with the precise bandwidths provided by each button press being defined by the operator, using the Menu system settings appropriate for the filters installed. These selections, labeled NOR/NAR1/NAR2, accommodate the three combinations most often used for different modes of operation, and the bandwidths provided are different, depending on the operating mode (see Figure 1-3). 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 MARK-V 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.



●IF Unit

For the sub-receiver, an optional 500 Hz Collins® Mechanical Filter (model YF-115C) is available as an option, and is ideal for spotting during a big CW pile-up.

Table 1－3 : IF Bandwidth Filter Selection

■Factory-installed Filter Setup

MODE \ BAND WIDTH	NOR (NOR)		NAR1 (NAR1)		NAR2 (NAR2)	
	2nd IF (8.2MHz)	3rd IF (455kHz)	2nd IF (8.2MHz)	3rd IF (455kHz)	2nd IF (8.2MHz)	3rd IF (455kHz)
SSB	2.4kHz	2.4kHz	2.4kHz	2.4kHz	-	-
CW	2.4kHz	2.4kHz	500Hz	2.4kHz	-	-
AM	Through	6.0kHz	2.4kHz	2.4kHz	-	-
RTTY PKT (LSB)	2.4kHz	2.4kHz	-	-	500kHz	2.4kHz

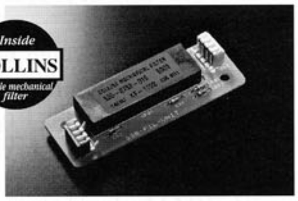
■Filter Selection with All Optional Filters Installed

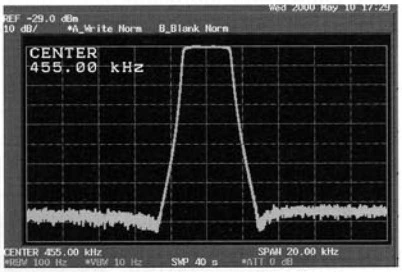
MODE \ BAND WIDTH	NOR (NOR)		NAR1 (NAR1)		NAR2 (NAR2)	
	2nd IF (8.2MHz)	3rd IF (455kHz)	2nd IF (8.2MHz)	3rd IF (455kHz)	2nd IF (8.2MHz)	3rd IF (455kHz)
SSB	Through	6.0kHz	2.4kHz	2.4kHz	2.0kHz (YF-114SN)	2.0kHz (YF-110SN)
CW	2.0kHz (YF-114SN)	2.0kHz (YF-110SN)	500Hz	500Hz (YF-115C)	250Hz (YF-114CN)	250Hz (YF-110CN)
AM	Through	6.0kHz	2.4kHz	2.4kHz	2.0kHz (YF-114SN)	2.0kHz (YF-110SN)
RTTY PKT (LSB)	2.0kHz (YF-114SN)	2.0kHz (YF-110SN)	500Hz	500Hz (YF-115C)	250Hz (YF-114CN) / 500Hz	250Hz (YF-110CN) / 500Hz (YF-115C)

※In the FM mode, the Bandwidth switches have no function.

(D) New! Collins® 10-Pole Mechanical Filter Built In!

A highlight of the IF filter complement is the inclusion of the new 10-pole Collins® 2.4 kHz SSB Mechanical Filter into the design of the MARK-V. 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. And compared to the original FT-1000MP's 8-pole Collins® Mechanical Filter, the MARK-V's 10-pole filter provides even better skirt selectivity, while retaining the other excellent characteristics of the FT-1000MP's Mechanical Filter.





●New-technology 10-pole Collins® Mechanical Filter Skirt Selectivity

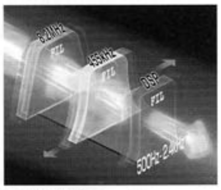
(E) New Technology Advance: IDBT (Interlocked Digital Bandwidth Tracking) System

The main selectivity system of the MARK-V actually consists of three chief platforms: the 8.2 MHz analog IF, the 455 kHz analog IF, and the EDSP bandpass filter. The analog IFs include such performance-enhancing features as the IF SHIFT and IF WIDTH circuits, which allow the net system bandwidth of the analog IF to be narrower, and its center frequency adjusted, over a wide range of values. When the IF signal enters the EDSP bandpass filter, additional selectivity enhancements are provided, extending the ultimate attenuation and skirt sharpness significantly.

In the original FT-1000MP, the EDSP bandpass filter was adjusted manually, using the Menu. In the MARK-V, the microprocessor is utilized to "slave" the two analog IFs, and the EDSP bandpass filter stage, so as to align the bandwidth of the EDSP to match the net system bandwidth of the analog IFs, as set by the NOR/NAR1/NAR2 switches and the positions of the WIDTH and SHIFT controls. For example, if you are using 2.4 kHz filters in both the 8.2 MHz and 45 kHz IFs, and have adjusted the WIDTH control to set a net residual bandwidth of 2.15 kHz, the IDBT feature adjusts the EDSP bandwidth to match the center frequency and roll-off frequencies (both high and low sides) of the IF filters.

The chief benefit of the IDBT system, which operates in the SSB mode, is to provide a significant improvement in shape factor, which can dramatically reduce the "buckshot" type of interference caused by an SSB station close to your frequency. It provides this improvement without the requirement to set the EDSP manually, as on the original FT-1000MP. And it brings the benefits of razor-sharp EDSP selectivity together with the analog IF filters to provide a system in which the AGC loop no longer can cause adverse effects on the EDSP.

Now some "all-digital" filtering systems used by other manufacturers purport to provide superior performance, because the entire filtering system is enclosed within the AGC loop. Unfortunately for the other manufacturers, there is an inherent problem with such designs that cannot be avoided: the processing time of the DSP. There is an unavoidable delay (a small number of microseconds) in the onset of AGC action in all-DSP designs, caused by the processing delay in the DSP IC; during this delay time, the incoming signal is allowed to pass through the IF without gain control, with the result that there is a "crackle" on the leading edge of strong signals, caused by the lack of AGC protection for the IF amplifiers. And because there is no "backup" filtering to protect the IF, there is no way to avoid the "crackling" on the incoming signals.



●IDBT Concept

●IDBT Controls

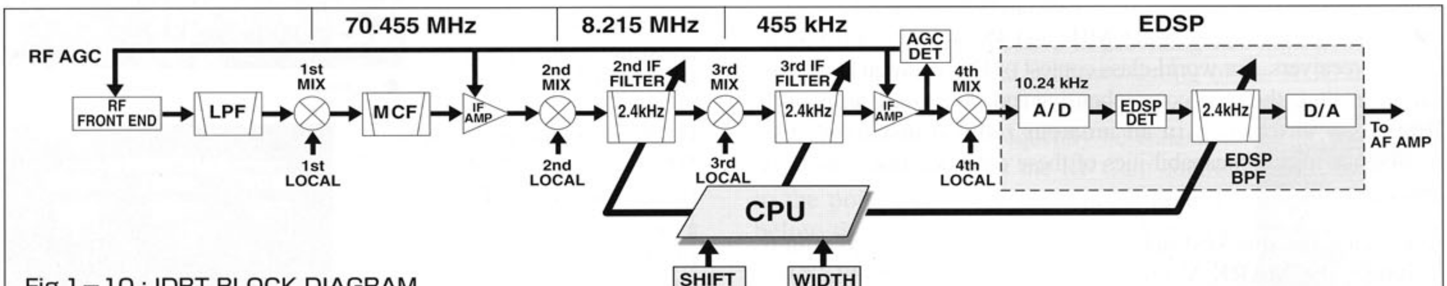


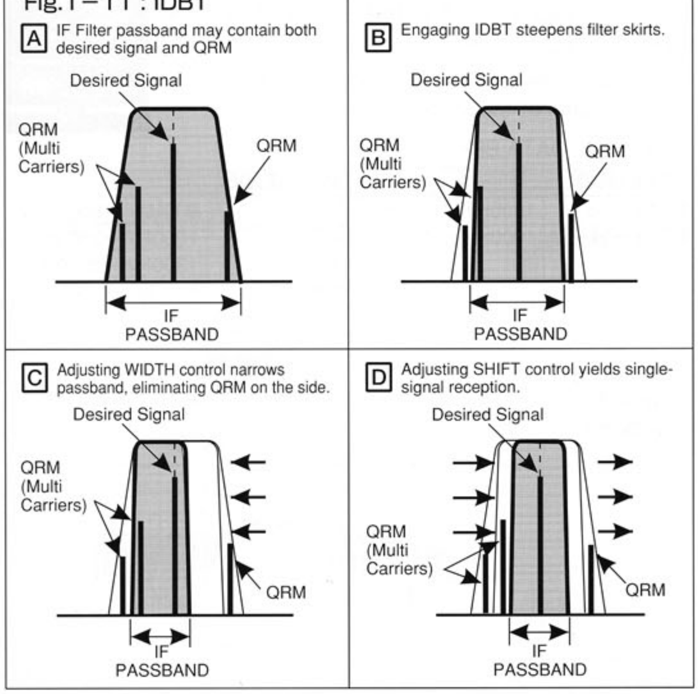
Fig.1－10 : IDBT BLOCK DIAGRAM

In the MARK-V, on the other hand, the EDSP is protected by 16 or 18 poles of analog filtering at the same bandwidth as that of the EDSP (thanks to the IDBT automatic control). The IF analog filtering, providing well over 100 dB of ultimate rejection, takes the unwanted incoming signal components out of the AGC loop, and then any remaining low-level bleed-through is annihilated by the EDSP bandpass filter. The incoming signal is always under AGC control, and thus no offensive "crackling" effect occurs.

To accomplish the control needed by the IDBT system, between 48 and 60 KB of CPU ROM are devoted to the analog IF, and 1 MB of EPROM are dedicated to this task in the EDSP. Extensive resources are needed to accomplish this engineering marvel, but the results are well worth the design effort expended.

Making the IDBT a pleasure to use are the comfortable rubber covers on the large WIDTH and SHIFT controls, which are the primary adjustment tools for the IDBT system. Because of the large size of these knobs, precise adjustment of the filter bandwidth and center frequency is simple and straightforward. Using the Menu, the resolution of the SHIFT and WIDTH controls may be adjusted (selections provided are 10 Hz and 20 Hz per step). And when you hear how clean a crowded 20-meter phone band can be, you'll be glad you got the MARK-V!

Fig.1−11 : IDBT



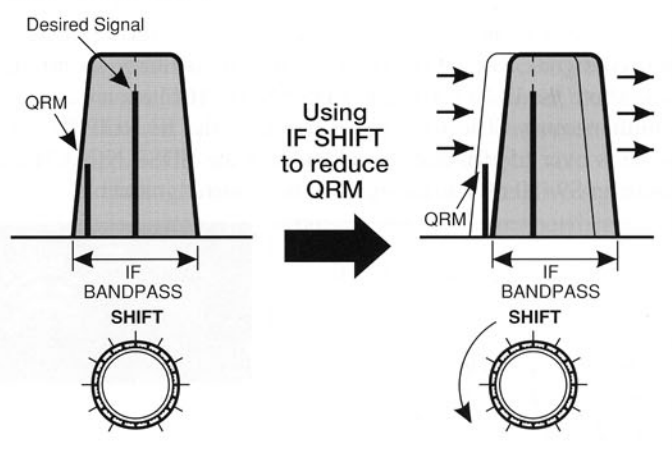
(F) Analog IF Filtering Systems

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 allow either high-side or low-side interference to be rolled off quickly and efficiently.

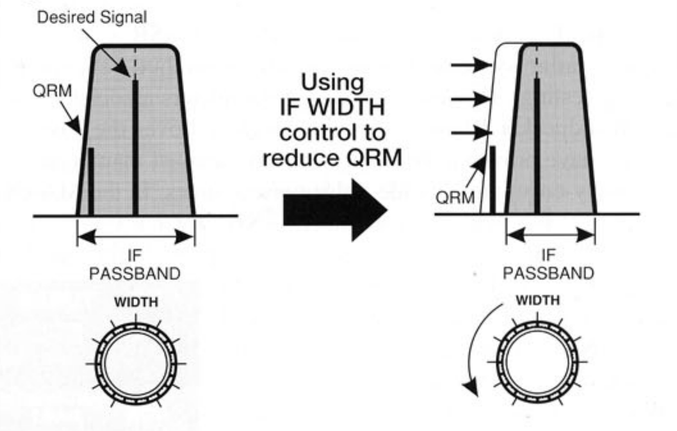
Fig.1−12 : IF SHIFT



■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.

Fig.1−13 : IF WIDTH



■ Combined Effect of SHIFT and WIDTH Control Adjustments

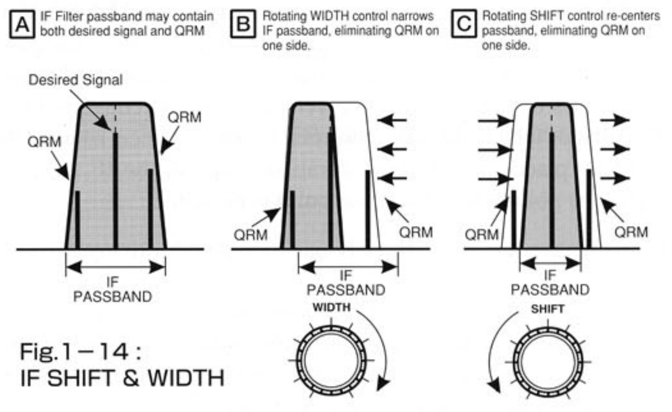


Fig.1−14 : IF SHIFT & WIDTH

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. The total notch depth of the IF NOTCH filter alone is over 65 dB, and the addition of the EDSP NOTCH can cause an S9+20 dB carrier signal to be rendered inaudible!

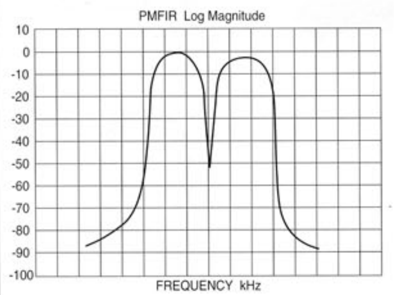


Fig.1－15 : IF NOTCH

(G) IF Analog Noise Blanker Circuitry

Two noise blankers are provided in the MARK-V 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 MARK-V 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. Access to these two Noise Blanker circuits is provided via the NB switch on the front panel; by holding in the FAST key, and pressing the NB key, you can now adjust the blanking level, and select NB1 or NB2, using the main tuning dial.

The IF Noise Blanker circuitry utilized in the MARK-V 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).

(H) APF Ultra-Narrow Filtering (CW/Data Modes)

The final filtering system for the CW and Data modes is the Digital Bandpass Filtering. Called "APF" (Audio Peaking Filter) for CW, this system allows the operator to select audio bandwidths of 240 Hz, 120 Hz, or even 60 Hz, thus reducing the noise bandwidth dramatically and allowing the detection of very weak signals under quiet conditions. Over 15 dB of sensitivity improvement may be realized by the reduction in audio bandwidth afforded by the APF system.

For Digital modes, the APF circuitry is utilized to provide optimized audio bandwidths for the operating mode selected. Using Menu #8-6, the best bandwidth for RTTY, PSK31, HF Packet, or SSTV can be set up in seconds, helping assure solid copy under difficult conditions. See Table 1-4 for details of the available bandwidths.

Table 1－4 : DATA BPF

RTTY MODE		DATA MODE	
RTTY－Lo	1800Hz～3200Hz	PACKET	800Hz～2500Hz
RTTY－Hi	1000Hz～2400Hz	SSTV	1000Hz～2500Hz
—	—	FAX	1300Hz～2500Hz
—	—	PSK31	880Hz～1120Hz

Fig. 1－16 : CW APF Patterns

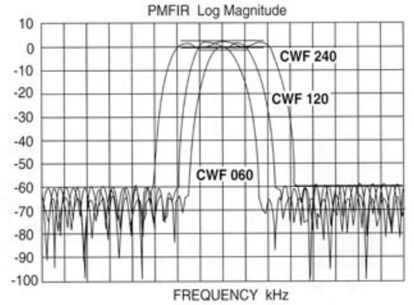
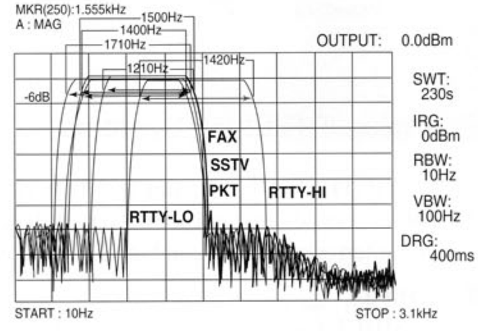


Fig. 1－17 : DATA BPF Patterns



(I) 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 MARK-V'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 MARK-V 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 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.

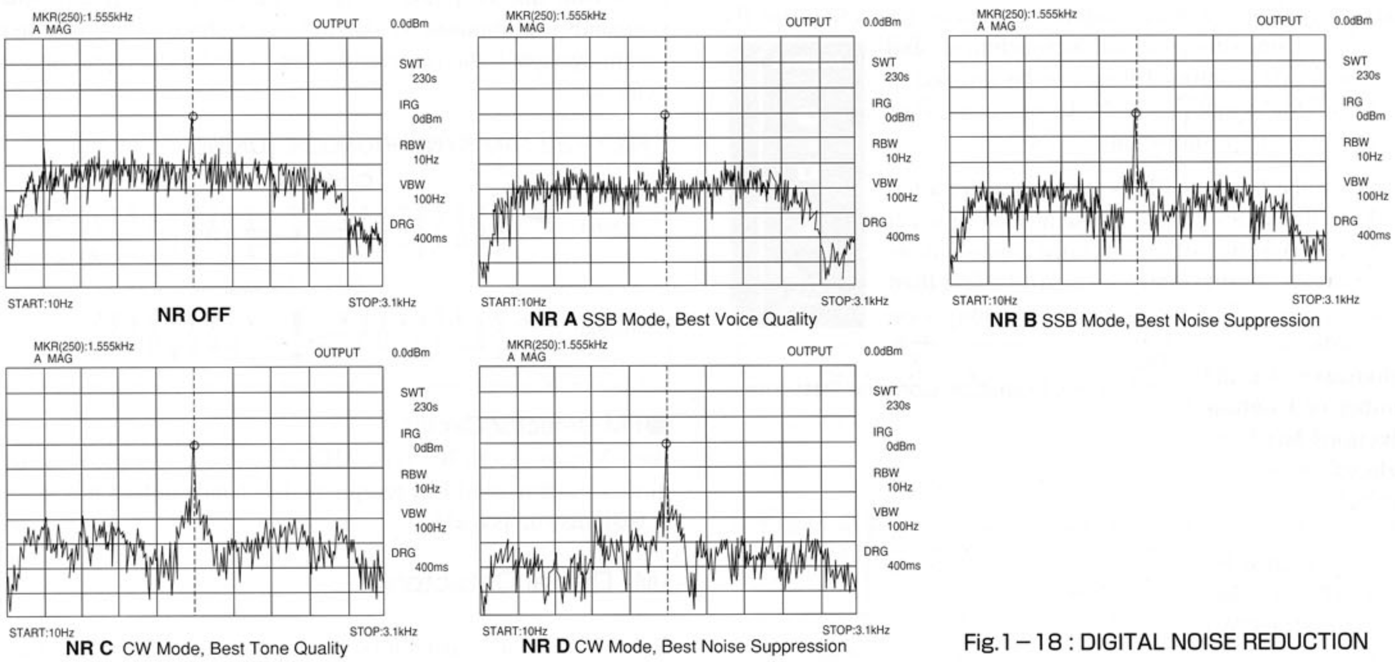


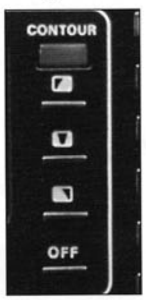
Fig.1－18 : DIGITAL NOISE REDUCTION

(J) EDSP Contour Functions

The "Contour" feature, pioneered by Yaesu in the original 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).

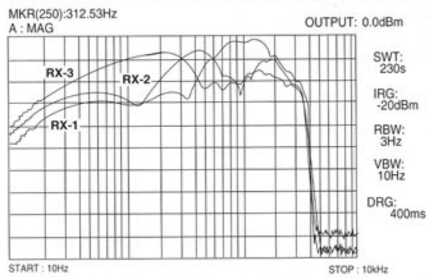
For digital modes such as RTTY and packet, the cutoff frequency is shifted to correspond to the higher (demodulated) audio frequencies used by digital modem units. On CW, the bandpass response can be varied from 240 Hz maximum bandwidth to 60 Hz minimum bandwidth, the latter of which presents some interesting 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 MARK-V, 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 band-pass 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.



Access to the Contour filters is now much easier, thanks to the re-design of the system used to select the filters. A series of color-coded push-buttons is now used, conveniently located to the left of the main tuning dial, providing quick comparison of Contour filter performance. And the number of Contour selections has been "reduced" by one: the original "bandpass" selection has now been superceded by the IDBT (for SSB) and APF (for CW) systems.

Fig.1－19 :
Digital RX Equalizer Contour Patterns



(K) EDSP Digital Auto-Notch Filter

The MARK-V'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 MARK-V 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

NOTCH Mode	Selection
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."

(L) (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:

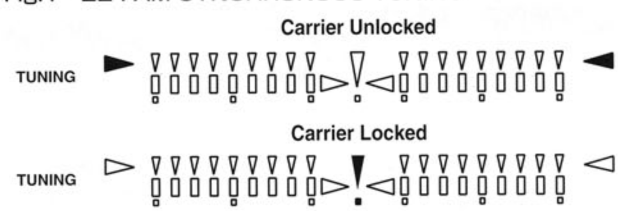
●SSB Product Detector

The μPC1037H 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.

Fig.1－22 : AM SYNCHRONOUS TUNING



●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.

(M) Digital Detectors

Besides the analog detectors, an important feature of the EDSP system is the provision of digital product detectors for SSB and CW, each with its own operating bandwidth. The digital product detectors have a much lower noise figure than do their analog counterparts, and their activation provides a significant reduction in the background "hiss" level.

(N) 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 MARK-V 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.

(O) Sophisticated Dual Receive System with Independent AGC Loops

The Dual Receive system architecture, widely acclaimed on the FT-1000D and FT-1000MP, 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.

The Dual Receive system of the MARK-V, unlike simpler systems used on other brands, uses two completely independent receiver sections. As a consequence, there are two independent AGC loops at work, and a strong signal appearing on the main receiver will not cause "pumping" of the sub receiver.

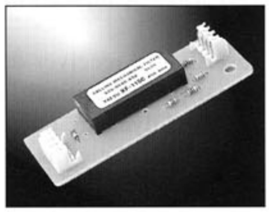
(P) Independent Sub Receiver Unit

An essential element of the MARK-V 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 2.0 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 and the MARK-V 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.



Collins® Mechanical Filter
YF-115C (CW 500Hz Filter)

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.

Fig.1-23 : DUAL RECEIVE

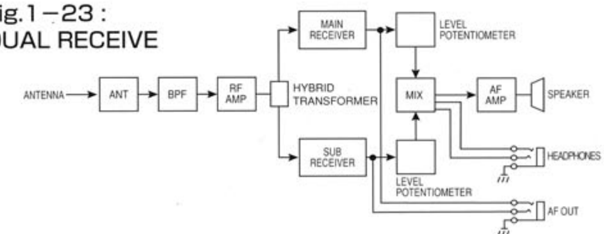


Fig.1-24 : SUB RECEIVER

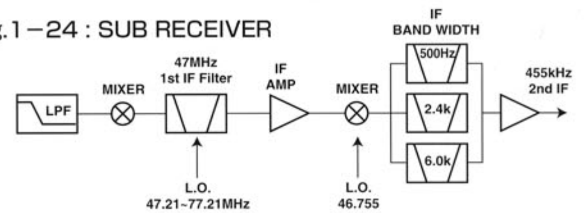
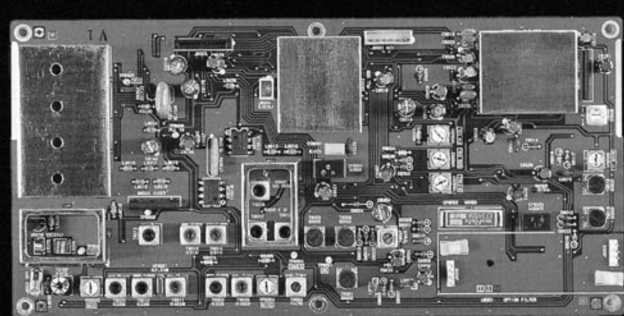


Table 1-6 : Sub Receiver AGC Selection (Menu Item 8-7)

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

●SUB RECEIVER UNIT



2. All-New, Powerful 200 Watt Transmitter Section

For more effective "barefoot" operation at home or on a DX-pedition, or to provide extra drive for your linear amplifier, the MARK-V incorporates an all-new 200-Watt power amplifier system, with an exclusive Class-A bias feature for the most discriminating signal quality aficionado.

1. Microphone Input and Audio Stage

(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 MARK-V FT-1000MP incorporates a low-noise microphone amplifier stage using bipolar transistors, as on the FT-1000MP, 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 μPC1037H 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 μPC1037H 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 10-pole 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.

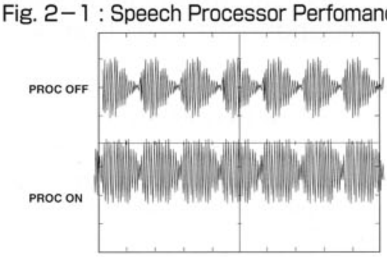
(C) RF Speech Processor

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, 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 MARK-V 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.

Fig. 2–1 : Speech Processor Perfomance



(D) EDSP Digital Microphone Equalizer

The EDSP system contains, as an important operating capability, a four-selection Microphone equalizer. This equalizer adds different levels of emphasis in different audio ranges, allowing emphasis of high-, mid-, and low-frequency ranges, along with a "crystal microphone" emulation, to allow the available power of the transmitter to be focused where your voice envelope is to be found.

Selection of the Microphone Equalizer setting (or disabling of it) is accomplished via Menu #4-4. See Figure 2-1 for a depiction of the equalization responses provided.

Fig. 2–2 : Digital Mic Equalizer Patterns

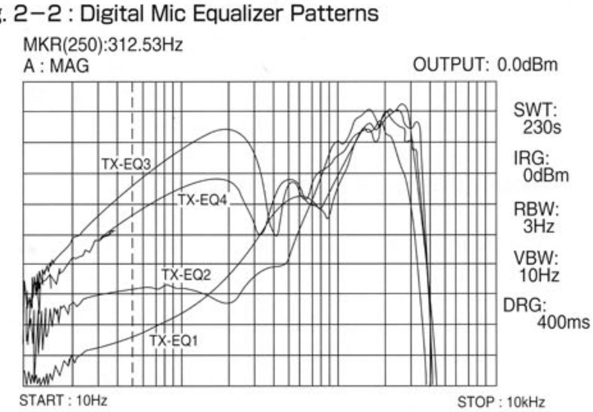


Table 2–1 : EDSP Transmitter Equalizer Selection (Menu Item 8–7)

Response Function	Comments
OFF	Equalizer disabled
1	Bandpass response natural-sounding flat passband
2	Low-cut response for DX pile-up or contest use
3	Bass-Enhancement for ragchew use
4	Mid-high enhancement emulates Crystal microphone

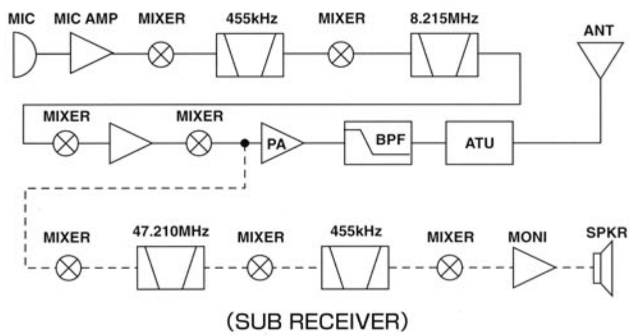
(E) Power Gain Control

The output from the power amplifier is precisely controlled, using PIN diodes under CPU control, to provide constant output despite minor impedance variations. Power control data is memorized, so if there are minor antenna impedance issues on different frequencies, the power output will not be affected.

(F) Transmit Monitor

The sub receiver is utilized, in the transmit mode, as a monitor receiver whenever the front panel MONI key is activated. The CPU commands the DDS to set the sub-receiver's frequency to match that of the transmit VFO, and the signal quality actually appearing at RF (not in the IF) can then be monitored, allowing more meaningful listening to your signal during microphone equalization adjustments and other activities.

Fig. 2−3 : MONITOR CIRCUIT

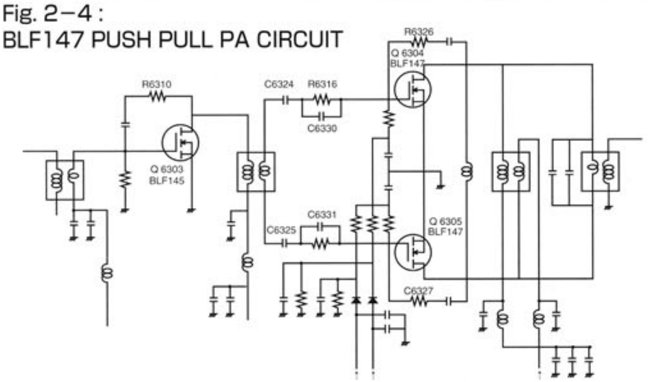


2. Transmitter PA Unit

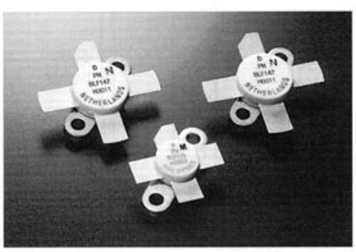
(A) Industry-leading 200 Watts of Power Output

The MARK-V's power amplifier stage utilizes a pair of Philips® silicon N-channel enhancement-mode high-power BLF147 D-MOS FET transistors in a push-pull configuration, with a supply voltage of 30 Volts. The BLF147 transistors, each capable of 150 Watts of output, are rugged, have excellent thermal stability, and are capable of sustaining a full load mismatch.

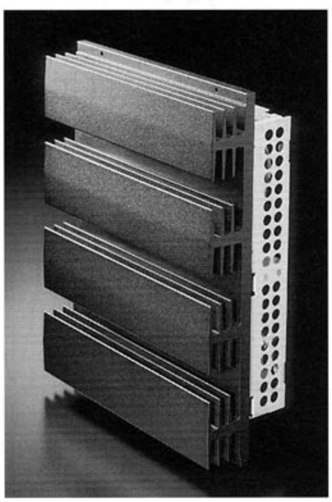
Fig. 2−4 :
BLF147 PUSH PULL PA CIRCUIT



The PA compartment is cooled using a unique T-configuration heat sink and thermostatically-controlled fan, which ensures that heat does not build up even during prolonged contest or DX-pedition operating sessions.

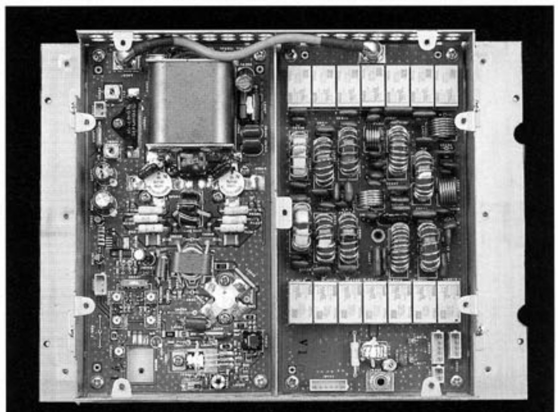


●Philips BLF147 Power MOS FET final amplifiers are driven by a BLF145 MOS FET driver stage.



●T-configuration Heat Sink

Following the final amplifier stage is a husky 200-Watt Low-Pass Filter (LPF) network designed using the FT-1000 LPF Unit as a foundation. Total harmonic suppression is typically better than 65 dB.



●200 W PEP PA UNIT & LPF

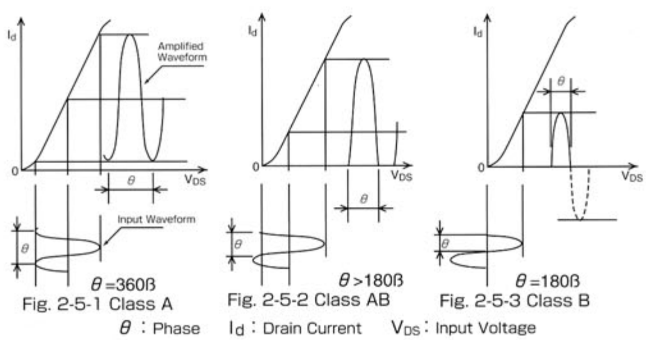
(B) Yaesu-exclusive Class-A Bias Selection

Among HF transceivers in the Amateur market, the MARK-V FT-1000MP stands alone in offering the capability to utilize Class-A bias in the final amplifier stage. Class-A operation results in a spectacularly clean signal output, with many benefits to the owner (and others on the band with you!).

Class A bias is frequently used in audio devices like stereo amplifiers, and it is generally used in Amateur transmitter designs in the pre-drive stage. However, it has not been used in Amateur power amplifier designs, because the heat dissipation requirements for Class-A operation are much more demanding. In Class A, an amplifier which typically puts out 200 Watts in Class AB intermittently now will be dissipating 200 Watts of power continuously. In the MARK-V, power output in Class A is about 75 Watts, which is still enough to drive most linear amplifiers to full output; the balance of the dissipated power is due to the high bias current associated with Class-A operation.

The theory of Class-A operation is quite different than for Class AB or Class B. In Class A, the conduction angle is a full 360°. The high bias and low drive level ensure that the PA devices are not driven to the point where output current is cut off. Both gain and linearity in Class-A operation are very high, but efficiency is low. In Class AB, the conduction angle is between 180° and 360°. Output current is flowing during more than half the drive cycle, but not during the full cycle as in Class A. Class AB operation, which is typically used in Amateur transmitters, results in higher efficiency than Class A (typically 50 - 60% for Class AB), with somewhat lower linearity than Class A. Class B utilizes a conduction angle of (exactly) 180°, and produces efficiencies of perhaps 65%, with still lower linearity than Class AB. See Figure 2-5 for a graphical depiction of these three amplifier operating modes.

Fig. 2–5 : AMPLIFIER OPERATING CHARACTERISTICS



The MARK-V utilizes a pair of FETs in push-pull, so as to achieve higher total power output (>200 Watts) than is obtainable from a single device. With a pair of BLF147 transistors in push-pull, total power output capability is at least 300 Watts, so the transistors are being operated at an output level that does not stress their design parameters.

The bias applied to the push-pull amplifier has an important effect on the linearity of any amplifier stage. The objective of Class A bias is to drive the output current above 0 Amps at all phase angles, with a small offset above zero to ensure linearity during operational variances. Because the bias is operating constantly, the heat associated with it must be dissipated on a continuous-duty basis, but the benefits, especially in terms of high-order IMD performance, are significant.

Evaluation of SSB envelope performance is done using a high-performance, narrow-bandwidth spectrum analyzer. A single input tone to such a spectrum analyzer is shown in Figure 2-6. Such a display tells us nothing about the linearity, and it is used chiefly for nearby spurious and/or noise evaluation.

By injecting two tones spaced about 600 Hz apart, however, we can evaluate the amplifier's ability to suppress intermodulation distortion. The two tones are adjusted to a level 6 dB below that of the single tone, and the intermodulation ratios are then evaluated.

The spectrum analyzer display will show a "Christmas Tree" pattern, with each peak corresponding to a different order of intermodulation. The first peaks either side of the two main peaks are the third-order IMD response, which is observed when someone tunes in your signal exactly on-frequency. The next peaks outward is the 5th-order IMD response, which is the first of a series of responses which create "splatter" either side of your signal. In a typical Class AB transmitter, the 3rd-order IMD will be 22 - 28 dB below either of the two tones (26 - 34 dB below PEP), while the 5th-order IMD will usually be about 45 dB below either of the two tones. See Figure 2-7.

In the case of the MARK-V in Class A, the 3rd-order IMD typically is suppressed 55 dB below PEP, while the 5th- and higher-order responses are difficult to measure at a level of -80 dB or greater. This is significantly better performance than in any other Amateur transceiver; it means that your signal, even though you may be very loud, will not be causing annoying "splatter" which can spoil the communications of those a few kHz away. Remember that, if you are using a linear amplifier, such "splatter" can not be amplified if it never enters the linear amplifier, so the benefits do not only apply during "barefoot" operation.

In sum, the cleanest signals on the air today are put out by Hams using the Yaesu MARK-V FT-1000MP.

Fig. 2–6 : SINGLE-TONE SPECTRAL GRAPH

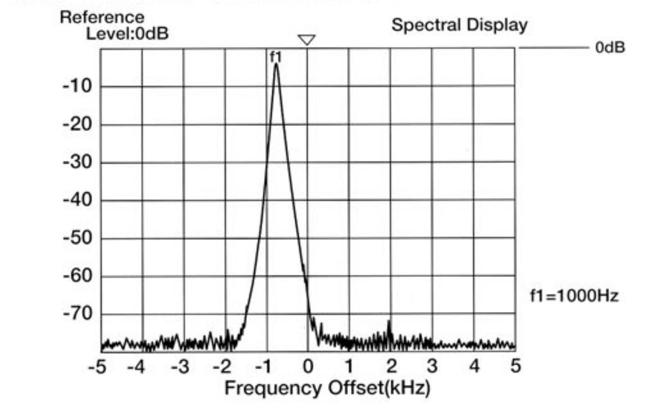


Fig. 2–7 : 2-TONE TX IMD (CLASS AB)

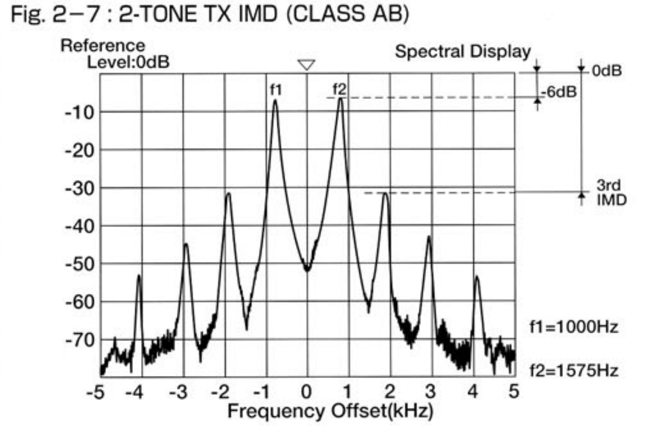
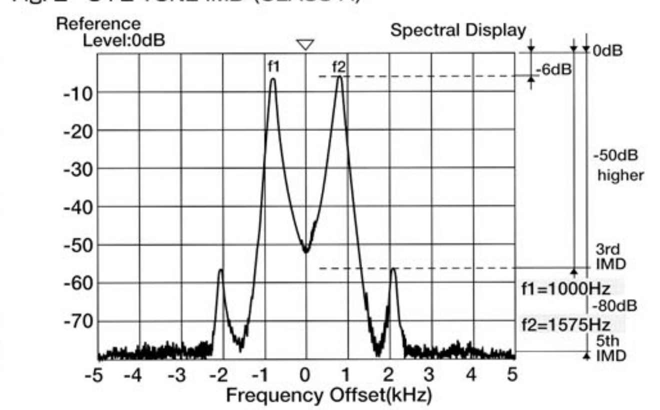


Fig. 2–8 : 2-TONE IMD (CLASS A)



3. High-power Automatic Antenna Tuner

Using its own 8-bit Central Processing Unit (CPU) for tuner control, the Automatic Antenna Tuner command and control circuitry chooses pre-selected fixed inductor values, and drives a variable capacitor, to achieve optimum impedance matching. Based on the platform utilized in the original FT-1000, the MARK-V's tuner combines high tuning speed and an advanced tuning algorithm to provide fast, precise adjustments.

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.

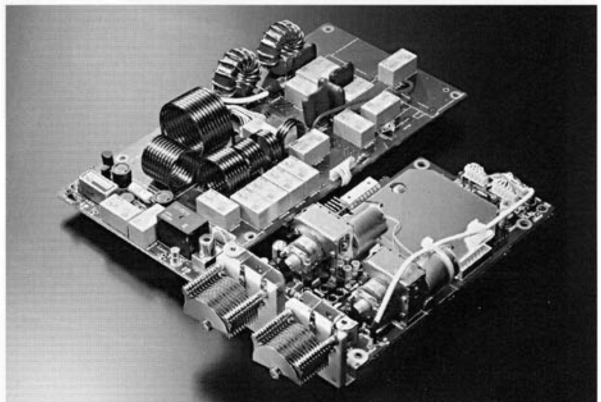
The control circuitry is "smart," in that it anticipates transmission requirements as you move around a band, presetting itself to (A) the impedance-matching data already stored in memory, or (B) the predicted impedance requirements based on your last-used frequency and the direction/magnitude of frequency. 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 quality components used in the automatic antenna tuner's design ensure that there is minimal heating caused my coil losses and other factors. After one minute of continuous transmission, for example, it is unusual to feel even the slightest heating of components. Accordingly, the tuner's compartment does not contribute significantly to the cooling requirements for the transceiver.

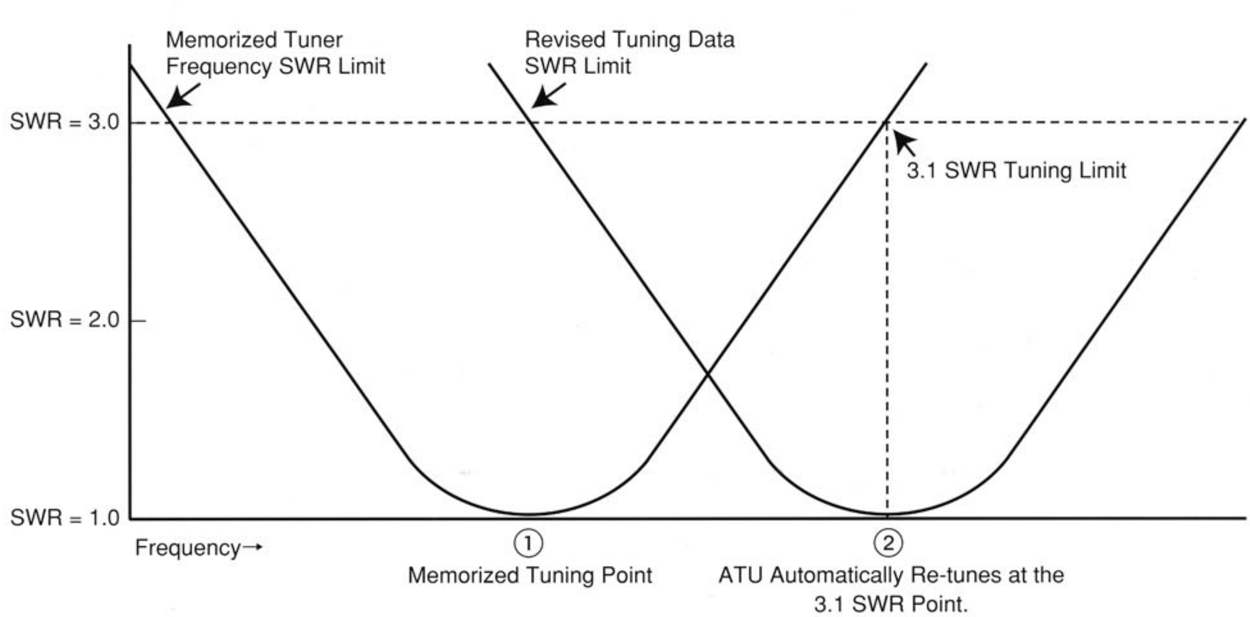
The antenna tuner also can sense and report a catastrophic antenna failure or erroneous antenna selection (e.g. the operator mistakenly attempts to use a 40-meter Yagi on 20 meters), and will suspend antenna tuning in such instances. If the impedance presented to the antenna jack exceeds 3:1, the tuner will refuse to "memorize" the necessary tuning settings, as such high SWR values indicate an antenna problem needing correction.

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



●AUTO ANTENNA TUNER UNIT

Fig. 2−9 : ANTENNA TUNER OPERATING CHARACTERISTICS



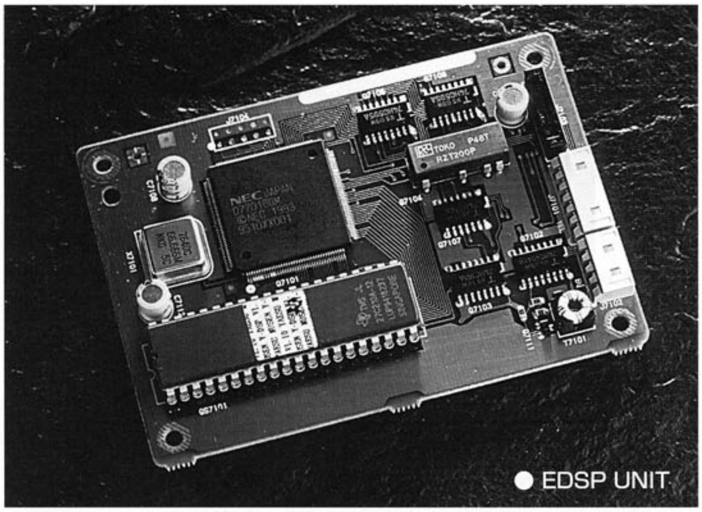
3. EDSP (Enhanced Digital Signal Processor)

The EDSP system's design is constructed around the high-performance NEC® DSP device, the μPD77016. The MARK-V 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.

1. 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 constancy, 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.



● EDSP UNIT

(A) Receiver

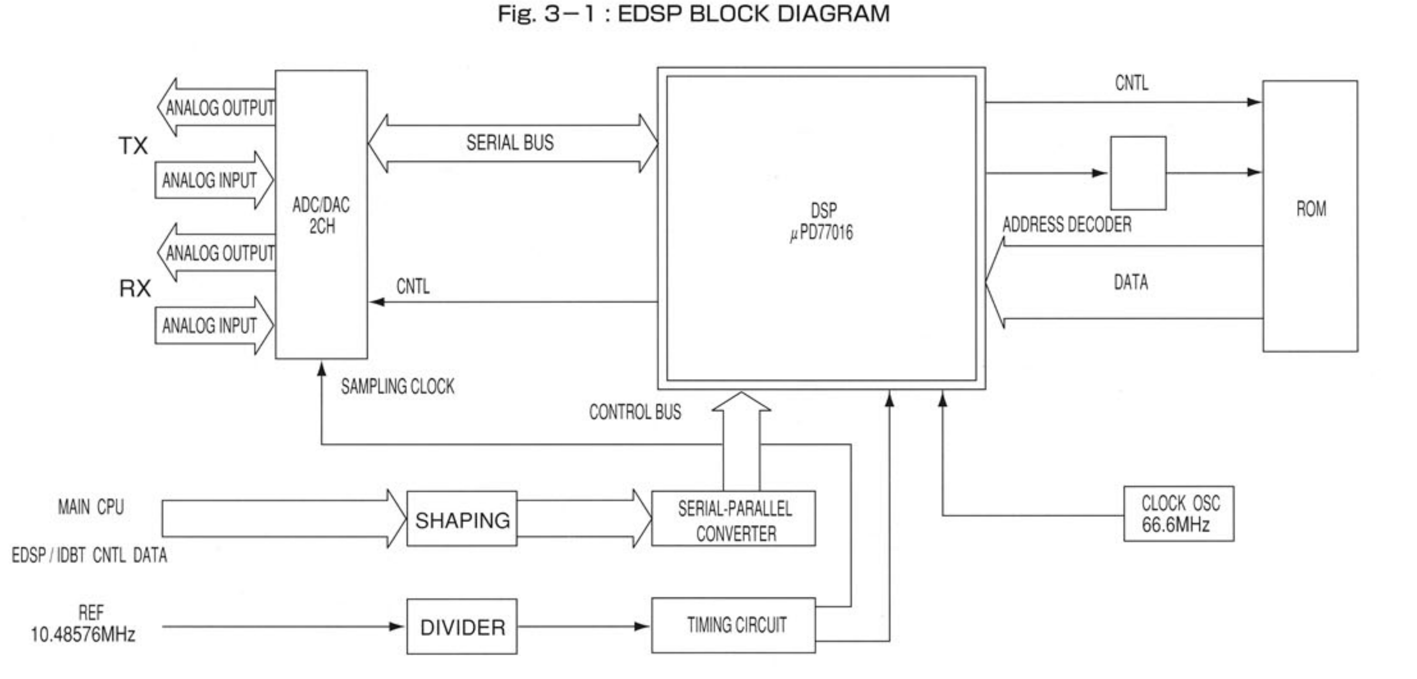
The signals which appear at the input of the EDSP circuitry will vary in composition, depending on the demodulation technique selected by the operator. If analog demodulation is selected, the analog (demodulated) audio signal is applied to the EDSP for processing; in the case of digital demodulation, a 10.24 kHz digitized IF signal is applied. Figure 3-1 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 $\Sigma\Delta$ 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 x 40.96 kHz = 2.62144 MHz.

Fig. 3－1 : EDSP BLOCK DIAGRAM



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 shirt selectivity and narrow bandwidths (down to 60 Hz) in the CW mode, with virtually undetectable ringing.

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.

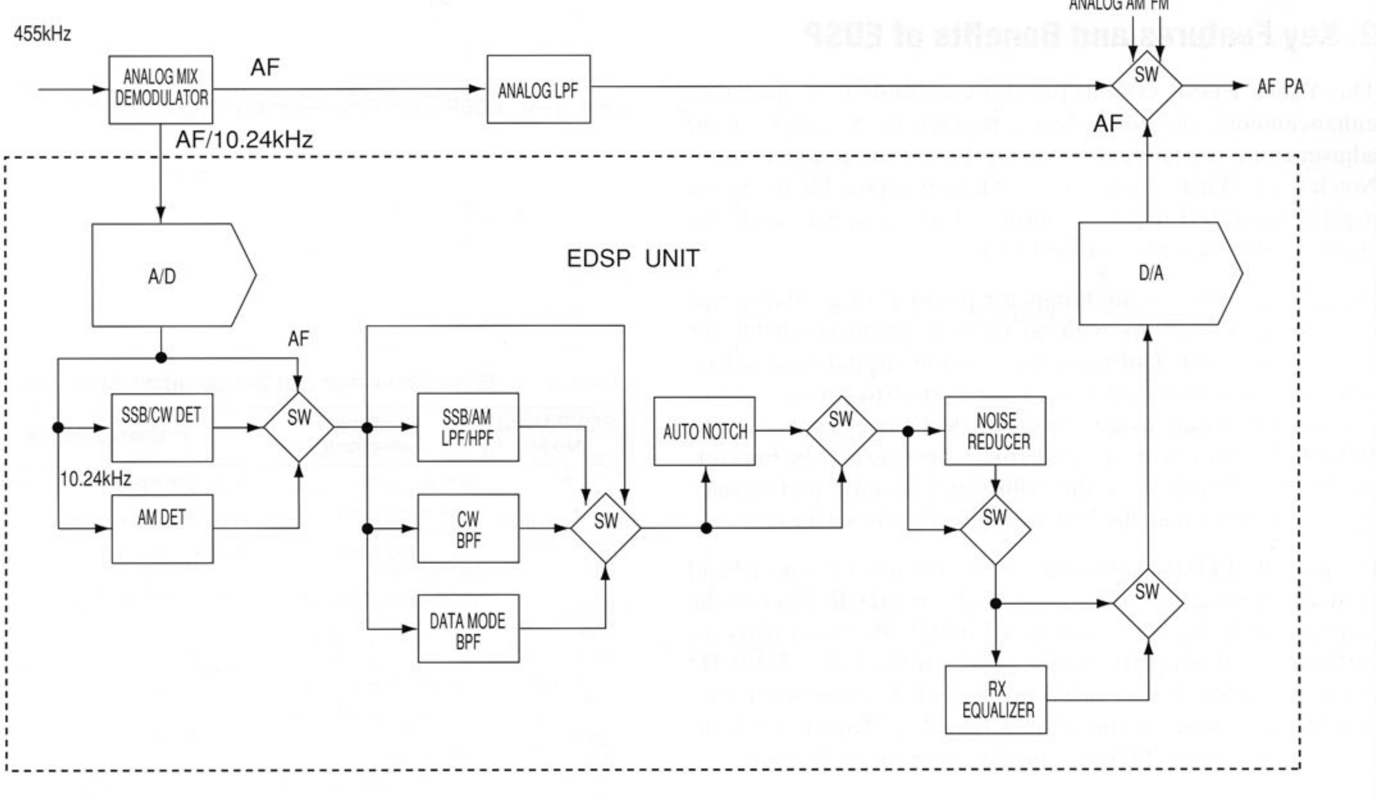
Next comes the Noise Reducer block, in which four different noise-reduction algorithms are utilized which compare the periodicity of the IF passbands components--signals and noise--and targets the less-correlated signals by the method of least squares. The four noise reduction protocols are adaptive 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. Autonotch 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. 3−2 : EDSP RX-MODE BLOCK DIAGRAM



(B) Transmitter

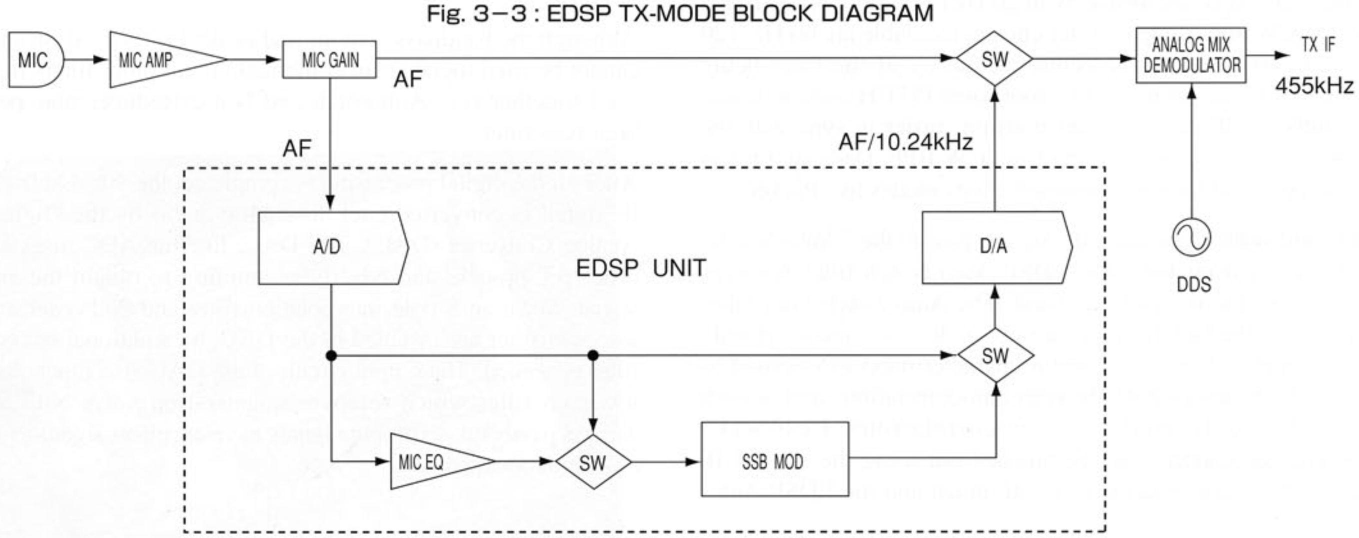
The EDSP architecture on the transmit side of the FT-1000MP is very similar to that of the receiver side. Both digital and analog modulators are provided, and the digital processing features 16-bit resolution, and 64x over-sampling. Great care has been taken to ensure that dynamic range in excess of 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 particular superior on the MARK-V 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.

Fig. 3–3 : EDSP TX-MODE BLOCK DIAGRAM



2. Key Features and Benefits of EDSP

The Yaesu EDSP system provides a number of operating enhancements, including Noise Reduction, Signal Contour adjustment, a digital Audio Peaking Filter, and a digital Auto-Notch filter. What's more, via the Menu it is possible to engage digital modulation and demodulation systems, with the characteristics described in Table 3-1.

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 MARK-V, 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.

Fig. 3–4 : EDSP TX IF Filter Selection (Menu Item 5-9)

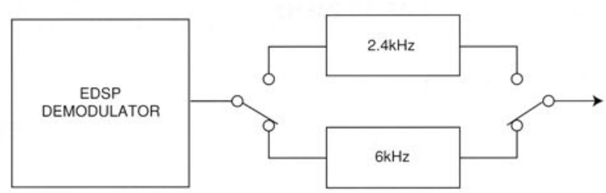


Table 3–1 : EDSP Modulation and Demodulation (Menu Item 7–7)

EDSP Menu Mode	Available Selections	Characteristics
SSB-R SSB Demodulation Technique (RX)	OFF: Analog Demodulation	Analog IF Filters set bandwidth
	100～3100: EDSP Demodulation	High-fidelity RX bandwidth
	300～2800: EDSP Demodulation	Narrow bandwidth ideal for crowded contest condditions
SSB-T SSB Modulation Technique (TX)	OFF: Analog Modulation	IF Filter sets bandwidth
	100～3100: Digital Modulation 150～3100: Digital Modulation 200～3100: Digital Modulation 300～3100: Digital Modulation	Selected low-frequency cut-off allows optimization of signal characteristics for rag-chewing or DX pile-ups.
CW-R CW Demodulation Technique (RX)	OFF: Analog Demodulation ON: EDSP Demodulation	Selecting "ON" engages EDSP demodulator with bandwidth 100-3100 Hz, and greatly reduces "hiss" level.

1. Single-Crystal-Reference Main Oscillator System

With all the attention given to establishing and maintaining high Signal-to-Noise ratio in the MARK-V, 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 band-width with rushing noise from a CW carrier, and yet one which provides transmit/receive turn-around times fast enough for the most demanding data applications.

Fig. 4−1 : TX C/N RATIO

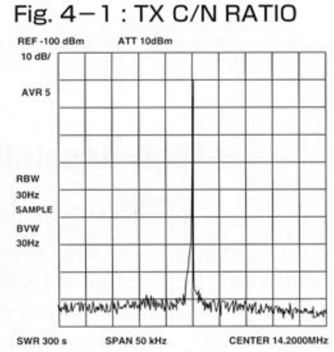


Fig. 4−2 : LOCAL OSCILLATOR BLOCK DIAGRAM

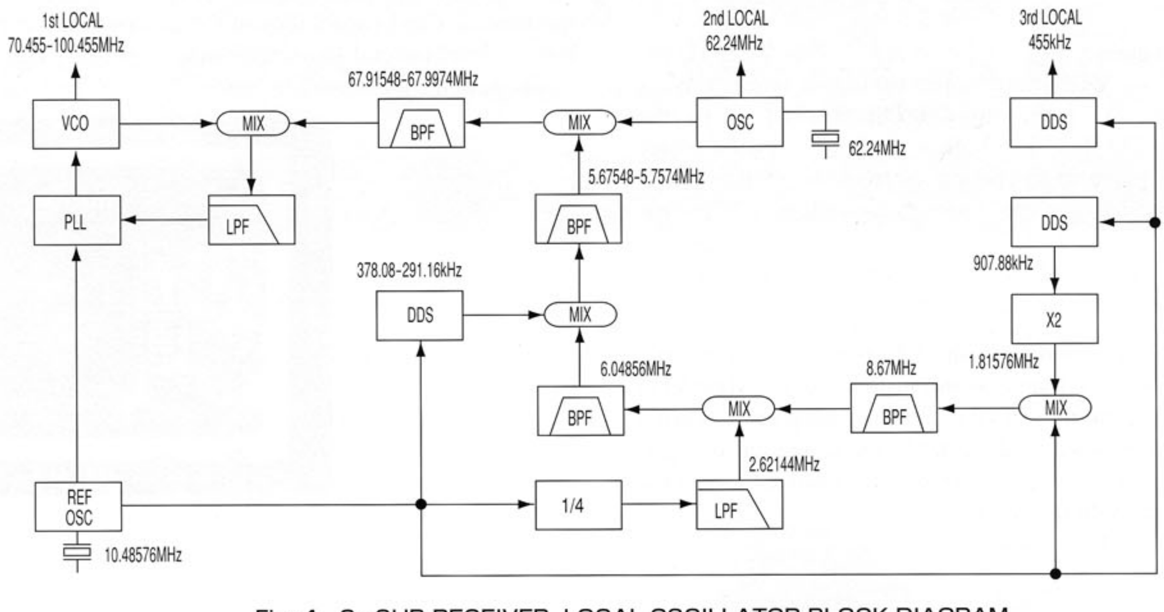
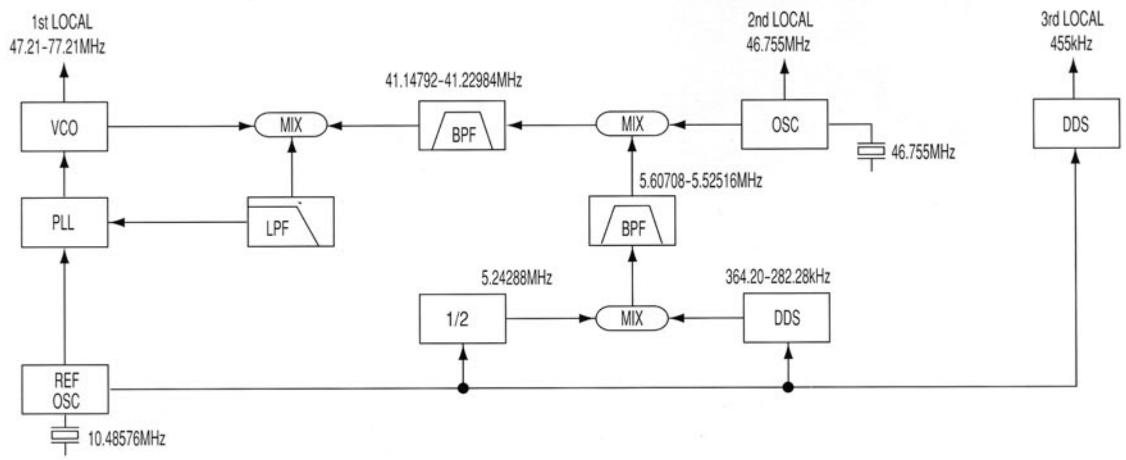


Fig. 4−3 : SUB RECEIVER LOCAL OSCILLATOR BLOCK DIAGRAM

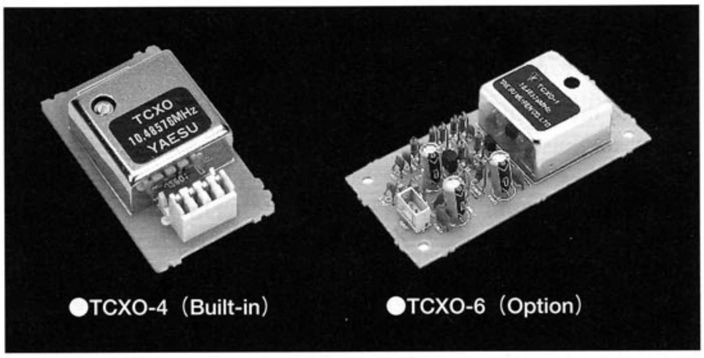


2. 0.5 ppm Built-in High Stability Reference Oscillator

An extra-cost option on many transceivers today, the high-stability TCXO-4 Reference Oscillator module is built into every MARK-V FT-1000MP.

At a typical internal temperature of 77° F (25° C), the TCXO yields a frequency stability of ±0.5 ppm, and over the temperature range of 14° to 122° F (-10° ~ +50° C), the TCXO provides ±2 ppm stability. For most all operating applications, including data work, this stability is entirely adequate.

If your operational requirements demand very high stability, the optional TCXO-6 installs in minutes, and it provides ±0.25 ppm stability at 77° F (25° C), and better than ±0.5 ppm stability from 14° to 122° F (-10° ~ +50° C).



●TCXO-4 (Built-in) ●TCXO-6 (Option)

3. Super-High-Resolution (0.625 Hz) DDS

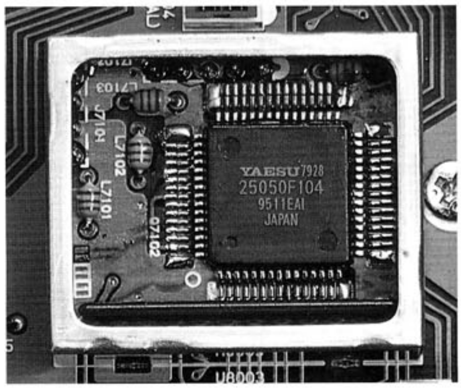
In a receiver designed to process weak signals (in the 0.1 μV region or lower) which may exist alongside very strong signals, it is important to generate a local oscillator signal with superior Carrier-to-Noise ratio. The proprietary new-generation DDS used in the MARK-V has achieved this objective, 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.

A popular feature retained from 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 Shuttle Jog now contains the ergonomic enhancements of the VRF and IDBT activations switches.

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.

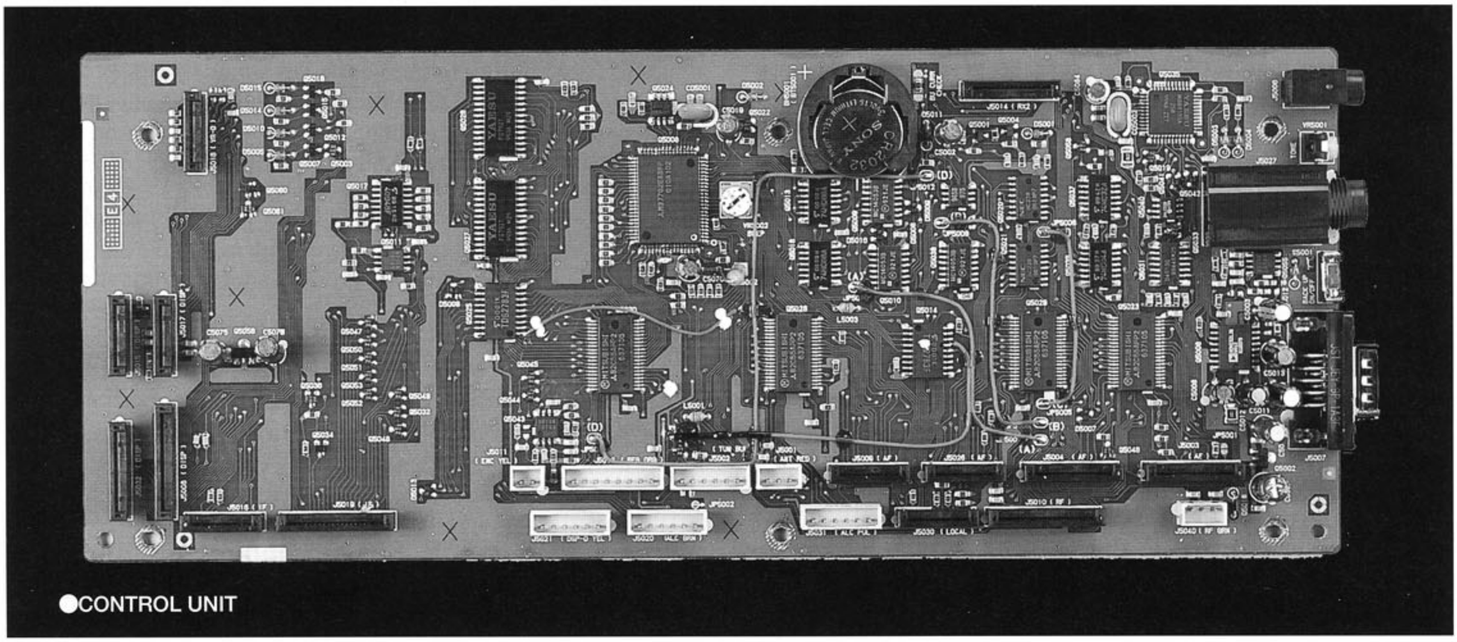


1. Control Circuit Architecture

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 large 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!



●CONTROL UNIT

2. High-Speed Dial Processing

Yaesu has pioneered the development of one-chip high-speed DDS technology in the amateur radio market, and the MARK-V 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.

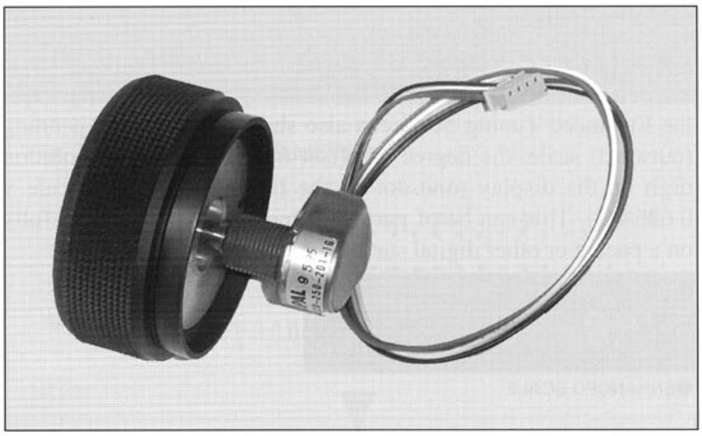
Through the Menu system, the tuning steps and tuning speed may be selected from a wide variety of choices, allowing an unparalleled degree of customization of this extremely important component of the ergonomic design package.

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	2	4
0.625 Hz	310 Hz	620 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.

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.



●Dial Mechanism

6. Display Features

The display of the MARK-V utilizes the design of the original FT-1000MP, with improved filter contrast to minimize bleed-through of unused display segments. The result is a complex yet easy-to-understand display that also is very easy to read.

1. Large Display with Multi-Function Meter

In the MARK-V, 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.

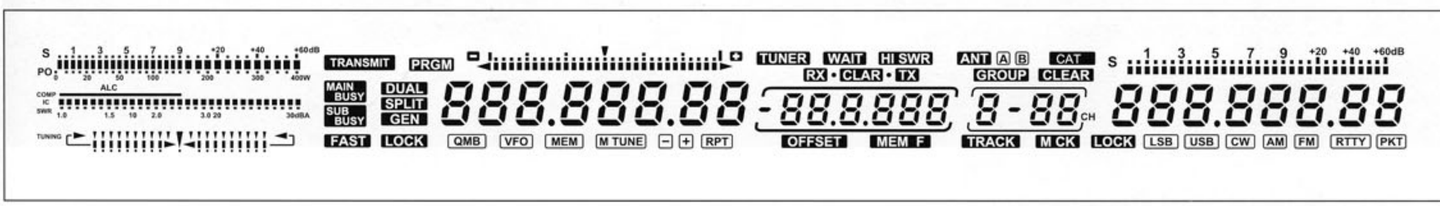
During transmission, multiple parameters may be displayed, allowing the operator to watch power output plus two out of the following six parameters: ALC, SWR, Compression Level, PA Collector Current, PA Input Voltage, and/or Microphone Input Level. On receive, both Main and Sub Receiver S-meter indications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

2. 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.

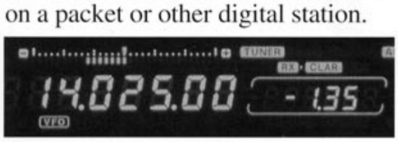
The MARK-V's frequency display features amber lighting, to set it apart from other indications on the LCD. The exact shade of color has been carefully chosen to provide the best visibility under a wide variety of ambient lighting conditions.



3. 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.



●ENHANCED SCALE

Fig. 6-1 :
0.625Hz SCALE (1dot=0.625Hz)

4. Multi-Display Panel

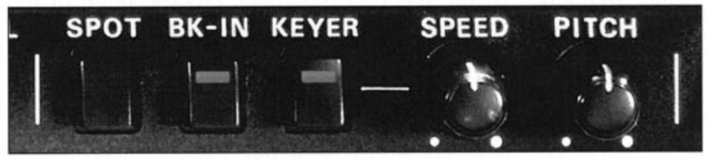
A small multi-display panel, located between the Main and Sub frequency displays, can be commanded to display one of four items.

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; or (C) the current CW pitch (default = 700 Hz).

Table. 6-1 : Multi-Display Selection (Menu Item 3-5)

MODE	COMMENT	DISPLAY
cLAr ;	CLARIFIER OFFSET	0.00
cHnL-F ;	LAST-USED MEMORY CHANNEL FREQUENCY	7.0.000 MEM F
oFFSEt ;	FREQUENCY DIFFERENCE BETWEEN MAIN AND SUB VFOS	00.0.000 OFFSET
A1-PITcH ;	CW PITCH CENTER FREQUENCY	C - 700

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



1. 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. When operating in the "semi-break-in" mode, Menu #7-5 (kYr-dLY) provides a separate "VOX" Delay setting, different from the one you use for SSB, so you can set the receiver recovery time exactly the way you want it for CW operation.

In its product review of the FT-1000MP, the American Radio Relay League commented, "This radio has excellent keying characteristics." These "excellent" characteristics have been carried over, unchanged, into the MARK-V.

2. 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 : Electronic Keyer Selection (Menu Item 7−0)

MODE	COMMENT
iAbic 1	ELECTRONIC KEYER
buG	MECHANICAL "BUG" EMULATOR
iAbic 2	ELECTRONIC KEYER WITH AUTOMATIC CHARACTER SPACING

●DOT/DASH WEIGHT ADJUSTMENT (Menu Items 7−1/7−2)

Fig. 7−1: Dot :Space Ratio Adjustment of 0.5 :1~2.0 :1

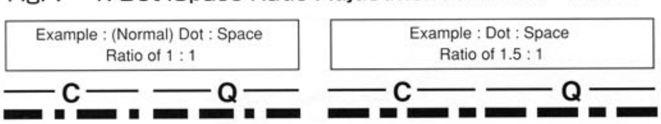
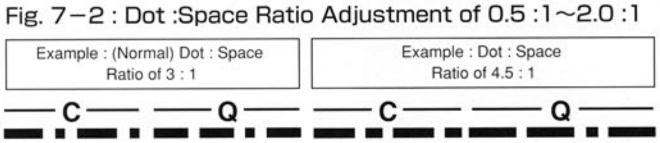


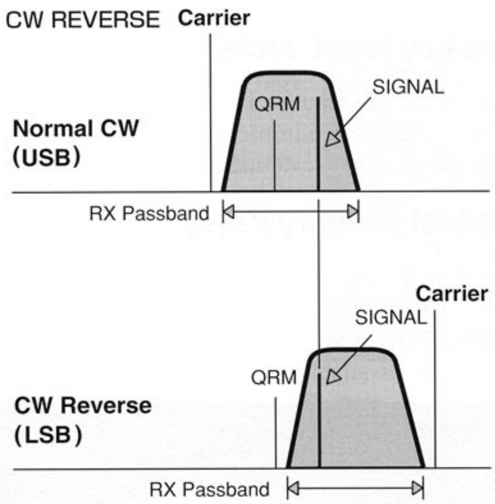
Fig. 7−2 : Dot :Space Ratio Adjustment of 0.5 :1~2.0 :1



3. 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. 7−3 : CW REVERSE



4. CW SPOT

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

5. CW Tuning Meter

A popular 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.

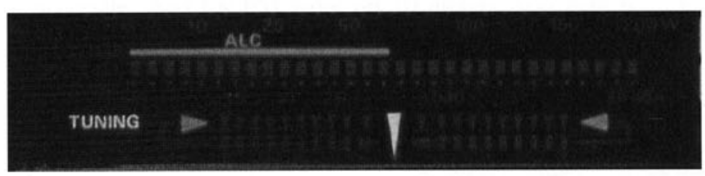
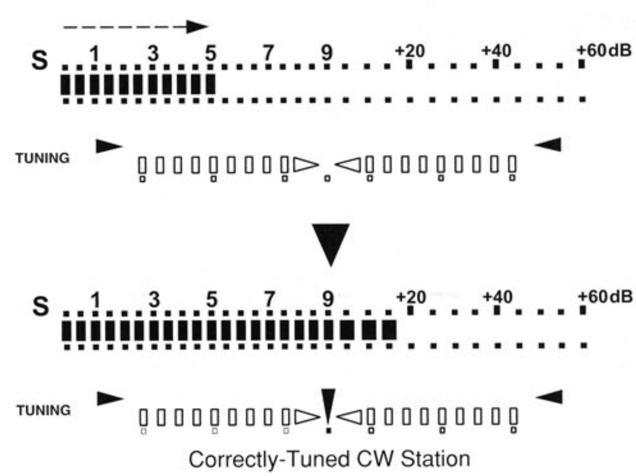


Fig. 7−4 : CW TUNING METER



6. 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 MARK-V 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.

7. 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.

8. 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 (or a home-constructed unit), a variety of functions are available, including:

Table. 7−2 : Contest Memory Keyer Feature (Menu Item 7−6)

Key#	FUNCTION	REMOTE CONTROL FEATURE
1	CHC	CQ MESSAGE
2	CHI	CONTEST #
3	CHU	INCREMENT CONTEST #
4	CHD	DECREMENT CONTEST #
5	CH0	MSG 0
6	CH1	MSG 1
7	CH2	MSG 2
8	CH3	MSG 3
9	CHW	WRITE MEMORY
10	MONI	PLAYBACK (NO Tx)
11	—	—
12	TUNING	TUNE

Additional features:

- Four memories which can store as many as 50 characters each;
- Your callsign can be stored for one-touch identification;
- 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; and
- Digits in the contest number may be "truncated" individually, per Table 7-3.

Table. 7−3 : Contest Number Truncation Format (Menu Item7−6)

No.	FORM		No.	FORM	
0	[8 (0)]	t (T) o (O)	5	[5 (5)]	E (E)
			6	[6 (6)]	Sent in Full
1	[1 (1)]	A (A)	7	[7 (7)]	b (B)
2	[2 (2)]	u (U)	8	[8 (8)]	d (D)
3	[3 (3)]	u (V)	9	[9 (9)]	n (N)
4	[4 (4)]	Sent in Full			

cntSt-no	
oFF	Sends contest number with no leading zeroes
999	Sends three-digit contest number with leading zero (es)
9999	Sends four-digit contest number with leading zero (es)
[- - - -]	Sends three-digit contest number with leading zero (es)

Fig. 7−5 : SIDE TONE ADJUSTMENT

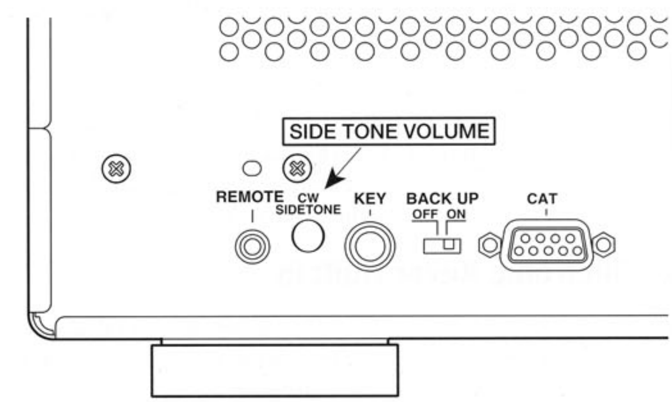
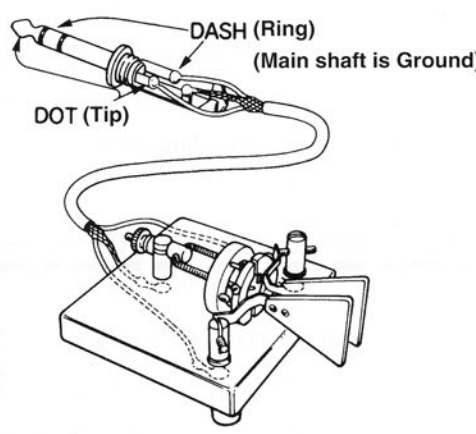


Fig. 7−6 : KEY CONNECTIONS



The MARK-V 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.

1. Improved Ergonomics on Front Panel

The MARK-V includes a number of ergonomically-driven enhancements to its front panel. For improved access, the APF, NR, and CONTOUR systems have been re-located, and enhanced by the use of pushbutton switches for selection. Additionally, the NOTCH, SHIFT, WIDTH, and CLAR knobs have been enlarged and isolated, making them much easier to operate after long hours on the air. For multiple-day operations such as DX-peditions, the MARK-V is without peer when it comes to ease of operation.

●Located to the left of the Main Dial are the convenient one-touch access buttons for the APF, NR, and CONTOUR features.

●Large rubber-grip control knobs make for effortless adjustment during extended operating sessions.

2. Shuttle Jog Dial

The Yaesu-exclusive Shuttle Jog tuning enhancement provides a different 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 or 1000 steps per second.

On the MARK-V, the IDBT and VRF activations switches have been conveniently located on the perimeter of the ring, so you don't have to move your hand away from the area of the main tuning dial when activating these important circuits.

3. 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 MARK-V'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.

4. 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).

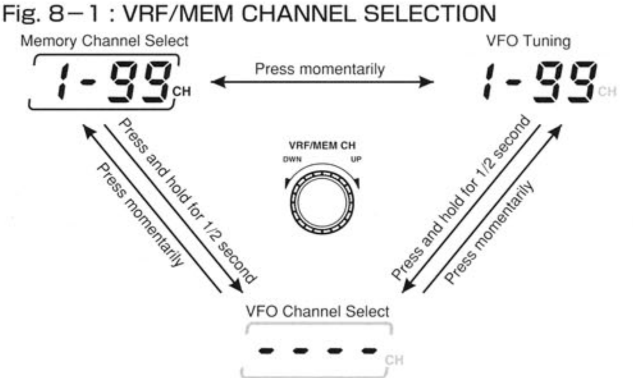
5. VRF/MEM CH Control

The [VFO/M CH] knob on the front panel serves a triple 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.

During VRF operation, this control is also used for manual setting of the center frequency of the preselector's filter passband. You can quickly press the knob to return to VFO or Memory Channel operation, too!

Fig. 8－1 : VRF/MEM CHANNEL SELECTION



6. Versatile Memory Functions

The MARK-V 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.

Fif. 8−2 : MEMORY SYSTEM

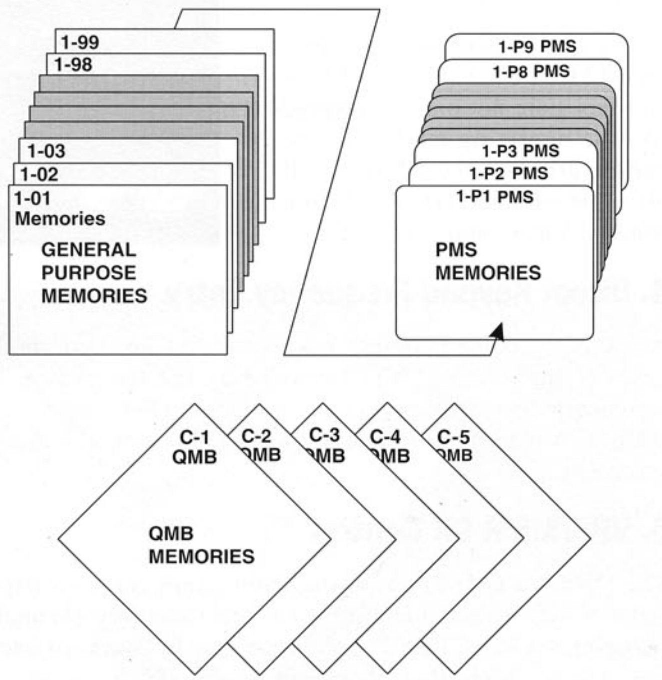


Fig. 8−3 : MEMORY GROUPING EXAMPLE (Menu Items 0−1/0−2/0−3/0−4/0−5)

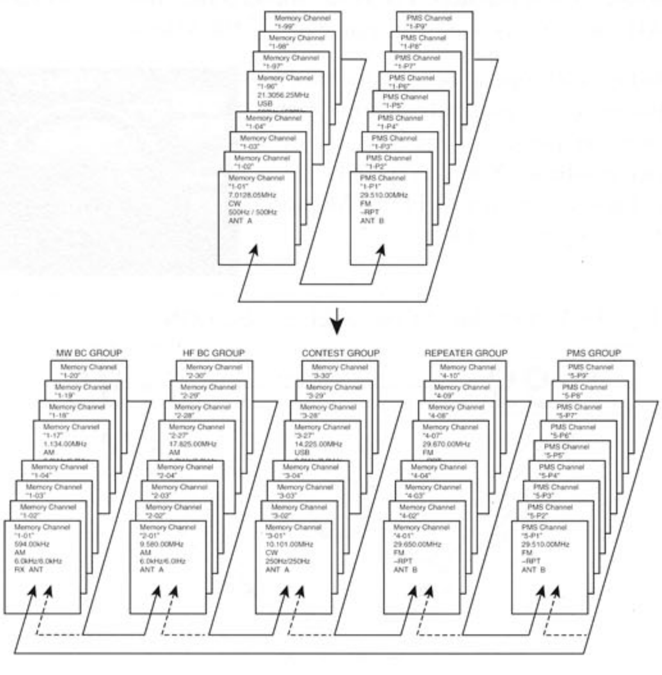
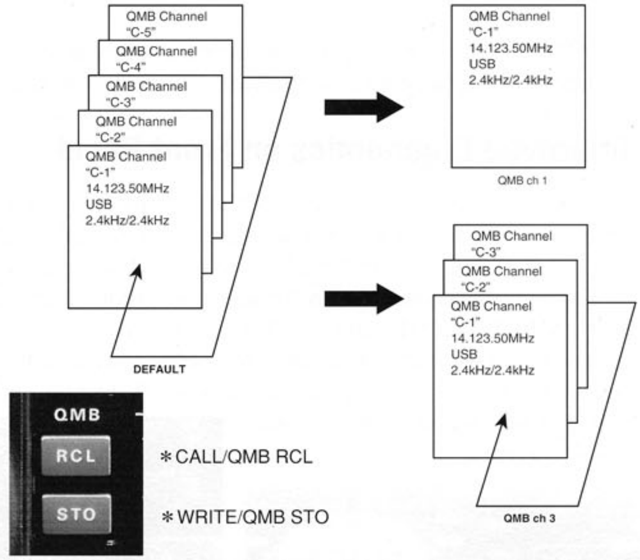


Fig. 8−4 : QMB MEMORY (MAX 5ch) (Menu Item 0−6)



7. VFO Selection Switches & AF Reverse

The MARK-V utilizes 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.

If you need to switch the Main and Sub VFO AF Gain control positions, in case something urgent appears on the sub receiver, a press of AF REV switch will accomplish this instantaneously.

●RX/TX LEDs Select and Indicate VFO Status

8. 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.

9. 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.

10. 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.

11. 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).

12. 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 Selection (Menu Item 7−9)

uFo-A		
MODE	ACTION	COMMENT
1	1/1.8	Replicates "1" Key.
2	2/3.5	Replicates "2" Key.
3	3/7.0	Replicates "3" Key.
4	4/10	Replicates "4" Key.
5	5/14	Replicates "5" Key.
6	6/18	Replicates "6" Key.
7	7/21	Replicates "7" Key.
8	8/24.5	Replicates "8" Key.
9	9/28	Replicates "9" Key.
10	0/29	Replicates "0" Key.
11	SUB/CE	Replicates "SUB" Key.
12	ENT	Replicates "ENT" Key.

Controls Main Dial (VFO-A)

uFo-b		
MODE	ACTION	COMMENT
1	1/1.8	Replicates "1" Key.
2	2/3.5	Replicates "2" Key.
3	3/7.0	Replicates "3" Key.
4	4/10	Replicates "4" Key.
5	5/14	Replicates "5" Key.
6	6/18	Replicates "6" Key.
7	7/21	Replicates "7" Key.
8	8/24.5	Replicates "8" Key.
9	9/28	Replicates "9" Key.
10	0/29	Replicates "0" Key.
11	SUB/CE	Replicates "SUB" Key.
12	ENT	Replicates "ENT" Key.

Controls Sub Dial (VFO-B).

F-tEyS		
MODE	ACTION	COMMENT
1	VFO/M	Exchanges contents of VFO and current memory channel.
2	A ► B	Copies contents of Main VFO (A) into Sub VFO (B).
3	A ⇆ B	Exchanges contents of Main VFO (A) and Sub VFO (B).
4	SPLIT	Activates "Split" operation (RX on Main VFO, TX on Sub VFO).
5	M ► A	Copies contents of current memory channel into Main VFO (A).
6	MCK	Allows checking of currently-selected memory channel data without changing current operating frequency.
7	A ► M	Stores data from Main VFO (A) into Memory.
8	QMB RCL	Recalls current Quick Memory channel.
9	QMB STO	Stores Main VFO (A) frequency into next Quick Memory register.
10	DUAL	Engages Dual Receive between the Main (A) and Sub (B) receivers.
11	M CH UP	Increments Memory Channel 1 channel Up.
12	M CH DWN	Increments Memory Channel 1 channel Down.

9. Ultra-quiet FP-29 Switching Power Supply

Providing the 30 V DC required by the final amplifier, and the 13.8 V DC used elsewhere in the transceiver, the external FP-29 Switching Regulator Power Supply is a low-profile, very quiet companion for the MARK-V.

Compact, yet capable of a total output of at least 490 Watts of power, the FP-29 is capable of operation either from 100-120 V or 200-240 V AC, making it ideal for DX-pedition use.

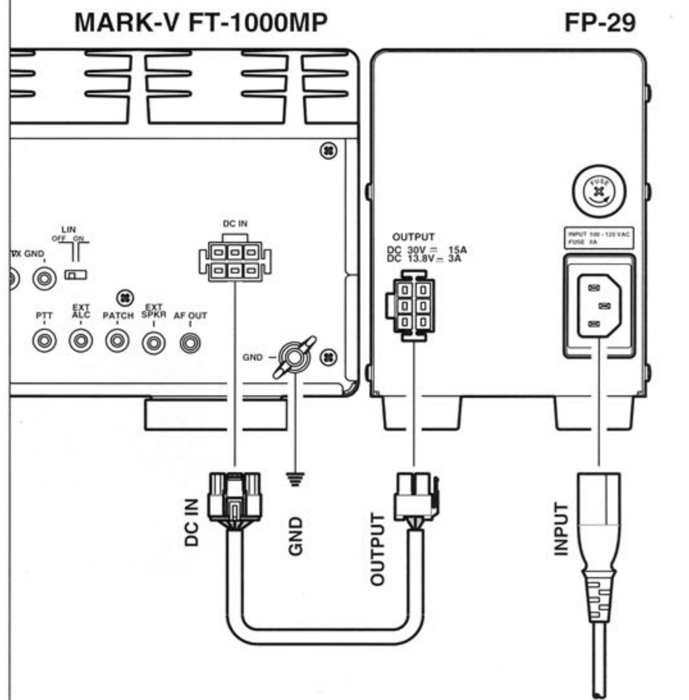
The FP-29 uses power MOS FET switching transistors in an all-new design that is at least 20 dB quieter than previous designs. The series bus line regulator design provides highly stable output, while being very forgiving of input AC line voltage variations.

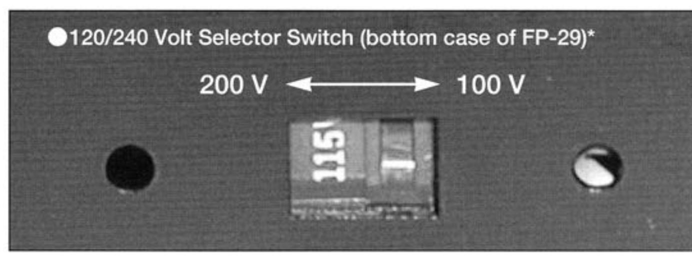
The separate FP-29 power supply greatly reduces the weight of the basic transceiver. Additionally, heat inside the transceiver is also reduced. The FP-29 connects to the MARK-V via a 2-meter (6.6') cable, allowing you to place the FP-29 on a shelf below the main operating surface.

When using the FTV-1000 50 MHz transverter, the FP-29 provides power for both the MARK-V and the transverter.

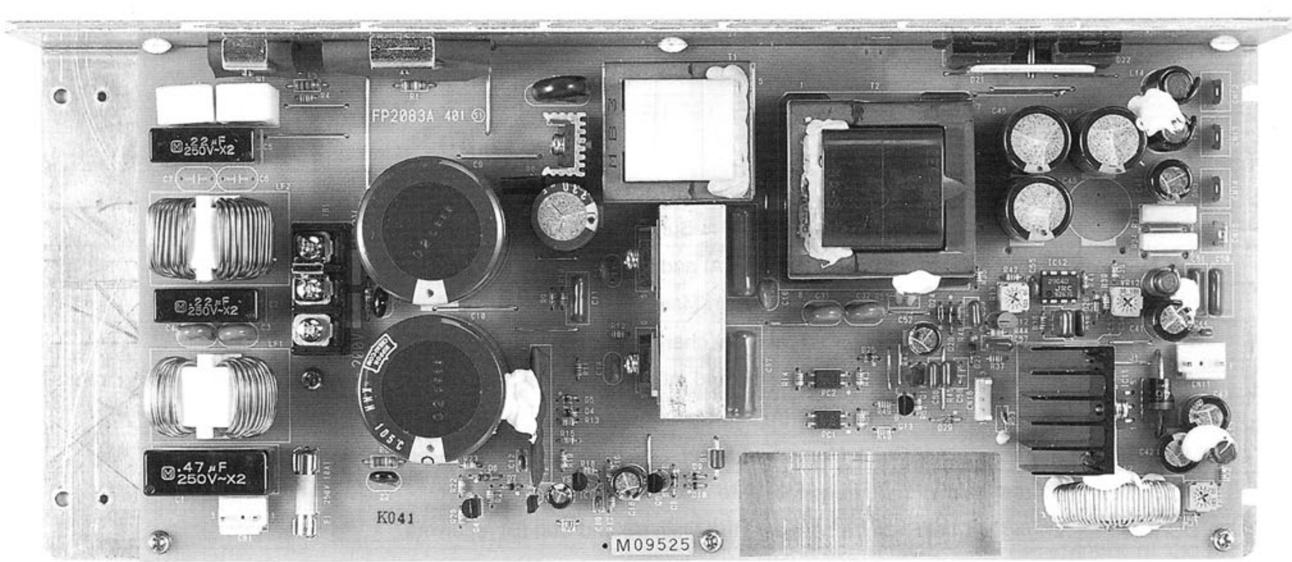
●FP-29 Matching Power Supply for MARK-V

Fig. 9−1 : MARK-V/FP-29 INTERCONNECTIONS





※Use a 5-Amp fuse when 200-240 Volt operation is selected.

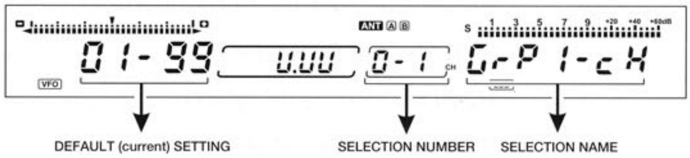


●High Capacity FP-29 Switching Regulator Power Supply

The Menu system of the MARK-V 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.

1. Menu Mode

A total of 84 Menu functions are available, pursuant to the chart below. The Menu mode is activated by pushing and holding in the [FAST] key; while holding it in, you press the [ENT] key. 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.



FUNCTION MENU

MENU No.	FUNCTION	TITLE	SETTING RANGE (DEFAULT)
0 - 1	MEMORY GROUP 1 CHANNELS	GrP1-cH	01～99(01～99)
0 - 2	MEMORY GROUP 2 CHANNELS	GrP2-cH	00～99(oFF)
0 - 3	MEMORY GROUP 3 CHANNELS	GrP3-cH	00～99(oFF)
0 - 4	MEMORY GROUP 4 CHANNELS	GrP4-cH	00～99(oFF)
0 - 5	MEMORY GROUP 5 CHANNELS	GrP5-cH	00～99(oFF)
0 - 6	QMB CHANNEL	quick-cH	1/2/3/4/(5)
0 - 7	NOT USED	—	—
0 - 8	AUTO CHANNEL UP	Auto-uP	(oFF)/on
0 - 9	EDSP ON/OFF	EdSP	oFF/(on)
1 - 0	VFO A & B DIAL FAST TUNING RATE	diAL-SPd	(4)/2
1 - 1	SHUTTLE JOG DIAL ENCODE SPEED	SJ-SPEEd	1～100(50)
1 - 2	IF SHIFT/WIDTH CONTROL TUNING STEP SIZE	SFt-StEP	(10)/20
1 - 3	MAIN VFO-A TUNING STEP SIZE	A-StEP	0.62[5]/1.25/2.50/5.00/(10.00)/20
1 - 4	SUB VFO-B TUNING STEP SIZE	b-StEP	0.62[5]/1.25/2.50/5.00/(10.00)/20
1 - 5	VFO CHANNEL STEP SIZE	cH-StEP	1～100(10)
1 - 6	QUICK SPLIT OFFSET TUNING	q-SPLit	−100～100(5)
1 - 7	AUTOMATIC SELECTING OF AGC RECOVERY TIME	AutoFASt	on/(oFF)
1 - 8	CLARIFIER TUNING OFFSET	cLAr-Tun	(on)/oFF
1 - 9	CLARIFIER TUNING STEP SIZE	cLAr-StP	0.62[5]/1.25/2.50/5.00/(10.00)/20
2 - 0	SCAN PAUSE	Scn-PAuS	(on)/oFF
2 - 1	SCAN RESUME MODE	Scn rES	(cAr-StoP)/cAr-time/cAr-SLo
2 - 2	NOT USED	—	—
2 - 3	MEMORY SCAN SPEED	nScn-SPd	100～1000(200)
2 - 4	DIAL (VFO) SCAN SPEED	dScn-SPd	1～100(10)
2 - 5	AUTO MEMORY WRITE	Auto-in	(oFF)/Grp-1/Grp-ALL
2 - 6	MEMORY SCAN SKIP	ScAn-ALL	on/(oFF)
2 - 7	SCAN DELAY TIME	Sc-dL-ti	1～10(5)
2 - 8	NOISE BLANKER	nb	A1～A15,B1～B15(A12)
2 - 9	NOTCH OPERATION	notcH	(iF-notcH)/Auto-dsp/SELEct

MENU No.	FUNCTION	TITLE	SETTING RANGE (DEFAULT)
3 - 0	FREQUENCY DISPLAY FORMAT	F-diSPLY	(oFFSEt)/carriEr
3 - 1	DISPLAY RESOLUTION	diSP-rES	(10H)/100H/1000H
3 - 2	EXPANDED TUNING SCALE	EtS-SEL	(cLAr)/diAl
3 - 3	TRANSVERTER DISPLAY	tr-diSP	(oFF)/50/144/430
3 - 4	LCD DISPLAY BRIGHTNESS	briGHt	(Hi)/Lo
3 - 5	PANEL OFFSET DISPLAY MODE	PnL-diSP	(cLAr)/cHnL-F/oFFSEt/A1-PITcH
3 - 6	SUB METER BAR GRAPH	S-bArdSP	(on)/oFF
3 - 7	MAIN METER PEAK-HOLD	P-HoLd	(oFF)/10～2000
3 - 8	SUB METER PEAK-HOLD	SP-HoLd	(oFF)/10～2000
3 - 9	NOT USED	—	—
4 - 0	RF POWER OUTPUT RANGE	rF out	10/75/(200)
4 - 1	KEY & PANEL BEEPER	bEEP	(on)/oFF
4 - 2	BEEP FREQUENCY	bEEP-F	220～7040(880)
4 - 3	TUNE-UP DRIVE POWER	tun-drv	10/(75)/200
4 - 4	TRANSMIT AUDIO EDSP	tr-EdSP	(oFF)/1/2/3/4
4 - 5	NOT USED	—	—
4 - 6	DVS RECORD VFO	dvS-rEc	(nAin)/Sub
4 - 7	DVS-2 PTT	duS-Ptt	(on)/oFF
4 - 8	HEADPHONE MODE	HEAdPHon	nono/(StErEo-1)/StErEo-2
4 - 9	AF GAIN CONTROL	AF GAin	(SEPErAtE)/bALAncE
5 - 0	SSB NORMAL FILTERS	SSB nor	8.2/455/8.25-455/(oFF)
5 - 1	2nd IF 2.0 kHz FILTER	8.2-2.0	on/(oFF)
5 - 2	CW NORMAL FILTER	CW nor	8.2/455/(8.2-455)
5 - 3	2nd IF 250 Hz FILTER	8.2-250	on/(oFF)
5 - 4	DATA NARROW 2 FILTERS	dAtAnAr2	8.2/455/(8.2-455) /500H
5 - 5	3rd IF 2.0 kHz FILTER	455-2.0	on/(oFF)
5 - 6	3rd IF 500 Hz FILTER	455-500	on/(oFF)
5 - 7	3rd IF 250 Hz FILTER	455-250	on/(oFF)
5 - 8	SUB VFO FILTER	Sub-FiL	on/(oFF)
5 - 9	TX EDSP FILTER	t-FiL	2.4/(6.0)
6 - 0	RTTY FREQUENCY SHIFT	rttY-SHF	(170)/425/850
6 - 1	RTTY POLARITY	rttY-PoL	(nor)/rEUErSE
6 - 2	RTTY TONE	rttY-ton	(Hi tonE)/Lo tonE
6 - 3	RTTY FREQUENCY DISPLAY	rtY-FdSP	(oFFSEt)/cArriEr
6 - 4	PACKET FREQUENCY DISPLAY OFFSET	PAc-FdSP	−3.000～3.000(−2.125)
6 - 5	PACKET TONES	PAc-tonE	1170/1700/(2125)/2210
6 - 6	NOT USED	—	—
6 - 7	CTCSS REPEATER TONE	ctcSS	33 Tone @ 67.0～250.3 Hz (88.5)
6 - 8	REPEATER TONE SETTING	tonE SEt	(contin)/t-burSt
6 - 9	REPEATER SHIFT	rPt-SHFt	0.00～200.00(100.00)

MENU No.	FUNCTION	TITLE	SETTING RANGE (DEFAULT)
7 - 0	KEYER MODE SELECTION	kEYEr	(iAbic 1)/buG/iAbic 2
7 - 1	CW "DOT" WEIGHTING	kYr-dot	0~127(10)
7 - 2	CW "DASH" WEIGHTING	kYr-dSH	0~127(30)
7 - 3	CONTEST KEYER ID	cntSt-no	(0000)~9999
7 - 4	BREAK-IN TIME DELAY	bk-in ti	0~30(5)
7 - 5	KEYER DELAY	kYr-dLY	(0.00)~5.10
7 - 6	CW PLAYBACK STYLE	A1-StYLE	see the chart on page 26
7 - 7	EDSP ENHANCED MODULATION & DEMODULATION	dSP-ndn	
	SSB (RX)	SSb-r	Selects 100~3100 Hz, or 300~2800 Hz filter response, or OFF. (oFF)
	SSB (TX)	SSb-t	Selects 100~3100 Hz, or 150~3100 Hz, 200~3100Hz, or 300~3100 Hz filter response, or OFF. (oFF)
	CW (RX)	cu-r	oFF(Analog)/on(EDSP)
	AM (RX)	An-r	oFF(Analog)/on(EDSP)
7 - 8	SUB VFO RECEIVER	Sub-rcvr	(on)/oFF
7 - 9	REMOTE CONTROL FUNCTION	rc-Func	(kEyEr)/F-kEyS/vFo-A/vFo-b
8 - 0	FAST BUTTON OPERATION	FASt-SEt	(toGGLE)/continoS
8 - 1	LOCK BUTTON OPERATION	Lock-SEL	(diAL)/PanEL/Pri
8 - 2	SPLIT MODE OPERATION	SPLt-SEt	(nor)/Auto/A=b
8 - 3	POWER AMPLIFIER	PA-cnt	(on)/oFF
8 - 4	RECEIVER FRONT-END RF AMPLIFIER	FrontEnd	tunEd/(FLAt)
8 - 5	ANTENNA SELECTION	Ant-SEL	(Auto)/on/oFF
8 - 6	USER SETTING	uSEr-SEt	
	MODE	nodE	(LSb)/uSb/A1-uPPEr/A1-Lo/rtty-L/rtty-u/Pac-Lo
	DISPLAY OFFSET	dSP-oFSt	−5.000~5.000 kHz 5Hz steps
	RX PLL OFFSET	r-PLL	−5.000~5.000 kHz 5Hz steps
	RX CARRIER	r-cAr	450.000~460.000 kHz 10Hz steps
	TX PLL OFFSET	t-PLL	−5.000~5.000 kHz 5Hz steps
	TX CARRIER	t-cAr	Settable by mode in 10Hz steps
	RTTY OFFSET (shift)	rttY-Set	−5.000~5.000 kHz 5Hz steps
	EASY SET	EASy-Set	(oFF)/SStv-L/SStv-u/PS31-L/PS31-u/FacS-L/FacS-u/PS31-SL/PS31-Su
8 - 7	SUB VFO RECEIVER AGC	Sub-AGc	(Auto)/SLo/FASt
8 - 8	ANTENNA TUNER	tunEr	(on)/oFF
8 - 9	CARRIER POINT OFFSET	cAr-oFSt	
	RX LSB CARRIER	r-LSbcAr	−0.200~0.500(0.000)10Hz steps
	TX LSB CARRIER	t-LSbcAr	−0.200~0.500(0.000)10Hz steps
	PROCESSOR LSB	Proc-LSb	−0.200~0.500(0.000)10Hz steps
	RX USB CARRIER	r-uSbcAr	−0.200~0.500(0.000)10Hz steps
	TX USB CARRIER	t-uSbcAr	−0.200~0.500(0.000)10Hz steps
	PROCESSOR USB	Proc-uSb	−0.200~0.500(0.000)10Hz steps
	TX AM CARRIER	t-A3-cAr	−3.000~3.000(0.000)10Hz steps

2. Direct Menu Mode Access

There also are several Menu items which are more directly accessed. See Table 10-1 for a listing of these and other Direct Menu Mode Access functions.

Table 10-1 Direct-Access Menu Mode

	Function	Press this key while holding in [FAST]Key
2-8	Noise Blanker (NB) Level	NB SWITCH
2-9	Notch Operation	NOTCH SWITCH
3-4	LCD Display Brightness	VCC/MIC (METER) SWITCH
7-5	Keyer Delay	BK-IN SWITCH
8-7	SUB(VFO-B)Receiver AGC	RX-(SUB VFO-B)INDICATOR

3. [USER] Configuration Mode
(Press the [PKT] key for 1/2 second to activate)

The MARK-V 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:

(A) 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 for adjustment in this mode.

Table 10-2 Basic Mode Selection

nodE (MODE)			
Display	Mode	Display	Mode
LSb	LSB	rtty-L	RTTY (LSB)
uSb	USB	rtty-u	RTTY (USB)
A1-uPPEr	CW (USB)	PAc-Lo	PKT (LSB)
A1-Lo	CW (LSB)	Default Selection "LSB"	

(B) 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 10-3 Display Offset Adjustment

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

(C) 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 10-4 RX PLL Oscillator Offset Adjustment

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

(D) 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 10-5 RX PLL Carrier Injection Point Adjustment

Display	r-cAr						
	RX Carrier Point						
Default Value	LSB	USB	CW (USB)	CW (LSB)	RTTY (LSB)	RTTY (USB)	PKT (LSB)
	456.450kHz	453.550kHz	454.300kHz	455.700kHz	457.210kHz	452.790kHz	457.120kHz
Range	450.000kHz~460.000kHz						

(E) Transmit PLL Offset

This setting allows 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 10-6 TX PLL Oscillator Offset Adjustment

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

(F) Transmitter Carrier Point

This setting is analogous to the Receiving Carrier Point adjustment described previously, this time applied to the transmit signal. The total adjustment range is 456.3 - 460 kHz.

Table 10-7 TX PLL Carrier Injection Point Adjustment

Display	t-cAr						
	TX Carrier Point						
Default Value	LSB	USB	CW (USB)	CW (LSB)	RTTY (LSB)	RTTY (USB)	PKT (LSB)
	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 450.000~453.7000kHz					
	USB : 450.000kHz~453.700kHz	その他 : 450.000kHz~460.000kHz					

(G) 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.

Table 10-8 RTTY SHIFT Adjustment

Display	rtty-SEt						
	RTTY SHIFT Offset						
Default Value	LSB	USB	CW (USB)	CW (LSB)	RTTY (LSB)	RTTY (USB)	PKT (LSB)
	0.000kHz	0.000kHz	0.000kHz	0.000kHz	−0.170kHz	0.170kHz	0.000kHz
Range	−5.000kHz~5.000kHz						

(H) EASY SET Presetting (Menu #8-6)

Menu #8-6 (EASy-SEt) provides a simple and convenient way of presetting the "USER" mode for operation on PSK31 (Upper or Lower Sideband injection), SSTV, or FAX.

Table 10-9 Custmization of Carrier Point Adjustment

EASy-SET	Mode	dSP-oFST Display Offset	r-PLL RX PLL Offset	r-cAr RX PLL Offset	t-PLL TX PLL Offset	t-cAr TX PLL Offset
SStv-L	SSTV (LSB)	0.000kHz	−1.750kHz	−1.750kHz	456.750kHz	456.750kHz
SStv-u	SSTV (USB)	0.000kHz	1.750kHz	1.750kHz	453.250kHz	453.250kHz
FAcS-L	FAX (LSB)	0.000kHz	−1.900kHz	−1.900kHz	456.900kHz	456.900kHz
FAcS-u	FAX (USB)	0.000kHz	1.900kHz	1.900kHz	453.100kHz	453.100kHz
PS3-L	PSK-31 (PKT-L)	−1.000kHz	−1.500kHz	−1.000kHz	456.000kHz	456.500kHz
PS31-u	PSK-31 (PKT-U)	1.000kHz	1.500kHz	1.000kHz	454.000kHz	453.500kHz
PS31-SL	PSK-31 (LSB)	−1.000kHz	−1.500kHz	−1.450kHz	456.450kHz	456.500kHz
PS31-Su	PSK-31 (USB)	1.000kHz	1.500kHz	1.450kHz	453.550kHz	453.500kHz

4. Customization of Carrier Points

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.

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

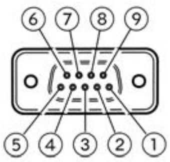
In the early 1980s, Yaesu pioneered the concept of the use of external control of an amateur radio transceiver, using a personal computer, with the introduction of the FT-980. More than a decade later, the MARK-V FT-1000MP carries on this proud tradition.

Applications which support the MARK-V 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. The MARK-V includes 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 MARK-V's rear panel CAT jack.

1. 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).

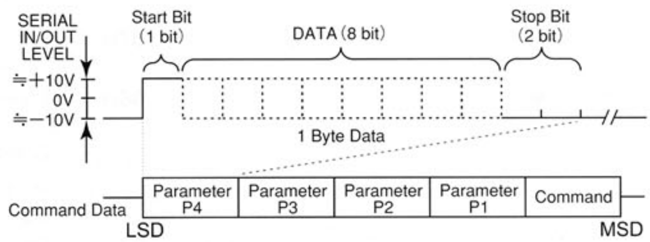
◀ Built-in RS-232C Interface allows direct computer connection to the MARK-V's D-SUB 9-pin connector.



① NC
② SERIAL OUT
③ SERIAL IN
④ N/A
⑤ GND
⑥ N/A
⑦ N/A
⑧ N/A
⑨ NC

Fig. 11－1 : CAT System Data Format

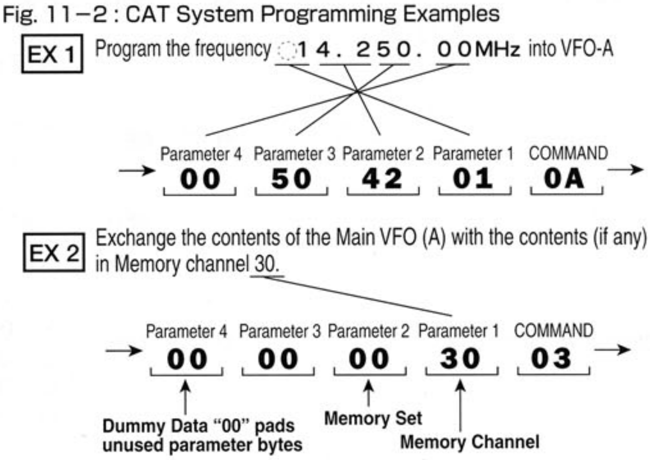
SPEED :4800 bits／sec
DATA BIT : 8
START BIT : 1
STOP BIT : 2
PARITY BIT : NONE



2. CAT System Coding Examples

Simple examples of CAT System programing are presented in Figure 2.

Fig. 11－2 : CAT System Programming Examples



※Parameters 4～1's commands are Hex-coded

CAT Control Commands

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
SPLIT	—	—	—	T	**01**H	Split Tx/Rx operation ON (T = **01**H) or OFF (T = **00**H)
Recall/Memory	—	—	—	X	**02**H	Recalls memory number X : **01**H～**71**H, corresponding to memories 1～99, P1～P9, and QMB 1～QMB 5.
VFO/MEM	—	—	K	X	**03**H	Enter (K = **00**H), Mask (K = **01**H) or Un-Mask (K : **02**H), memory channel X (**01**H～**71**H).
LOCK	—	—	—	P	**04**H	Tuning knob Lock/Unlock : P = **00**H : Main Dial Lock P = **01**H : Main Dial Unlock P = **02**H : Sub Dial Lock P = **03**H : Main Dial Unlock
A/B	—	—	—	V	**05**H	Select VFO-A (V = **00**H), or VFO = B (V : **01**H).
[M▶B]	—	—	—	X	**06**H	Copy memory X (**01**H～**71**H) to last-used VFO.
UP (▲)	—	—	U	V	**07**H	Step VFO-A/B (V = **00**H/**01**H) up by 100 kHz/1 MHz (U = **00**H/**01**H).
DOWN (▼)	—	—	D	V	**08**H	Step VFO TA/B (V = **00**H/**01**H) down by 100 kHz/1 MHz (D = **00**H/**01**H).
CLAR	CI	C2	C3	C4	**09**H	Clarifier offset direction & frequency in BCD C1 = Hz offset (C1 = **00**H～**99**H) C2 = kHz offset (C2 = **00**H～**09**H) C3 = Hz offset (C3 = **00**H/**FF**H) Clarifier On/Off/Reset : C4 = RX CLAR ON/OFF (C4 = **00**H/**01**H) TX CLAR ON/OFF (C4 = **80**H/**81**H) CLAR CLEAR (C4 = **FF**H)
Set Main VFO-A Operating Freq.	FI	F2	F3	F4	**0A**H	New operating frequency in BCD format (F1～ F4) see text for formatting example.
MODE	—	—	—	M	**0C**H	Select Operating Mode M : LSB : M = **00**H USB : M = **01**H CW : M = **02**H CW (R) : M = **03**H AM : M = **04**H AM (Sync) : M = **05**H FM : M = **06**H FM-W : M = **07**H RTTY (L) : M = **08**H RTTY (U) : M = **09**H PKT (L): M = **0A**H PKT(F) : M = **0B**H L
Pacing	—	—	—	N	**0E**H	Add N millisecs (**00**H～**FF**H) delay between each byte of all downloaded data returned from the transceiver
PTT	—	—	—	T	**0F**H	Transmitter ON (T = **01**H) or OFF (T = **00**H)
Status Update	X	—	—	U	**10**H	Instructs the radio to return 1, 16, 32, or 1863 bytes of Status Updata data. X is significant only when U = 1～4. X = **00**H～71H : desired memory channel (1～99, P1～P9, or QMB 1～QMB 5) U = **00**H All 1863 byte U = **01**H 1-byte Memory Channel Number U = **02**H 16-byte Operating Data U = **03**H 2 x 16-byte VFO (A&B) Data U = **04**H 1 x 16-byte Memory Data
Electronic Keyer	KI	K2	K3	K4	**70**H	Activates remote control and contest keyer functions. K1 = **00**H (fixed value) K2 = keyer function : **00**H = Message 0 **05**H = Contest Number **01**H = Message 1 **06**H = Decrement Contest Number **02**H = Message 2 **07**H = Increment Contest Number **03**H = Message 3 **08**H = Message Playback w/o Tx **04**H = CQ/ID Message **09**H = Write Message into Memory K3 = **01**H (fixed value) K4 = **1B**H (fixed value)

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
EDSP Enhanced Digital Signal Processing	—	—	PI	P2	**75**H	EDSP Settings, where P2 is : RX EDSP OFF (30H), P1 = **00**H AM EDSP Demodulation On (**31**H), P1 = **00**H USB EDSP Demodulation (**32**H), with audio response of 100 Hz~3.1 kHz (P1 = **00**H) or 300Hz~2.8kHz (P1 = **10**H) LSB EDSP Demodulation (**32**H), with audio response of 100 Hz~3.1 kHz (P1 = **00**H) or 300Hz~2.8kHz (P1 = **10**H) AF Filter Off (**40**H), P1 = **00**H AF LPF On (**41**H), where P1 = [FCUTOFF (Hz)] /20 (HEX format) AF HPF On (**42**H), where P1 = [FCUTOFF (Hz)] /20 (HEX format) CW 240 H BWF (**45**H), where P1 = FCENTER (BCD format) CW 120 Hz BWF (**46**H), where P1 = FCENTER (BCD format) CW 60 Hz BWF (**47**H), where P1 = FCENTER (BCD format) Data Mode AF Filter On (**48**H), where P1 = FSK (**10**H), SSTV (**20**H), Packet (**30**H), or FAX (**40**H) Random Noise Filter (**4A**H) Off/On (P1 = **00**H/1YH) Audio Notch Filter (**4B**H) Off/On (P1 = **00**H/**10**H) AF Equalization (**4E**H), where P1 = Off (**00**H), Bank 1 (**10**H), Bank2 (**20**H), Bank 3 (**30**H), Bank 4 (**40**H) TX EDSP Off (**B0**H) USB EDSP Modulation (**B2**H), with audio response of : 100Hz~3.1kHz (P1 = **10**H), 50Hz~3.1 kHz (P1 = **20**H), 200Hz~3,1kHz (P1 = **30**H), 300Hz~3.1 kHz (P1 : **40**H) LSB EDSP Modulation (**B3**H), with audio response of : 100Hz~3.1 kHz (P1 = **10**H), 150Hz~3.1 kHz (P1 = **20**H) 200Hz~3.1 kHz (P1 = **30**H), 300Hz~3.1 kHz (P1 = **40**H) AF Equalization (**4E**H), where P1 = Off (**00**H) Bank1 (**10**H), Bank2 (**20**H), Bank3 (**30**H), Bank4 (**40**H)
TUNER	—	—	—	T	**81**H	Switch Antenna Tuner ON (T = **01**H) or OFF (T = **00**H)
Tuner Start	—	—	—	—	**82**H	Start Antenna Tuning
Dual Operation	—	—	—	D	**83**H	Switch Dual Receive ON (D = **01**H) or OFF (D = **00**H)
[RPT]	—	—	—	R	**84**H	Switch Simplex Operation (R = **00**H), Minus Shift (R = **01**H), or Plus Shift (R = **02**H) for Repeater Operation
[A▶B]	—	—	—	—	**85**H	Copy Data Display in VFO-A or VFO-B.
Set SUB VFO-B	FI	F2	F3	F4	**BA**H	Enter new operating frequency in F1~ F4, in BCD format : see text for example.

Command or Key	Parameter Bytes				Opcode	Parameter Description
	1st	2rd	3rd	4th	5th	
BAND WIDTH	X1	—	—	X4	**8C**H	Select filter bandwidth for selected IF (see below): **8.2 MHz** / **455 kHz** / **VFO** THRU : X4 = **09** / 6.0kHz : X4 = **84** / Both : X1 = **00** 2.4kHz : X4 = **00** / 2.4kHz : X4 = **80** / VFO-A : X1 = **01** 2.0kHz : X4 = **01** / 2.0kHz : X4 = **81** / VFO-B : X1 : **02** 500Hz : X4 = **02** / 500Hz : X4 = **82** 500Hz : X4 = **03** / 500Hz : X4 = **83**
MEM Channel	—	—	S	X	**8D**H	Tag memory channels 1 through 99 (X = **01**H~**6C**H), to be skipped (S : **01**H) or included (S = **01**H) while scanning.
Step VFO-A UP/DOWN	—	—	—	T	**8E**H	Step frequency of VFO-A UP (T = **00**H) or DOWN (T = **01**H)
CTCSS Encoder Tone Frequency Select	E	E	E	E	**90**H	Select one of 33 CTCSS subaudible tones where E = **00**H~**20**H E = **00**H 67.0Hz / E = **0B**H 118.8Hz / E = **16**H 173.8Hz E = **01**H 71.9Hz / E = **0C**H 123.0Hz / E = **17**H 179.9Hz E = **02**H 77.0Hz / E = **0D**H 127.3Hz / E = **18**H 186.2Hz E = **03**H 82.5Hz / E = **0E**H 131.8Hz / E = **19**H 192.8Hz E = **04**H 88.5Hz / E = **0F**H 136,5Hz / E = **1A**H 203.5Hz E = **05**H 94.8Hz / E = **10**H 141.3Hz / E = **1B**H 210.7Hz E = **06**H 100.0Hz / E = **11**H 146.2Hz / E = **1C**H 218.1Hz E = **07**H 103.5Hz / E = **12**H 151.4Hz / E = **1D**H 225.7Hz E = **08**H 107.2Hz / E = **13**H 156.7Hz / E = **1E**H 233.6Hz E = **09**H 110.9Hz / E = **14**H 162.2Hz / E = **1F**H 241.8Hz E = **0A**H 114.8Hz / E = **15**H 167.9Hz / E = **20**H 250.3Hz
Read Meter & Panel	—	—	—	—	**F7**H	Instruct radio to return digitized indications of various meter level readings and front panel control settings (4 repeated bytes, and **F**7H) selected by : M = **00**H Main S-Meter / M = **87**H TUN Meter M = **01**H Sub S-Meter / M = **F0**H Shuttle Jog Dial M = **80**H PO Meter / M = **F1**H CW Pitch Setting M = **81**H ALC Meter / M = **F2**H Remote Control A/D Level M = **83**H IC Meter / M = **F3**H SHIFT Setting M = **84**H VCC Meter / M = **F4**H WIDTH Setting M = **85**H SWR Meter / M = **F5**H EDSP Contour Selection M = **86**H MIC Meter / M = **F6**H EDSP NR Selection
Repeater Offset	XI	X2	X3	X4	**F9**H	Set offset for RPT shift, valid values are 0~500 kHz in 1-kHz step. Use BCD format for X2~X4 X1 is 10's & 100's of Hz / X2 is 1's & 10's of kHz X3 must be **00** H, **01**H, or **02**H / X4 must be **00**H
Read Internal	—	—	—	F	**FA**H	Instructs radio to return either five or six Status Flags bytes. 5-Byte Format (F = **00**H): Status Flag Byte #1, Status Flag Byte #2, Status Flag Byte #3, *ID Byte #1 (**03**H), *ID Byte #2 (**93**H) 6-Byte Format (F = **01**H): Status Flag Byte #1, Status Flag Byte #2, Status Flag Byte #3, Status Flag Byte #4, Status Flag Byte #5, Status Flag Byte #6

12. DATA-Mode Features of the MARK-V FT-1000MP

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

Dedicated Packet (AFSK) and RTTY (FSK) modes are provided on the MARK-V, 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, PSK-31 (USB/LSB), RTTY (USB/LSB), PKT (LSB), PKT (FM), and other popular digital modes may be set up with optimized carrier points, display offsets, and receive filter settings.

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.

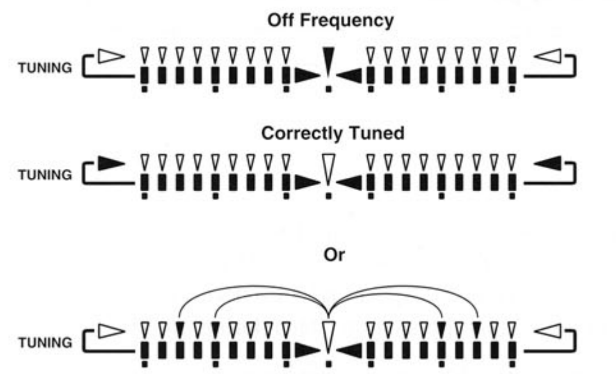
1. Connections for AFSK Operation: Use Packet Jack/Packet Mode (Or USER Mode)

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 12−1 : RTTY MODE MENU SETTINGS

MENU No.	FUNCTION	AVAILABLE SETTINGS
6−0	FSK Shift	170/425/850Hz
6−1	RTTY Polarity	NORMAL/REVERSE
6−2	NORMAL/REVERSE	HIGH 2125Hz/LOW 1275Hz

Fig. 12−1 : RTTY/PACKET TUNING INDICATOR



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.

For PSK31 operation using a computer's "sound card," the same principles apply.

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 MARK-V. 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 page 34 of this Technical Overview. Typically, the "SSTV" or "FAX" settings will provide satisfactory operation.

Fig. 12−2 : RTTY/TNC SYSTEM CONNECTIONS

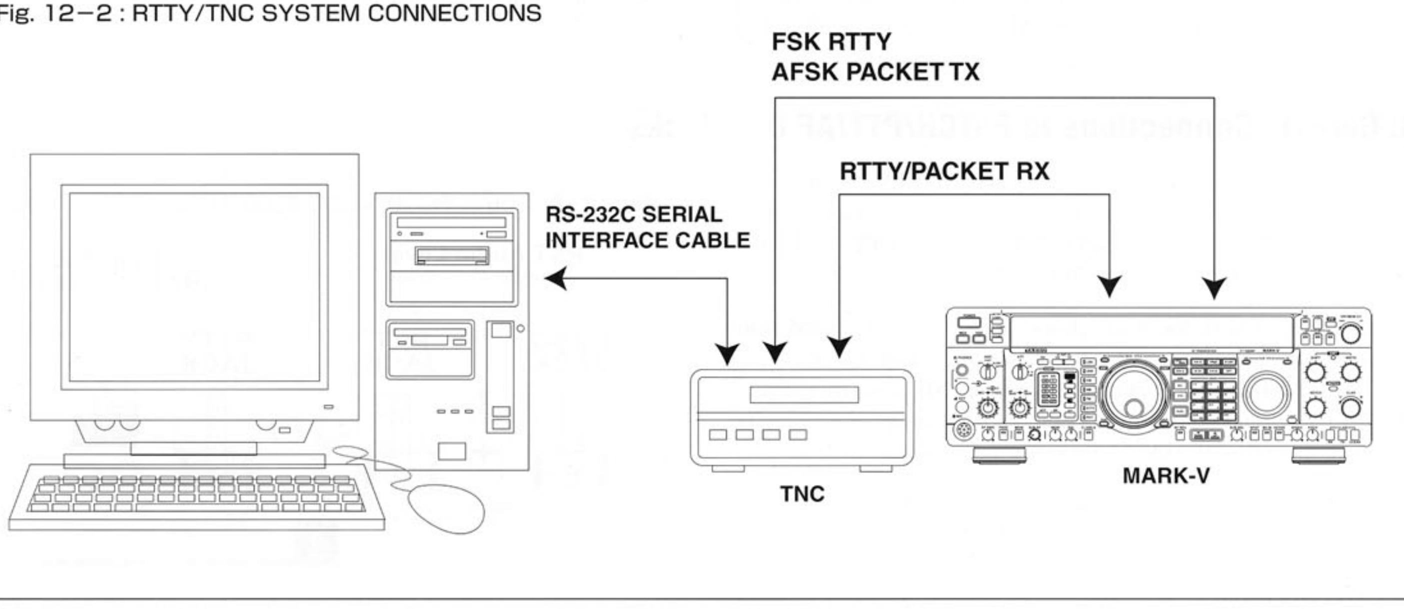


Fig. 12−3 : RTTY TERMINAL UNIT CONNECTIONS (FSK)

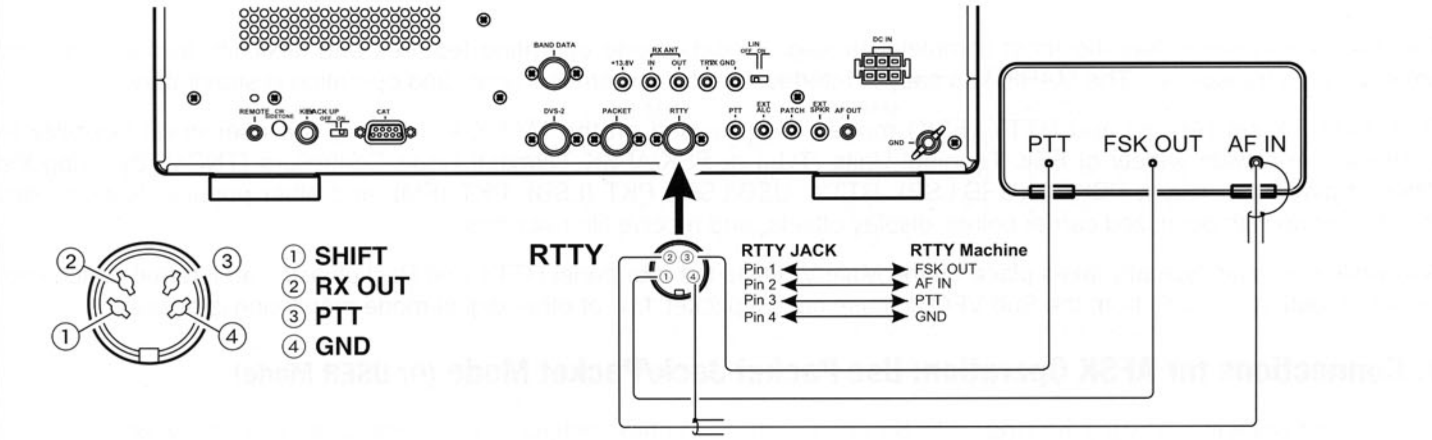
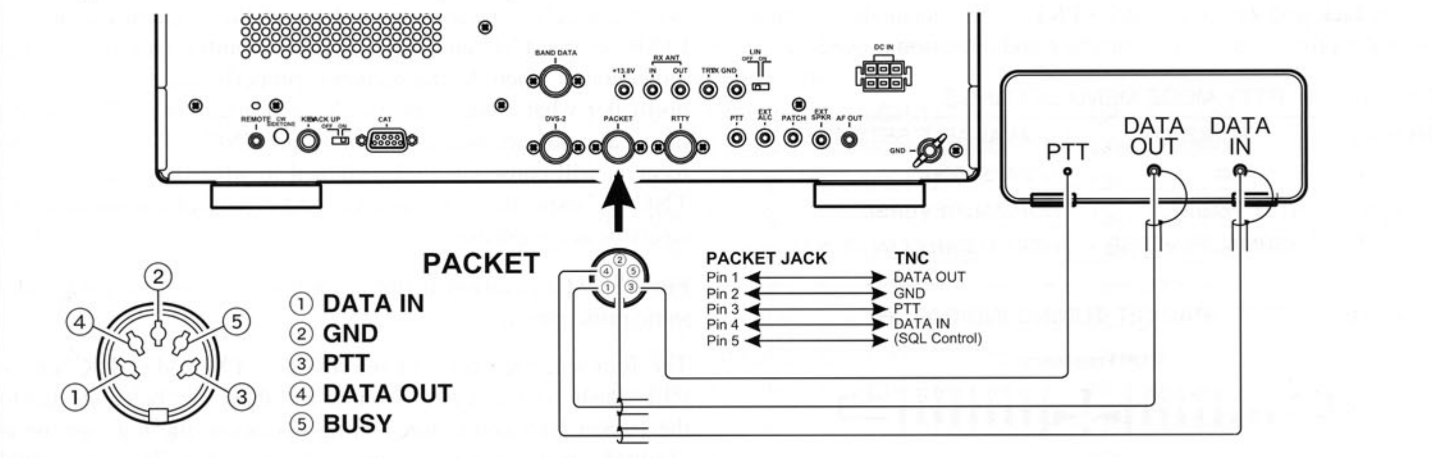


Fig. 12−4 : TNC CONNECTIONS (AFSK)



2. Connections for FSK RTTY Operation

Thanks to the very-fast-acting DDS circuits, a true frequency-shifted keying carrier generator is provided on the MARK-V 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 MARK-V 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 MARK-V 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.

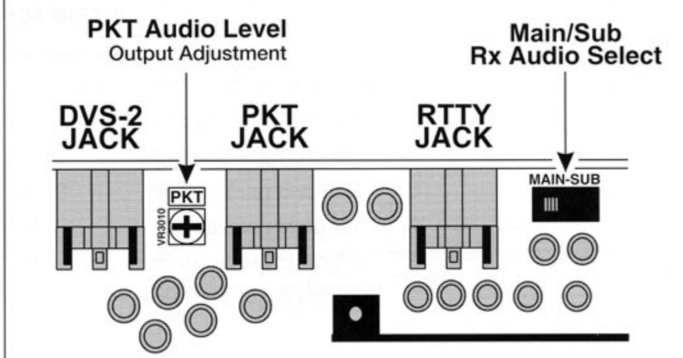
3. Generic Connections to PATCH/PTT/AF OUT Jacks

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 600 Ω. The Tip connector is Main Receiver audio, and the Ring connector is Sub Receiver audio.

Fig. 12−5 : SUB BAND RX AUDIO SELECTOR SWITCH (AF UNIT)



4. SSTV Scan Converter Connections

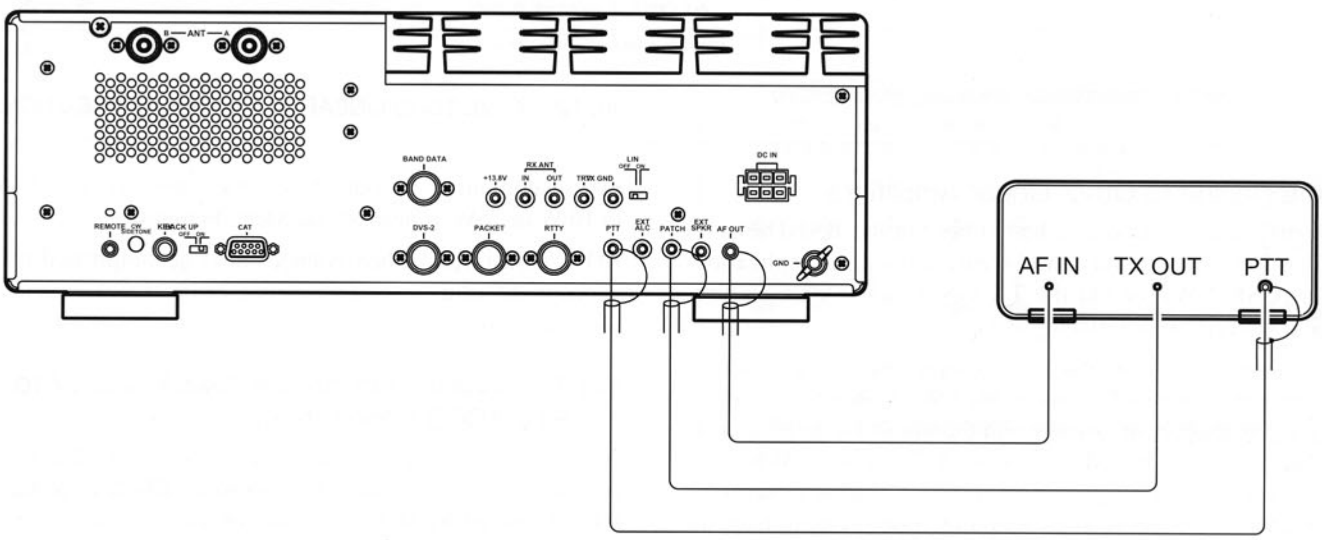
If your SSTV Scan Converter provides a microphone input, it is generally easiest to connect the TX Audio and PTT (and their grounds) via the front panel Mic Jack, and Receive audio and its ground via the AF OUT jack on the rear panel. Operation is identical to that described in the previous section;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

5. WeatherFax 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. 12−6 : SSTV SCAN CONVERTER CONNECTIONS



6. Linear Amplifier Interconnections

Thanks to the convenient jacks provided on the rear panel of the MARK-V 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 MARK-V:

•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 100 V DC at 500 mA, 60 VAC at 200 mA (AC or DC), or 30 V AC at 1 A, 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 MARK-V'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 VL-1000 Solid-State 1000W Linear Amplifier

Yaesu's VL-1000 Quadra System provides high reliability, and its 1000 Watts of output power capability provides a significant boost in signal strength. The VL-1000 operates on the 160-6 meter bands (USA version: 160-15, 6 meters).

T/R control, as well as automatic bandswitching data, are provided via Band Data cables supplied with the VL-1000. An RCA-to-RCA jumper cable is also required for connection of the ALC control line.

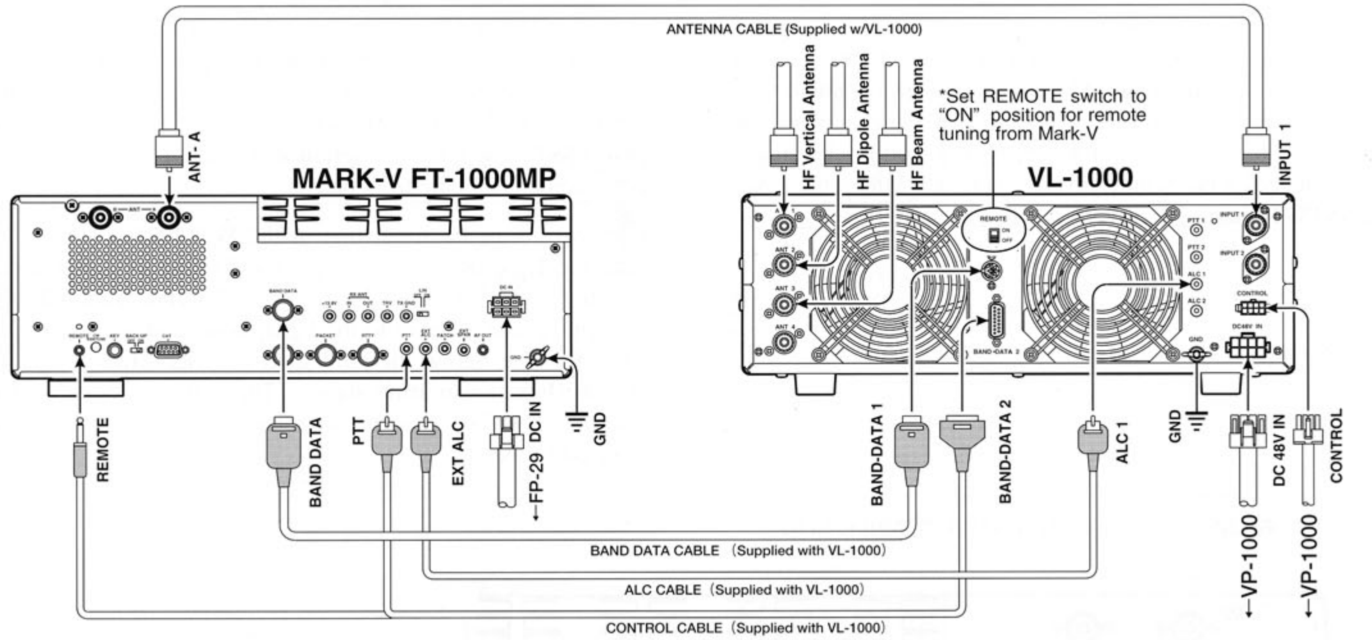


Fig. 12−7 : VL-1000 LINEAR AMPLIFIER CONNECTIONS

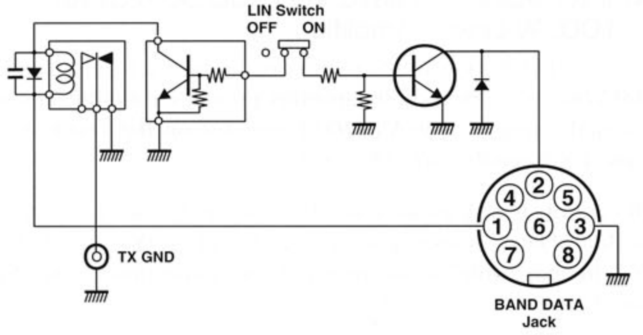
(B) Interfacing to Other Linear Amplifiers

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 #7-4 may be used to set a sequencing delay for the internal keyer of anywhere in the range 0~30 ms, so as to avoid activation of the MARK-V'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 #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 10 W, 75 W, or 200 W 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.

Fig. 12−8 : TX-GND CIRCUIT



•The maximum power output from the transceiver may be limited to 10 W or 75W, 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.

(C) Transverter Interfacing (See Page 47 for FTV-1000 Information)

A dedicated transverter interconnection jack (RCA type) is provided on the rear panel for providing RF drive to the Yaesu FTV-1000 50 MHz transverter, or 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 Menu, allows the final amplifier stage of the MARK-V to be disabled during transverter operation.

Table 12−2 : TRANSVERTER CONNECTIONS

1	TRV RF IN	Transverter TX RF Input (Typ. 50mV @ 50Ω) Connect to rear panel TRV Jack
2	RX ANT IN	Receive Converter RF Input Connect to rear panel (RX) IN Jack
3	ALC	External ALC Input Connect to rear panel ALC Jack
4	TX GND	Connection which closes to Ground on Transmit Use for T/R switching in transverter, if required. Positive voltage only, +40 V DC at <300 mA.

13. Top Panel Controls and Interconnection Jacks

The following controls are accessible beneath the removable panel on the top half of the transceiver case.

① HPA-S
This control sets the audio level available from the sub receiver to headphone jack A (3.5 mm plug).

② HPA-M
This control sets the audio level available from the main receiver to headphone jack A (3.5 mm plug).

③ HPB-S
This control sets the audio level available from the sub receiver to headphone jack B (1/4-inch plug).

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

⑤ TUN-M
This is a presetting control for the tuning meter.

⑥ FM MIC
During FM operation, this control adjusts the microphone gain (and transmitter deviation). More clockwise settings produce a wider bandwidth signal.

⑦ VOX
This control sets the gain of the VOX circuit, to set the level of microphone audio needed to activate the transmitter during voice operation while the VOX button on the front panel is depressed.

⑧ DLAY (VOX Delay)
This control sets the hang time of the VOX circuit, between the moment you stop speaking, and the automatic switch from transmit back to receive. Adjust this for smooth VOX so the receiver is only activated when you want to listen.

⑨ A-VOX (ANTI-VOX TRIP)
This control sets the level of negative feedback of receiver audio to the microphone, to prevent receiver audio from activating the transmitter (via the microphone) during VOX (voice-actuated transmit/receive switching) operation.

⑩ PKT
This control adjusts the tuning meter segment indications for Packet center tuning.

⑪ RTTY
This control adjusts the tuning meter segment indications for RTTY center tuning.

⑫ CW
This control adjusts the tuning meter segment indications for CW center tuning.

Fig. 13−1 : Top Control Panel

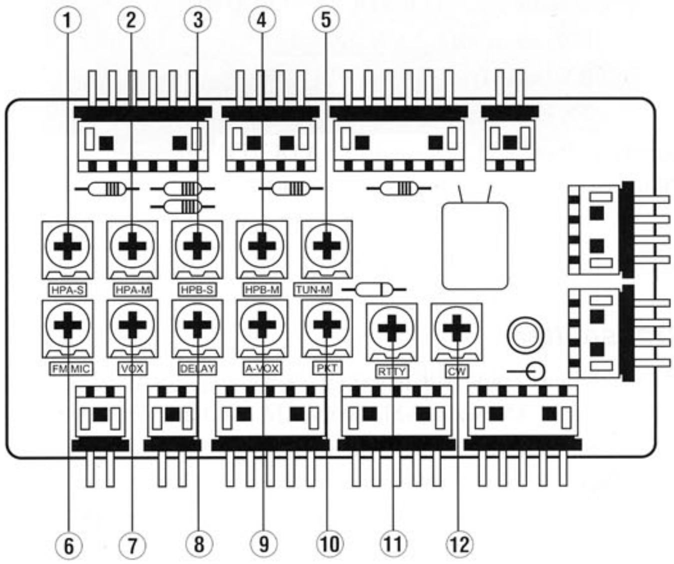
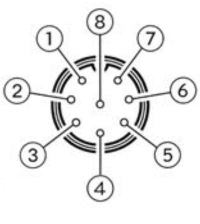


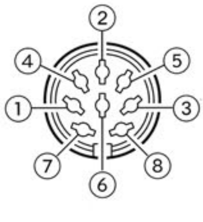
Fig. 13-2: Interface Connectors

MIC



① UP
② +5V
③ DOWN
④ FAST
⑤ GND
⑥ PTT
⑦ MIC GND
⑧ MIC

BAND DATA

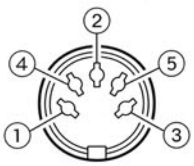


① +13V
② TX GND
③ GND
④ BAND DATA A
⑤ BAND DATA B
⑥ BAND DATA C
⑦ BAND DATA D
⑧ LINEAR

DVS-2

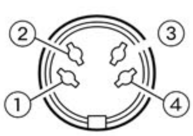
① VOICE IN
② VOICE OUT
③ PTT
④ +9V
⑤ CNTL 1
⑥ CNTL 2
⑦ GND

PACKET



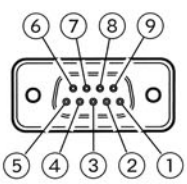
① DATA IN
② GND
③ PTT
④ DATA OUT
⑤ BUSY

RTTY



① SHIFT
② RX OUT
③ PTT
④ GND

CAT



① NC
② SERIAL OUT
③ SERIAL IN
④ N/A
⑤ GND
⑥ N/A
⑦ N/A
⑧ N/A
⑨ NC

General

RX Frequency Range : 100 kHz ~ 30 MHz

TX Frequency Ranges : 160 ~10 m (Amateur bands only)

Frequency Stability : ± 0.5 ppm (after 1 min. @ 25 ℃)
± 0.25 ppm
(after 1 min. @ 25 ℃, w/TCXO-6)

Operating Temperature Range : -10 ℃ ~ +50 ℃

Emission Modes : LSB, USB, CW, FSK, AFSK, 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 : 16.6~150 Ohms, unbalanced
(Tuner ON, TX only)

Power Consumption :

	13.8 VDC	30 VDC
RX (no signal)	2.3 A	–
RX (signal)	2.7 A	–
TX (200 W)	2.2 A	14.5 A

Supply Voltage : 30 VDC and 13.8 VDC (FP-29)

Dimensions (WHD) : 16 ″ x 5.3 ″ x 13.7 ″
(410 x 135 x 347 mm)

Weight (approx.) : 31 lbs. (14 kg.)

Transmitter

Power Output : Adjustable up to 200 watts
(50 watts AM carrier),

Class A mode (SSB) : 75 watts maximum

Duty Cycle : 100% @ 100 watts,
50% @ 200 watts (FM & RTTY, 3-minute TX)

Modulation Types: SSB: J3E Balanced,
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 and 1000 Hz

Harmonic Radiation : Better than -60 dB (Typical)

SSB Carrier Suppression : At least 40 dB below peak output

Undesired Sideband Suppression : At least 55 dB below peak output

Audio Response (SSB) : Not more than -6 dB from 400 to 2600 Hz

3rd-order IMD : - 31 dB @ 200 watts PEP, or better
(Class A mode) - 50 dB @ 75 watts PEP (Typical)

Microphone Impedance : 500 to 600 Ohms

Receiver

Circuit Type : Quad-conversion superheterodyne
(triple conversion for FM)

Intermediate Frequencies:
Main RX ; 70.455 MHz/8.215 MHz/455 kHz,
Sub RX ; 47.21 MHz/455 kHz

Sensitivity :

Modes	0.5 - 1.8 MHz	1.8 - 30 MHz
SSB/CW (2.0 kHz)	2 μV	0.16 μV
AM (6 kHz)	13 μV	2 μV
FM	–	0.5 μV

(with preamp on, IDBT on, SSB/CW/AM for 10 dB S/N, FM for 12 dB SINAD, 0 dBμ = 1 μV)

Selectivity (-6/-60 dB):

BandWidth	Modes	Min. -6 dB BW	Max. -60 dB BW
2.4 kHz	all except FM	2.2 kHz	4.2 kHz
2.0 kHz	all except FM	1.8 kHz	3.6 kHz
500 Hz	CW/RTTY/Packet	500 Hz	1.8 kHz
250 Hz	CW/RTTY/Packet	250 Hz	700 Hz
	AM (Wide)	4 kHz	14 kHz
	FM	8 kHz	19 kHz

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)

Maximum Audio Output : 2.0 W into 4 Ohms with <10 % THD

Audio Output Impedance : 4 to 8 Ohms

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

1. 200 Watt 50 MHz Transverter: FTV-1000

Now the exceptional performance of the Mark-V FT-1000MP can be enjoyed by the discriminating VHF operator! The FTV-1000 50 MHz Transverter brings an elite-class level of performance to the 50 MHz fan, with both high power (200 Watts) and superb receiver characteristics unmatched on other transverter designs.

The 50 MHz band is among the most challenging of Amateur bands in terms of design. Signals can be very weak, and many operators are fortunate enough to live in super-quiet locations, so excellent noise figure is required. But very strong signals are also commonplace, and operators in noisy locations need a radio that can deal with these obstacles well. The FTV-1000, when connected to the MARK-V, creates a quintuple-conversion superheterodyne system that promises you the best possible chances of snaring that rare DX during the high-sunspot times of Cycle 23.

And because you may be operating your FTV-1000 in a crowded environment where signal purity is important, the FTV-1000 includes provision for operation in Class A at 50 Watts of power output, producing an ultra-clean signal that will be the envy of everyone else on the band.

When coupled with the VL-1000 Quadra System Linear Amplifier, the FTV-1000 is the backbone of the most high-performance 50 MHz station setup available in the Amateur market today!

(A) FTV-1000 Receiver Front End: Engineered for Highest Performance

When the FTV-1000 is engaged, the converted 28 MHz energy is fed directly to the first mixer of the MARK-V FT-1000MP, without any intervening preamplification. This ensures best possible dynamic range throughout the conversion process.

In the FTV-1000 front end, one has a choice of preamplifier stages. For the best dynamic range, a four-FET preamp stage is provided, utilizing husky SST310 JFETs in a parallel, push-pull design.

In very low-noise applications such as EME (moonbounce), a pair of SGM20167 Gallium MES FETs are provided in a push-pull circuit, yielding both high gain and superb signal-to-noise ratio. And in strong-signal situations, the preamps may be bypassed, and 12 dB attenuator is also provided for local work.

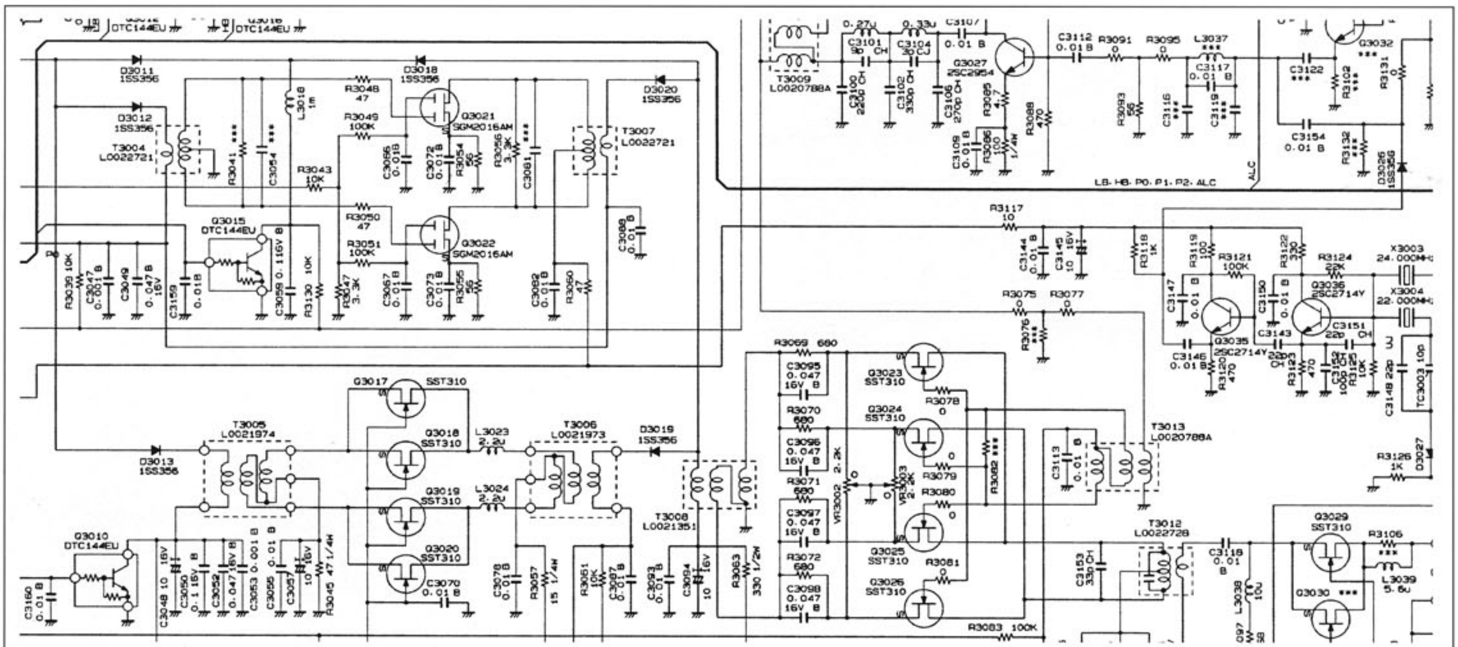
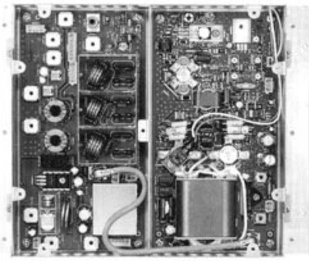


Fig. 15−1 : FTV-1000 Receive Converter Front End

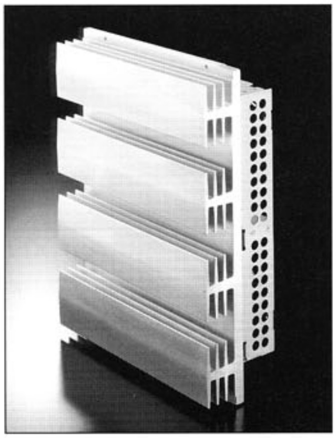
(B) 200-Watt High-Power Amplifier Stage

The FTV-1000's power amplifier stage mirrors that of the MARK-V, utilizing high-gain Philips® BLF147 Power MOS FETs driven by a BLF145 driver MOS FET. Providing a full 200 Watts of PEP output, the power amplifier stage utilizes the 30 Volt DC available from the FP-29 Power Supply, and when the FTV-1000 is turned on, the PA in the MARK-V is automatically disabled.

Cooling in the FTV-1000 is also similar to that in the main transceiver. A T-configuration heat-sink provides high dissipation of heat, and a thermostatically-controlled cross-flow fan ducts heat through the heat sink blades and out the rear of the transverter. The result is a transmitter system that runs cool even under the heavy duty cycle conditions of DX-pedition or VHF contest use.



●FTV-1000 Power Amplifier
Left : Low-Pass Filter
Right : PA Module

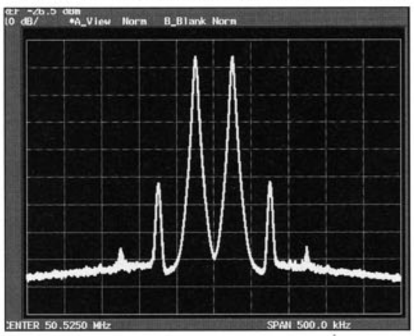


●Innovative "T" Heat Sink

(C) Ultra-Clean Class-A Bias Capability

Just like the MARK-V, the FTV-1000 includes an operating bias switch on the front panel, providing the operator with the option to select Class A operation. While operating Class A at 50 Watts of power output, 3rd-order IMD is typically suppressed by 50 dB, and the splatter-producing 5th-order IMD is typically 65 dB down or better.

Fig. 15−2 : 50 MHz Class-A IMD Performance



Using Class-A when driving a linear amplifier, of course, means that offensive splatter is not delivered to the linear for amplification, thus reducing the possibility that you will cause interference to other nearby operators.

(D) Ergonomic, Effortless Operation

The FTV-1000 sports an ergonomically-designed front panel, with easy-to-use rocker switches and clear, easily-understood panel labels. When you turn the FTV-1000 on, you automatically disconnect the PA in the MARK-V, without the need to push other switches or reset a menu selection. Both functional and attractive, the FTV-1000 is the perfect complement for the MARK-V, and there is no better transceiver/transverter combination available in the world today!

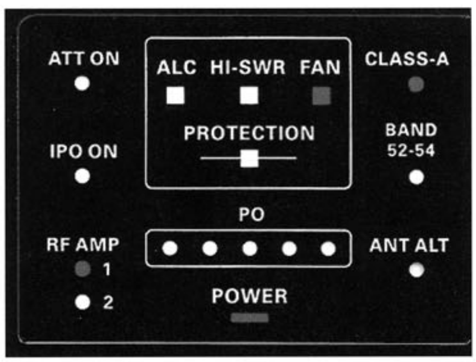
●Easy-Access Front Panel Controls

●Convenient Rear-Panel Interface Jack

(E) Protection Circuits and Indicators

The FTV-1000 includes extensive protection circuits designed to keep your transverter safely operating for many years. Its front panel includes a number of handy indicators which can alert you to anomalies in your station, so that corrective action may be taken. These include:

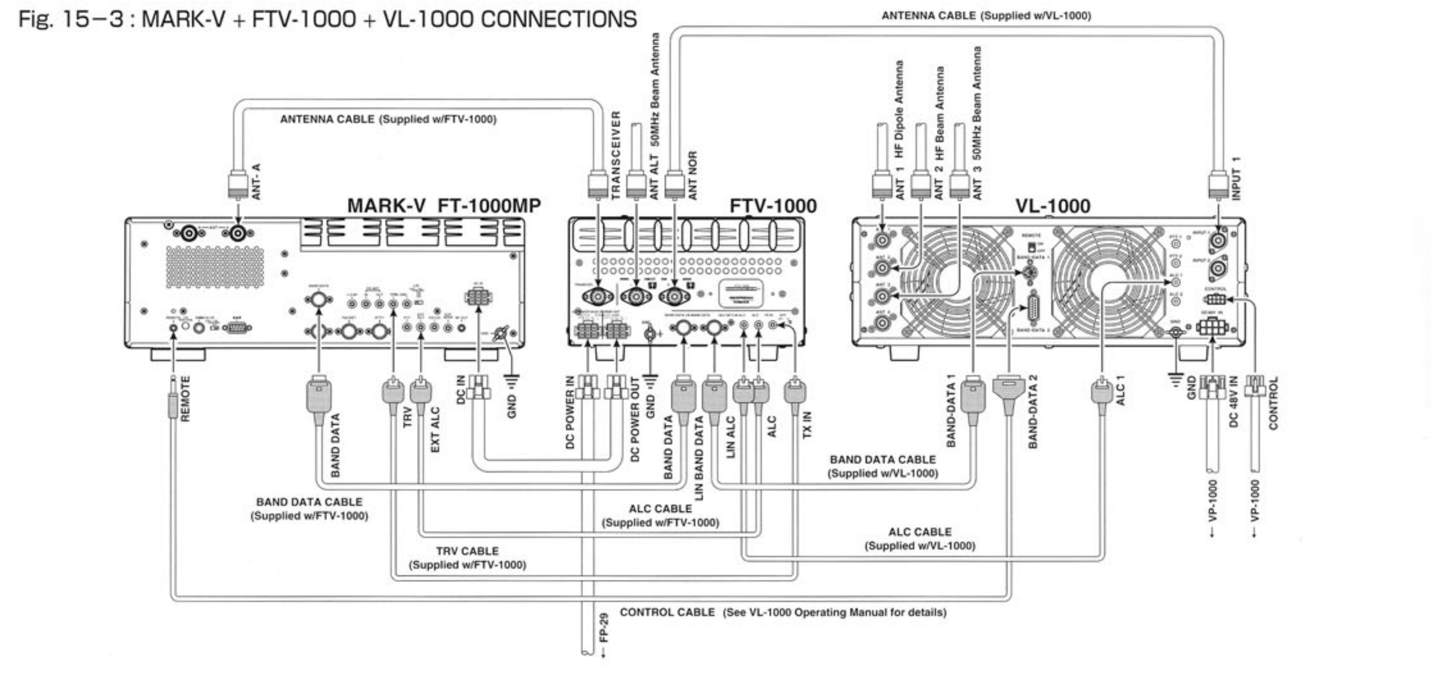
•ALC: This indicator appears when an abnormally-high ALC voltage condition is observed.
•HI SWR: This indicator lights up when the observed antenna system SWR exceeds 2.5:1.
•FAN: When the thermostat causes the cooling fan to become engaged, this indicator appears. The onset of fan operation does not necessarily indicate any problem.
•PROTECTION: If the power amplifier's heat sink reaches an abnormally high temperature, this indicator appears.
•PO: These five LEDs indicate the power output level.



(F) Two Antenna Jacks

The rear panel of the FTV-1000 contains two antenna jacks. The "NOR" jack may be connected to your HF antenna system, which will be fed through to the MARK-V whenever the FTV-1000 is turned off. The "ALT" jack may be connected to your 50 MHz antenna system, and will be the antenna selected for 6-meter operation. Or you can connect 50 MHz antennas to both ports, and connect your HF antenna(s) to the "B" antenna jack on the MARK-V, and the antenna port memory of the MARK-V will always keep your antenna selections properly configured.

Fig. 15−3 : MARK-V + FTV-1000 + VL-1000 CONNECTIONS



(G) 50 MHz Frequency Display on MARK-V

You may set up the MARK-V for display of the actual "50 MHz" frequency, using Menu #3-3. Although frequency conversion is to the 28-30 MHz band, the transceiver's display will show "50" as the operating band, making operation even more straightforward.

(H) Use with VL-1000 Quadra System for High Power Output

The FTV-1000 is completely compatible with the VL-1000 Quadra System Linear Amplifier, which will provide between 500 and 1000 Watts of power output on the 50 MHz band when driven by the FTV-1000. Interconnection is simple and straightforward, and full T/R and ALC control interfaces are provided.

(I) Specifications

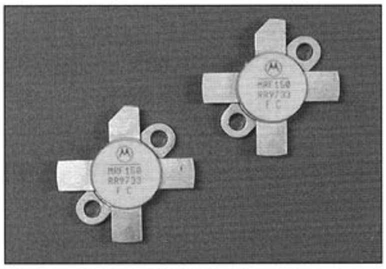
Frequency Range: 50-54 MHz
Antenna Impedance: 50 Ohms
Power Output: 200 Watts PEP
Spurious Emissions: At least 60 dB down
Power Source: DC 30 V and 13.8 V
(supplied by FP-29 Power Supply of MARK-V)
Dimensions: 9.8"x 5.4"x 13.1"WHD (248 x 136 x 332 mm)

2. HF/50 MHz 1 kW (50 MHz : >500 W) Linear Amplifier : VL-1000 Quadra System

When rare DX appears on any band between 160 meters and 6 meters, you need to activate your big 1 kW power amplifier fast. And while other DXers are waiting for their amplifier's "green light" to appear after warm-up, you'll already be filling out a QSL card if you own the VL-1000 Quadra System from Yaesu! Its solid-state, instant-on design gives you full power in seconds, and its conservative design is your assurance of reliable operation year after year.

(A) Innovative RF Design Featuring Quad Push-Pull Modules

Designing a power amplifier capable of reliable operation over the wide 1.8 - 54 MHz frequency range is a difficult challenge. Yaesu's engineers tackled the problem by adopting a conservative approach, using a pair of Motorola® MRF150 power FETs as a building block. Four such two-FET modules were then combined, producing a high-power linear amplifier with consistent power output, running at a fraction of its total output capability.



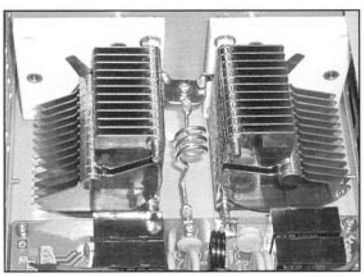
●High Output PA MRF150 FETs

(B) Microprocessor-Based High-Power Automatic Antenna Tuner

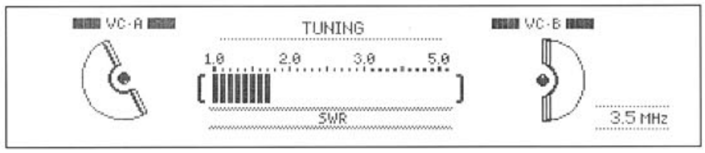
Controlled by a 16-bit microprocessor, the automatic antenna tuner in the VL-1000 provides lightning-fast resolution of the optimum values of inductance and capacitance so as to provide a satisfactory feedpoint impedance for your amplifier.

The carefully-designed software algorithms driving the tuning process quickly analyze the impedance presented by the antenna system, sending instructions to the stepping motors which drive the tuning capacitors, while simultaneously selecting inductance values which will resolve the complex impedance mismatch being corrected.

The status of tuning may be observed on the LCD, and a band-spanning "Before and After" tuning graph shows the effects of impedance matching performed by the auto-tuner.



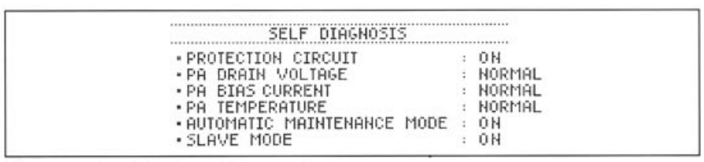
●Wide-spaced Variable Tuning Capacitors in 1 kW Automatic Antenna Tuner



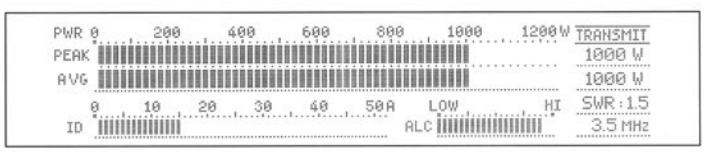
● "Auto-Tuning In Progress" Display

(C) Huge, High-Resolution Liquid Crystal Display Monitors Amplifier Status

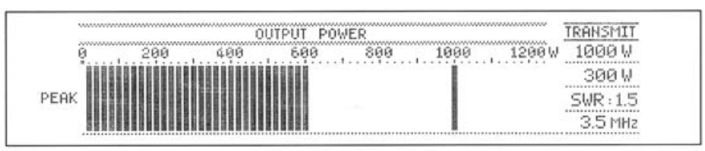
The VL-1000 front panel is highlighted by a huge 7 1/2" x 1 4/3" (190 x 43 mm) Liquid Crystal Display (LCD), which utilizes a high-resolution dot-matrix design that provides a wide range of amplifier status monitor selections. You can observe Peak and Average Power, SWR, final transistor Drain Current, ALC Voltage, T/R Status, and the operating band, and a self-test diagnostic menu appears each time the amplifier is switched on.



●Power-On Self-Test Diagnostic Screen



●Multi-Function Transmit Status Screen



●Peak-Hold Power Output Display

(D) Active Safety and Protection Features

To protect your VL-1000 from potential damage, and ensure operator safety, the VL-1000 provides a wide variety of protection sensors and circuits. The microprocessor constantly monitors heat sink temperature, antenna system SWR, and amplifier voltage/current, issuing an instantaneous, descriptive alert to the operator should an anomaly occur. But the VL-1000 is forgiving of minor problems, unlike other solid-state amplifiers: if the automatic antenna tuner is turned off, but the SWR rises just above 2:1, the VL-1000 will simply switch itself from High to Low power (500 Watts output), saving you the inconvenience of having to re-start the amplifier all over again.

●Typical Protection Alert Display

(E) Clean, High-Level Engineering Design

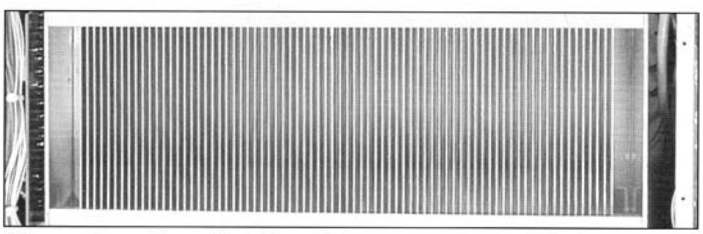
While many low-cost amplifiers operate near the edge of their design's capability, the Quadra System is designed with significant operating margins in all areas, ensuring both high reliability and spectral purity for your station's output signal. This conservative design approach gives you the confidence of knowing that your Quadra System is up to the challenge of high-duty-cycle CW contest operation, or week-long expedition use.

●Optional MR-1000 Rack Mount Minimizes Desk Space Requirements

(F) High-Quality, Self-Maintaining Switching Relays

In most high-power amplifiers, the switching relays are the components most prone to failure. In the Quadra System, high-quality, high-reliability relays are employed for all critical switching functions, and their long-term reliability is further enhanced by the Self Maintenance mode, which automatically "exercises" the relays periodically while the VL-1000 is turned off (the VP-1000 power supply must be engaged). The Self Maintenance mode helps prevent the build-up of contaminants on relay contacts which could lead to early failure.

(G) Direct Air Flow Cooling System



●Large-Area, Direct-Flow Heat Sink

To provide the most efficient intake of cooling air, and maintain a safe operating temperature for the amplifier components, the VL-1000 utilizes a large-area, direct-air-flow cooling system, enhanced by a pair of quiet, thermostatically-controlled cans which draw air across the power-generating devices. The result is a high-power amplifier system that runs cool even under high duty cycle operating conditions.

(H) Two Input and Four Output Antenna Connectors

The wide frequency coverage of the Quadra System requires the use of more than one antenna, yet many manufacturers only provide one antenna jack. The VL-1000 includes rear-panel "SO-239" (Type "M") jacks which can accommodate two different exciters, and up to four antenna connections. The antenna selection is automatically memorized when changing bands, eliminating the inconvenience of making manual antenna changes.

●Convenient Rear-Panel Interconnections

(I) Matching Power Supply: VP-1000

An amplifier system is only as good as its power supply, and the matching VP-1000 Switching Power Supply is a design masterpiece, perfect for the high-reliability expectations of the Quadra System owner. The VP-1000 provides 48 Volts DC at 48 Amps for the VL-1000's PA stage, along with +12 Volt and -12 Volt lines for control functions. The utilization of a separate power supply minimizes heat buildup in the amplifier compartment, thus enhancing reliability.

The VP-1000's utilizes eight 2SK1250 Power MOS FETs in a full bridge converter circuit design, providing the required 48 Amps of current from a package that only weighs about 32 pounds total (14.6 kg). Total current drain from the AC mains is approximately 14 Amps.

Designed for use worldwide, the VP-1000 is designed for operation from AC input sources of 100 Volts to 240 Volts without any re-wiring of internal connections!* Just connect your AC plug in accordance with local specifications, and you're on the air!

*Maximum power output when using 100-120 VAC is 500 Watts.

(J) VL-1000 Specifications

● GENERAL

Frequency Coverage:	Amateur Bands 1.8 ~ 54 MHz
USA Version:	1.8 ~ 21.45 MHz, 50 ~ 54 MHz
Power Output:	SSB/CW 1 kW, AM 250 W,
	FSK (RTTY)/FM 500 W(@AC 200-240V*)
	50 MHz: SSB/CW/FSK (RTY)/FM 500 W,
	AM 125 W
	* "Low" Power or 100-120V Operation:
	SSB/CW/FSK (RTTY)/FM 500 W,
	AM 125 W
Voltage Requirements:	DC +48V, DC +12V, DC -12V
Current Requirements:	48A (+48V), 2.8A (+12V), 0.1A (-12V)
Size (incl. feet/connectors):	16 1/4" x 6" x 17 3/4" WHD (413 x 151 x 451 mm)
Weight:	46.3 lb. (21 kg)

● LINEAR AMPLIFIER SECTION

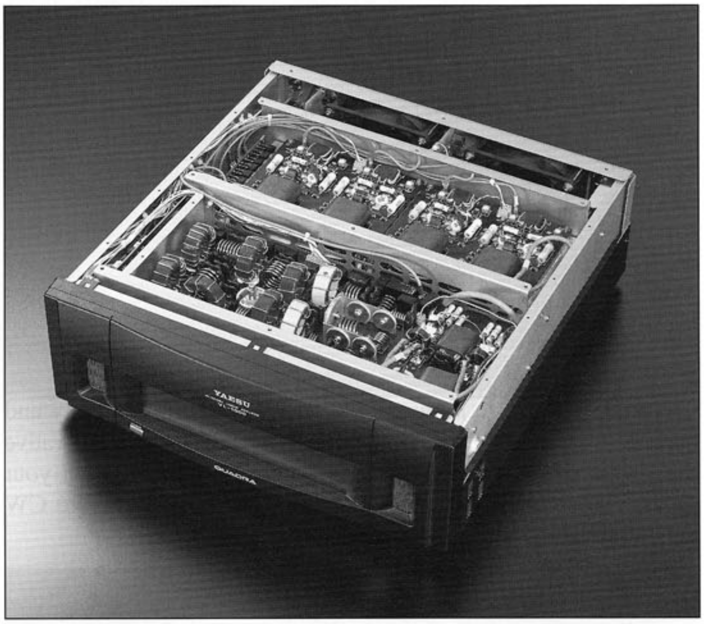
Power Input:	SSB/CW 2100 W, AM 550 W,
	FSK (RTTY)/FM 1100 W
	50 MHz: SSB/CW/FSK (RTTY)/
	FM 1100 W, AM 300 W
Drive Power (typical):	80 Watts
Spurious Emissions:	-50 dB or better (HF)
	-60 dB or better (50 MHz)
3rd-Order IMD:	At least 30 dB down

● AUTOMATIC ANTENNA TUNER SECTION

Input Impedance:	50 Ohms
Impedance Matching Range:	16.7 ~ 100 Ohms (1.8 MHz)
	25 ~ 100 Ohms (50 MHz)
	16.7 ~ 150 Ohms (HF bands)
Maximum Input Power:	1200 Watts
Insertion Loss:	Less than 0.5 dB
Max. Tuned SWR:	1.5:1 or less

(K) VP-1000 Specifications

Input Mains Voltage:	200-240 V AC or
	100-120 V AC (Automatic switching)
Output Polarity:	Negative Ground
Output Voltage:	DC +48V, DC +12V, DC -12V
Current Consumption:	14 A (1 kW @ 240 V or 500 W @ 120 V)
Size (incl. feet/connectors):	16 1/4" x 6" x 15" WHD
	(413 x 151 x 381 mm)



● MD-100A8X Desk Microphone

The MD-100A8X Desk Microphone is a high-performance, multiple-use microphone styled to match your MARK-V station. It includes an active filter circuit for high-frequency emphasis, along with two low-frequency cut-off filters, which may be used in conjunction with the EDSP Mic Equalizer in the MARK-V to focus the maximum amount of your voice waveform into useful power output. Whether your interest in in busting DX pile-ups, or enjoying high-fidelity rag-chews, the MD-100A8X is an ideal accessory for your leading-edge station!

Fig. 15–4 : MD-100A8X Block Diagram

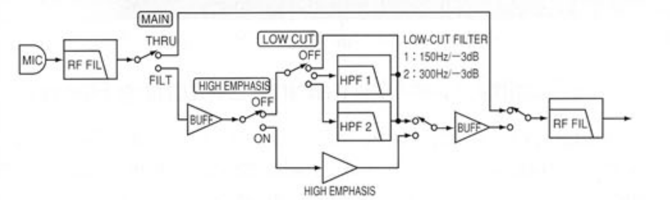
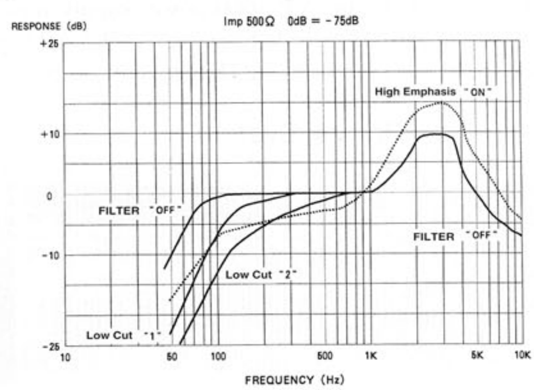


Fig. 15–5 : MD-100AX8 Mic Equalizer

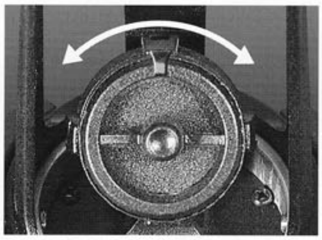


● MD-200A8X

The MD-200A8X is a stylish, high-quality Desk Microphone designed for base station use with the latest generation of Yaesu HF transceivers. The MD-200A8X employs a studio-quality Dynamic element, optimized for high-fidelity SSB operation, allowing faithful reproduction of the operator's voice during operation.

Yaesu's exclusive VSPC (Variable Side Pressure Control) allows the operator to adjust the frequency response of the microphone, from a totally-flat response to a high-articulation response with moderate peaking above 1500 Hz. The VSPC technique provides this response control without the distortion and reduced signal-to-noise ratio that can accompany active "equalizer" circuits.

The MD-200A8X includes provision for the incorporation of a user-supplied Dynamic, Magnetic, or Crystal microphone element, allowing selection of the supplied Dynamic element or the custom element. A slide switch on the base of the MD-200A8X allows easy switching between elements, as your operating needs change with band conditions.



●VSPC(Variable Side Pressure Control)Technique
(Patent Pending)

●"ON THE AIR" Red LED

●Rugged PTT Scaning Control

● SP-8 External Speaker

Providing a large (3.6" / 92 mm), high-quality external dynamic speaker for your MARK-V station, the SP-8 also includes a variety of passive high-cut and low-cut filters which can reduce fatigue and enhance signal-to-noise ratio in the audio line. Its controls are easy to preset for either SSB or CW, and you can also set up the response manually. What's more, the SP-8 can accommodate inputs from two different receivers. Both 1/4" and 3.5 mm headphone jacks are provided on the front panel.

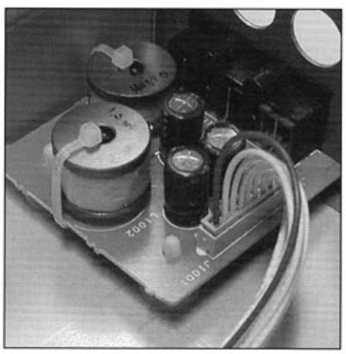


Fig. 15−6 : SP-8 Filter Block Diagram

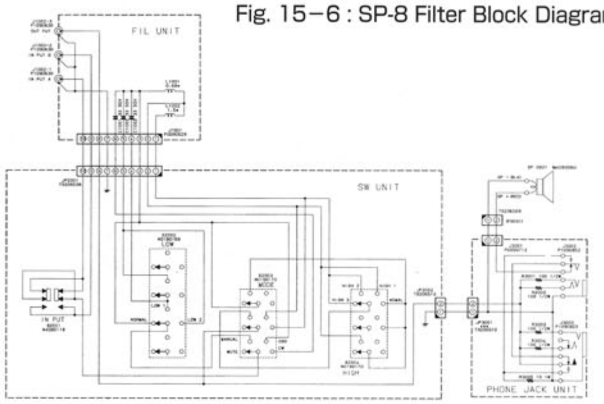


Table 15−1 : SP-8 Filter Characteristics

MODE		Filter Response
SSB		Rolls off frequencies above 2.4 kHz @ -6 dB/oct ave.
CW		Provides peaked response between 600 and 700 Hz.
MANUAL (FILTER)	LOW NORM	No modification of audio response.
	LOW 1	Rolls off frequencies below 300 Hz @ -6 dB/oct ave.
	LOW 2	Rolls off frequencies below 600 Hz @ -6 dB/oct ave.
	HIGH NORM	No modification of audio response.
	HIGH 1	Rolls off frequencies below 2.4 kHz @ -6 dB/oct ave.
	HIGH 2	Rolls off frequencies below 1000 Hz @ -6 dB/oct ave.
	HIGH 3	Rolls off frequencies below 700 Hz @ -6 dB/oct ave.
MUTE		Cuts off audio output from speaker, PHONES jacks, and LINE OUT jack.

● DVS-2 Digital Voice Recorder

A handy accessory for your MARK-V station is the DVS-2 Digital Voice Recorder, which allows recording and playback of both receiver audio and your own voice.

Capable of up to 16 seconds of recording time, the DVS-2 can store four 4-second or two 8-second "CQ Contest" type messages, contest exchanges, your callsign, or other information which you repeat often during contest operation. On receive, you can make a recording of the last 16 seconds of receiver audio, stopping the recording to verify the identification of a weak signal you've having trouble copying.

● FH-1 Remote Control Keypad

The FH-1 Remote Control Keypad is a multiple-use accessory which can greatly enhance the ease of operation of your MARK-V station.

The FH-1 may be used to engage the MARK-V's message memory electronic keyer function, for automatic sending of contest messages (including sequential serial numbers). The FH-1 may also be configured as a remote keypad for direct frequency entry to either the Main or Sub VFO, and it may also be used for extensive Memory/VFO control. The FH-1 connects, via a single cable, to the MARK-V's rear-panel REMOTE jack.

● TCXO-6 High-Stability Temperature-Compensated Reference Oscillator

For applications where exacting frequency accuracy and stability are required, the optional TCXO-6 provides incredible ±0.5 ppm stability from +32° F to +122° F (0° ~ +50° C), ideal for HF Packet or PSK-31 operation.

While the built-in TCXO affords (excellent) ±2 ppm stability from 14° to +122° F (-10° to +50° C), at 14 MHz this can amount to a frequency error of up to 28 Hz. By installing the TCXO-6, this frequency variance will be reduced to an incredible ±7 Hz!

● YH-77STA Stereo Headphones

For hours of listening comfort with your MARK-V, choose the YH-77STA Stereo Headphones. A lightweight open-air design, the YH-77STA will not cause fatigue like heavier "ear-muff" headphone types. What's more, you can take full advantage of the MARK-V's versatile audio separation and/or mixing capability while using Dual Receive. The YH-77STA comes equipped with a 3.5 mm miniature stereo plug, which fits directly into the "HEADPHONE A" jack on the front panel of the MARK-V, and an adapter for 1/4" jacks is also provided.

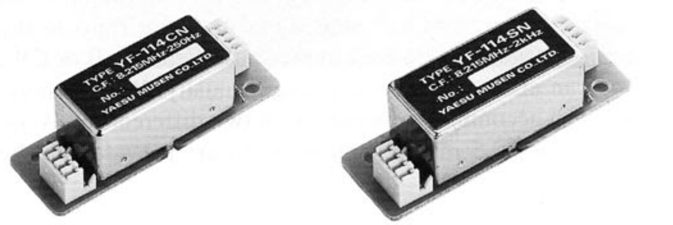
● IF Filter Options

YF-114SN 2nd IF (8.2 MHz) SSB Narrow Filter

Eight-pole crystal filter, 2.0 kHz bandwidth at -6 dB.

YF-114CN 2nd IF (8.2 MHz) CW Narrow Filter

Eight-pole crystal filter, 250 Hz bandwidth at -6 dB.



YF-110SN 3rd IF (455 kHz) SSB Narrow Filter

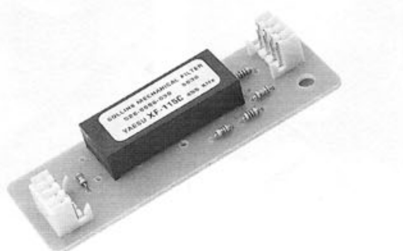
Eight-pole crystal filter, 2.0 kHz bandwidth at -6 dB.

YF-110CN 3rd IF (455 kHz) CW Narrow Filter

Eight-pole crystal filter, 250 Hz bandwidth at -6 dB.

YF-115C Collins® Mechanical CW Filter

Installs in the Main Receiver's 3rd IF (455 kHz), and also in the Sub Receiver for narrow-bandwidth CW pile-up spotting. Bandwidth is 500 Hz at -6 dB.

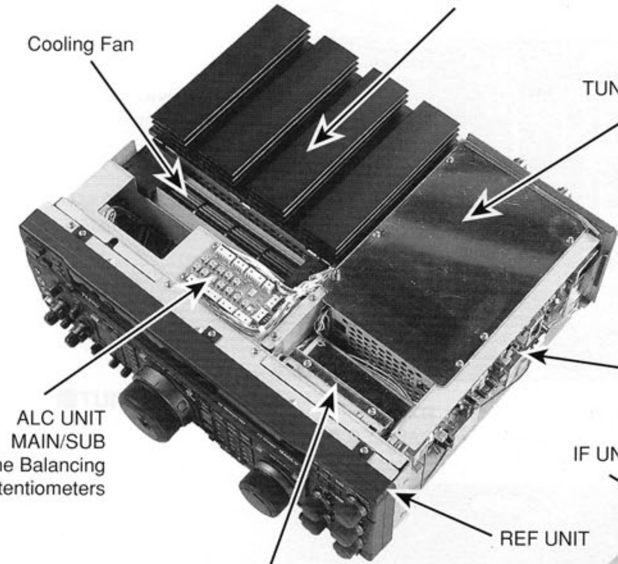


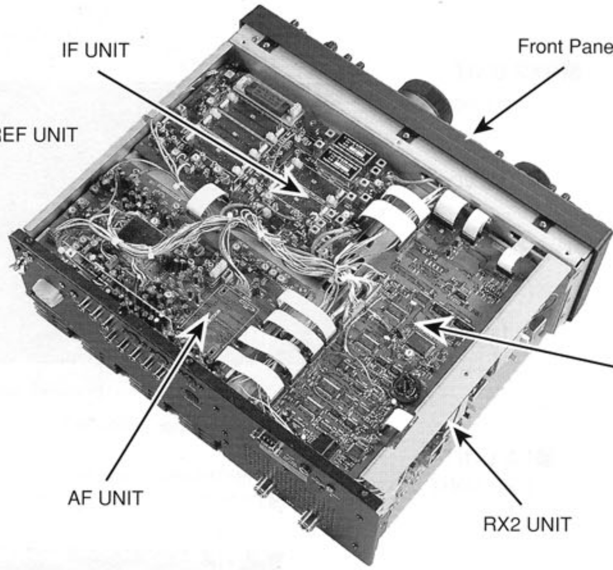
16. Dissecting the MARK-V

FRONT PANEL

REAR PANEL


MARK-V FT-1000MP
VERTEX STANDARD CO. LTD. MADE IN JAPAN
B — ANT — A
BAND DATA
RX ANT
+13.8V
IN
OUT
TRV
TX GND
LIN
OFF ON
DC IN
REMOTE
CW SIDETONE
KEY
BACK UP
OFF ON
CAT
DVS-2
PACKET
RTTY
PTT
EXT ALC
PATCH
EXT SPKR
AF OUT
GND





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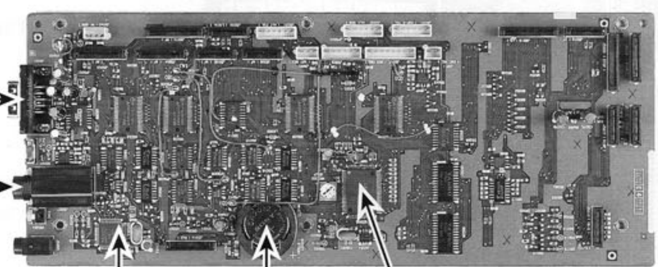
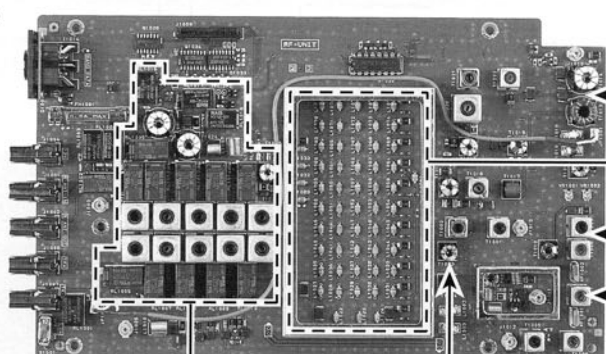


■RF UNIT



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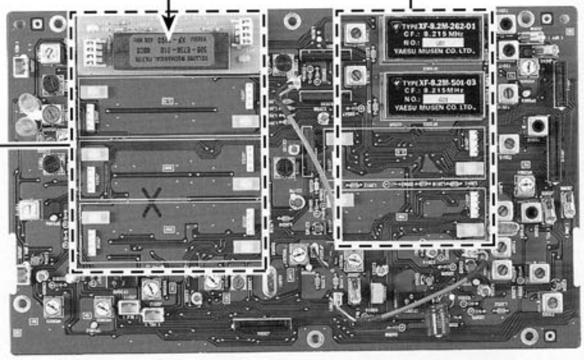

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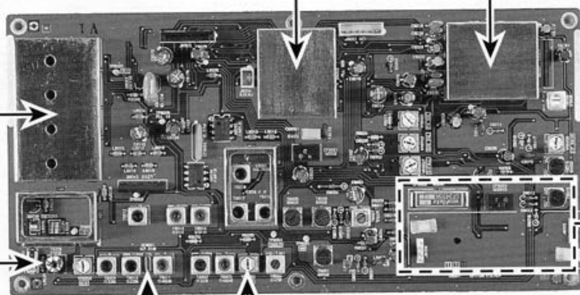

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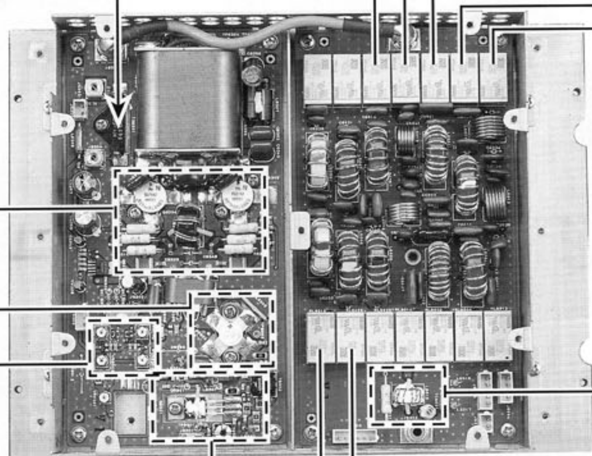

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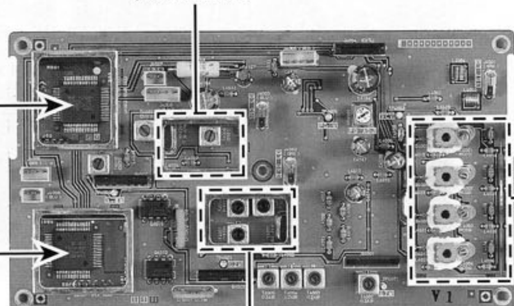

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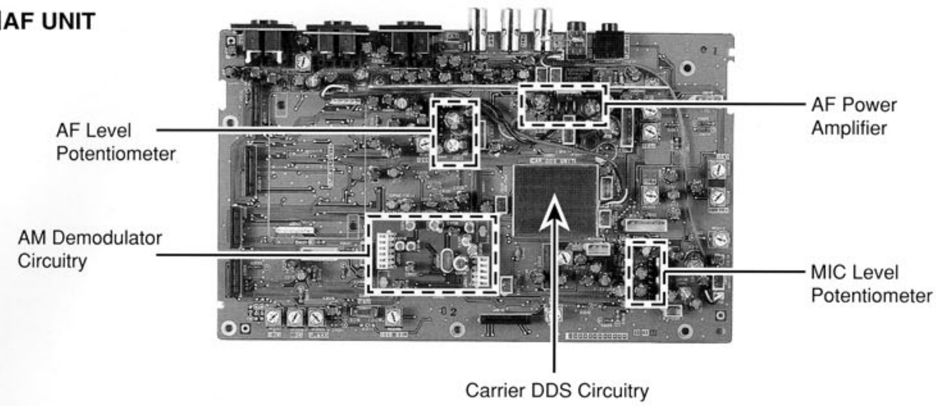

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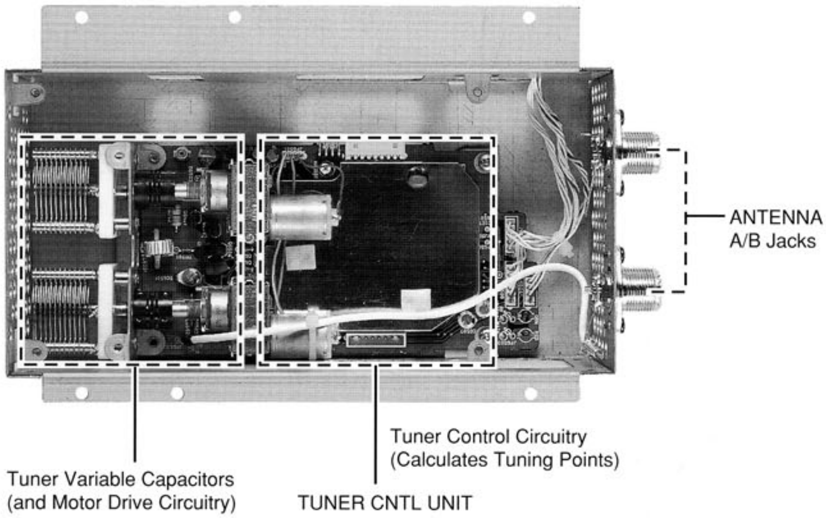

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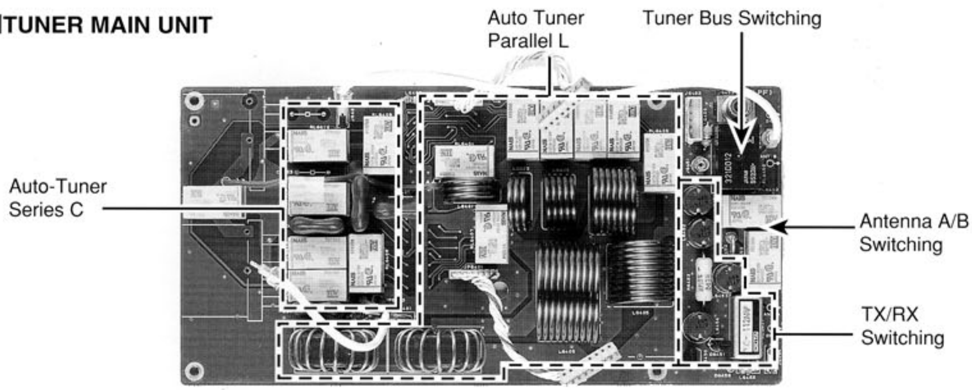
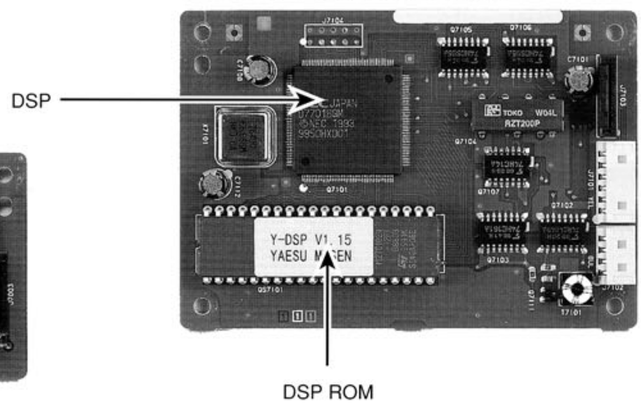
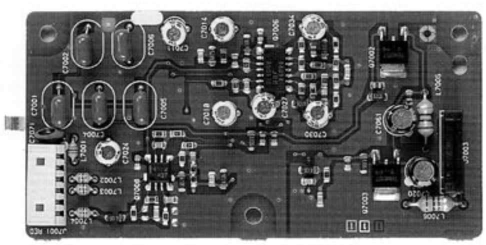


■DSP-D UNIT (Digital Section)



■DSP-A UNIT (Analog Section)

A-D、 D-A



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