# CQ REVIEWS:

# The Yaesu FT-One
## All-Mode Solid-State General-Coverage Transceiver
## Part I

**BY JOHN J. SCHULTZ*, W4FA**

*Because of the major nature of the FT-One, we are breaking tradition and running the review in two parts. W4FA has once again done a monumental job in preparing this review. Consequently, the manuscript and illustrations are quite voluminous. This unorthodox approach will allow us to present the review in its entirety.* —K2EEK

*The FT-One makes an impressive sight sitting on the operating desk.*

Yaesu Musen must believe that h.f. amateur communications still have a great future in store. Their FT-One transceiver not only carries a prestigious designation, but it is obviously packed with features, both electrical and constructional, that are designed to preserve its value for years to come.

To start, it must be said that most advertising photographs do not do complete justice to the transceiver as I realized after I saw the real thing. The front-panel color is a soft gray with the knobs being darker gray with aluminum skirts. The main digital display is yellow (not red as seen in some photographs), while the auxiliary digital display has red digits. The two panel meters have soft-green illumination. It is an impressive-looking unit that seems to combine a functional appearance along with a visually appealing aspect. That factor may, at least, help the situation a bit when you try to convince your non-amateur XYL or OM that you need a new transceiver costing about $2,500!

According to Yaesu's literature, their design project for the FT-One started about four years ago. The following quote from their literature gives a bit of interesting insight into what it must be for a company to get involved in a completely new transceiver design rather than just adding a few more "bells and whistles" to an existing design:

"As technology progressed, the design was revamped to take advantage of the more sophisticated devices available to the engineers. Finally, early in 1981, the last major component was soldered in place, and the arduous task of evaluating the final design in computer simulations and field torture tests was begun. Assembly line fixtures were built, computerized testing programs were debugged, and hundreds of thousands of parts were ordered. A proud research and development staff presented its report to their President: "We've done it!"

Of course, Yaesu did expect to spin-off a lot of the investment in design work, assembly tools, techniques, etc., involved in the FT-One in later transceiver designs, and one can already see this appearing in designs such as the FT-980 and FT-102. However, there doesn't seem to be much doubt that the FT-One will remain Yaesu's top-of-the-line h.f. transceiver for the foreseeable future.

### General

Table I gives the specifications for the FT-One. It is a long list and contains a lot of detailed information that readers might want to refer back to later on. In general, however, the FT-One represents a complete departure from the usual type of 9 MHz i.f. design transceiver Yaesu has produced over the years, which was limited to amateur-band-only coverage. The FT-One covers continuously the 150 kHz to 29.9999 MHz range on receive with tuning down to 100 Hz steps. On transmit, it covers fully all existing and proposed amateur bands and can be very easily modified for a full transmit capability from 1.8 to 29.9999 MHz for those amateurs who have a need for such a capability (e.g., MARS operation). It has provisions for s.s.b., c.w., a.m., FSK, and f.m. modes of operation with only the latter mode requiring an optional PC board instal-

*c/o CQ Magazine

**TRANSMITTER**

**Frequency range:**

| | |
|---|---|
| 160m band | 1.8 to 2.0 MHz |
| 80m band | 3.0 to 4.0 MHz |
| 40m band | 7.0 to 8.0 MHz |
| 30m band | 10.0 to 11.0 MHz |
| 20m band | 14.0 to 15.0 MHz |
| 17m band | 18.0 to 19.0 MHz |
| 15m band | 21.0 to 22.0 MHz |
| 12m band | 24.0 to 25.0 MHz |
| 10m band | 28.0 to 29.99 MHz |

**Tuning steps:**
Selectable 1 MHz, 100 kHz, 100 Hz, 10 Hz

**Emission types:**
LSB, USB (A3J/J3E*), CW (A1/A1A*), AM (A3/A3E*), FSK (F1/F1B*), **FM (F3/F3E*)
* New emission designation per WARC '79
** With optional FM unit installed.

**Power output (minimum):**

| | 160m through 15m | 10m |
|---|---|---|
| SSB, CW | 100W (PEP) | 90W (PEP) |
| AM | 25W | 25W |
| FM, FSK | 50W | 50W |

**Carrier suppression:**
better than −40 dB below peak output.

**Unwanted sideband suppression:**
better than −50 dB below peak output, (measured at 14 MHz, 1 kHz tone)

**Non-harmonic spurious radiation:**
better than −40 dB below peak output

**Harmonic radiation:**
better than −50 dB below peak output

**Audio response:**
better than −6 dB from 300 Hz to 2700 Hz

**3rd order intermodulation distortion:**
better than −31 dB below peak output

**Frequency stability:**
less than 300 Hz drift during the first 30 minutes after 10 minutes warm-up; less than 100 Hz every 30 minutes thereafter.

**Modulation type:**
A3J: Balanced Modulator
A3: Low Level Modulation
F3: Variable Reactance

**Maximum deviation (FM, optional Unit installed):**
±5 kHz

**FSK shift frequency:**
170 Hz.

**Output impedance:**
50 ohms, unbalanced (nominal)

**Microphone impedance:**
Low Impedance (500 to 600 ohms)

**RECEIVER**

**Frequency range:**
150 kHz to 29.9999 MHz (continuous)

**Clarifier range:**
±9.9 kHz

**Sensitivity:**
(CW, SSB, and AM figures measured for 10 dB S+N/N)
* 1.8 to 30 MHz ** 150 kHz to 1.8 MHz
SSB/FSK(W)/CW(W)
* better than 0.3 μV, ** better than 5.0 μV
CW(N)
(with optional XF-8.9KCN filter installed)
* better than 0.2 μV, ** better than 2.5 μV
CW(M)/FSK(N)
(with optional XF-8.9KC filter installed)
* better than 0.25 μV, ** better than 3.0 μV
AM
* better than 2.0 μV, ** better than 30 μV
AM
(with optional XF-8.9KA filter installed)
* better than 3.0 μV, ** better than 50 μV
FM
(with optional FM unit installed)
better than 20 dB of Quieting from 1.8 to 29.99 MHz

**Intermediate frequencies:**

| | |
|---|---|
| 1st IF: | 73.115 MHz |
| 2nd IF: | 8.9875 MHz |
| Width/shift IF: | 10.76 MHz |
| Noise Blanker IF: | 455 kHz |
| FM IF (with optional FM unit installed): | 455 kHz |

**Image rejection:**
better than −80 dB

**IF rejection:**
better than −70 dB for all frequencies

**Selectivity:**

| | −6 dB | −60 dB |
|---|---|---|
| SSB, CW(W), FSK(W) | 2.4 kHz | 4.0 kHz |
| CW(N)* | 300 Hz | 900 Hz |
| CW(M)*, FSK(N)* | 600 Hz | 1.2 kHz |
| AM* | 6 kHz | 10 kHz |
| FM** | 12 kHz | 24 kHz |

* with optional filter installed
** with optional FM unit installed
NOTE: These figures apply as maximum bandwidths with Width control set to maximum.

**RF attenuator performance:**
from 0 dB to 25 dB attenuation, continuously adjustable

**Dynamic range:** (at maximum sensitivity)
better than 90 dB with standard SSB filter
better than 95 dB with optional 600 Hz CW(M) filter
better than 97 dB with optional 300 Hz CW(N) filter

**Audio output power:**
3-watts minimum (into 4 ohms, with less than 10% THD)

**Audio output impedance:**
4 to 16 ohms

**POWER REQUIREMENTS**

**Voltage:**
AC: 100 to 120V, or 200 to 234V; 50 to 60 Hz
DC: 13.5V ±10%, negative ground

**Power consumption:**

| | AC | DC |
|---|---|---|
| Receive | 90 VA | 2.7 A |
| Transmit (100W output) | 560 VA | 20 A |
| Backup (Power Switch OFF) | 3.5 VA | 0.07 A |

**Dimensions (WHD):**
approximately 370mm x 157mm x 350mm; 380mm x 165mm x 465mm with all feet, knobs and heatsink

**Weight:**
approximately 17 kg.

*Table I– FT-One specifications.*

lation. The minimum *output* power is 100 watts except on f.m. and FSK where it is 50 watts and a.m. where it is 25 watts. It is self-contained in the sense that a.c. (110/220 v.a.c.) and d.c. power supplies, cooling fan, a speaker, and optional electronic keyer are or can be built in. So, for instance, if one were using one of the newer beam antennas which provide very flat s.w.r. curves across an amateur band, one only has to add a microphone and paddle to the FT-One for s.s.b., c.w., a.m. and f.m. operation. The transceiver is completely "no-tune" in every sense for both receive and transmit operation and doesn't even have a bandswitch. The main frequency readout is on a six-digit display with an analog kHz display on the skirt of the main tuning knob.

Considering some of the foregoing, one may then wonder what functions are played by the myriad, although neatly arranged, rotary controls, switches, pushbuttons, etc., on the front panel of the FT-One. They do, of course, have to do with all sorts of features contained in the transceiver, ranging from now commonplace VOX to advanced features dealing with frequency selection and storage. It takes a bit of time to appreciate how to use all the features for maximum flexibility. They are probably best highlighted and explained as a basic look is taken at the circuitry of the FT-One and then later on as performance impressions are given. However, a summary of the main features besides the frequency coverage, power, and mode capabilities just mentioned are:

1. Dual v.f.o. system with the equivalent of 10 internal v.f.o.'s.
2. Tuning steps of 10 Hz, 100 Hz, or 1 MHz, using the main tuning knob.
3. Entry of frequencies into memory from keyboard or from tuning-knob setting. Recall of frequencies by keyboard command or rotary v.f.o. switch selection.
4. Manual scanning using keyboard switches or automatic scanning with a stop-on-signal feature.
5. Full cross-band or split-frequency operation using different sidebands, if desired, and with full break-in on c.w.
6. R.f. attenuator using a PIN diode.
7. Active IC audio filter for peak/notch functions over the 300–1500 Hz range.
8. RIT (clarifier) with a ±9.9 kHz range.
9. A.g.c. selection for slow-fast-off.
10. Variable i.f. bandwidth tuning allowing control of passband width and placement (about 400–2400 Hz width adjustment).
11. Provisions to accommodate optional c.w., FSK, and a.m. i.f. filters.
12. Adjustable VOX and c.w. delay down to full break-in on c.w.
13. Noise blanker with adjustable threshold.
14. R.f. speech processor with compression adjustment.
15. Microphone squelch circuit to cut out background noise during speech pauses.
16. Dual metering with one meter serving as a multimeter (to include s.w.r.) and the other meter dedicated as an "S" meter on receive and a.l.c. level meter on transmit.
17. Full provisions for the connection of external equipment—linear, transverters, etc.

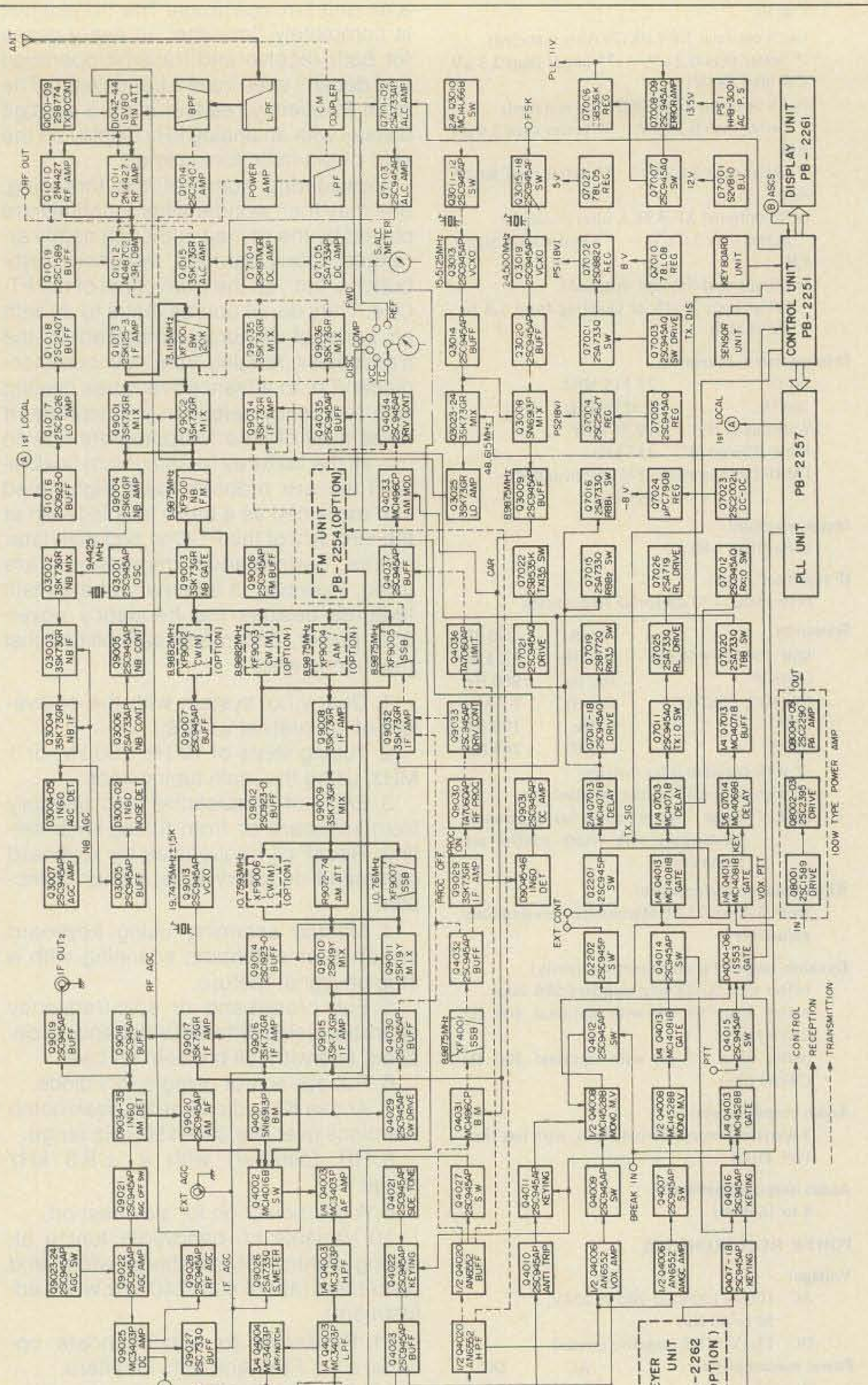


*Fig. 1– Overall block diagram of the FT-One.*

## Circuitry

A block diagram for the FT-One is shown in fig. 1. The diagram looks overwhelming at first, but by following a few of the signal paths indicated, one can at least understand the basic circuit scheme used and appreciate a few of the novel ideas which are incorporated.

Referring to the upper right-hand corner (antenna input) of the block diagram, one can trace the receive signal path as going to a fixed low-pass filter (to reduce TV/image overload), then to a bandpass filter block containing 10 diode-switched filters, through the PIN diode antenna block, and on to a pushpull 2N4427 r.f. amplifier stage. The signal then proceeds on to a double-balanced mixer (Q1012) where it is translated up to the first i.f. at 73.115 MHz. Fig. 2 shows some details of the "front-end." The diagram is rather complex, but one can see the rather elaborate bandpass filter block on the left. The filters are switched in or out according to band data information from the microprocessor in the FT-One. The 10 bandpass filters, starting from the top, are divided into frequency ranges of:

| | |
|---|---|
| 1. 1.8 MHz and below | 6. 5.0–7.0 MHz |
| 2. 1.8–2.0 MHz | 7. 7.0–10.0 MHz |
| 3. 2.0–3.0 MHz | 8. 10.0–14.0 MHz |
| 4. 3.0–4.0 MHz | 9. 14.0–20.0 MHz |
| 5. 4.0–5.0 MHz | 10. 20.0–30.0 MHz |

The interesting push-pull r.f. amplifier using 2N4427's is shown in the middle of the diagram. It uses broadbanded input/output transformers. The PIN diode variable attenuator is immediately before the input transformer and consists basically of diodes D42, 43, and 44. The functions of the rest of the stages can be ascertained by comparing fig. 2 with the block markings on fig. 1. XF01, at the lower right of fig. 2, is the 73.115 MHz, 20 kHz wide i.f. crystal filter.

The 73 MHz i.f. is then translated to a 8.9882 MHz i.f. where the main signal selectivity in the FT-One takes place. Just to the right of the middle in fig. 1 one can see the various blocks which represent the standard 8.9882 MHz crystal s.s.b. filter and the optional a.m., c.w.-medium and c.w.-narrow crystal filters. The i.f. signal then flows through an up-down mixing arrangement employing an s.s.b. crystal filter at 10.76 MHz (or optional c.w. crystal filter) so the "windows" of the 8.9882 MHz filter and 10.76 MHz filter can be superimposed on each other to achieve variable passband tuning. In addition to having the bandwidth variable, an i.f. shift feature is accomplished by having the frequency of the second local oscillator made slightly variable (see Q3013 in the right middle of the diagram). After the variable passband tuning stages, the signal goes on to several stages of i.f. amplification at 8.9882 MHz and then on to the various a.m. and s.s.b. detector stages, peak/notch filter circuits, and a.f. amplifier stages. There are a great many other stages associated with the receive signal path which have to do with the "hang" a.g.c. action and, particularly, gain equalization in the i.f. stages so the switching in of different filters does not change the apparent overall gain. Other circuitry provides for various frequency offsets depending on the mode of operation so the frequency readout remains correct.

The noise blanker circuitry is a bit different from that found in most transceivers in that the 8.9875 MHz i.f. signal is translated down to a 455 kHz i.f., the noise signal detected, and the detected/rectified signal used to drive a gate

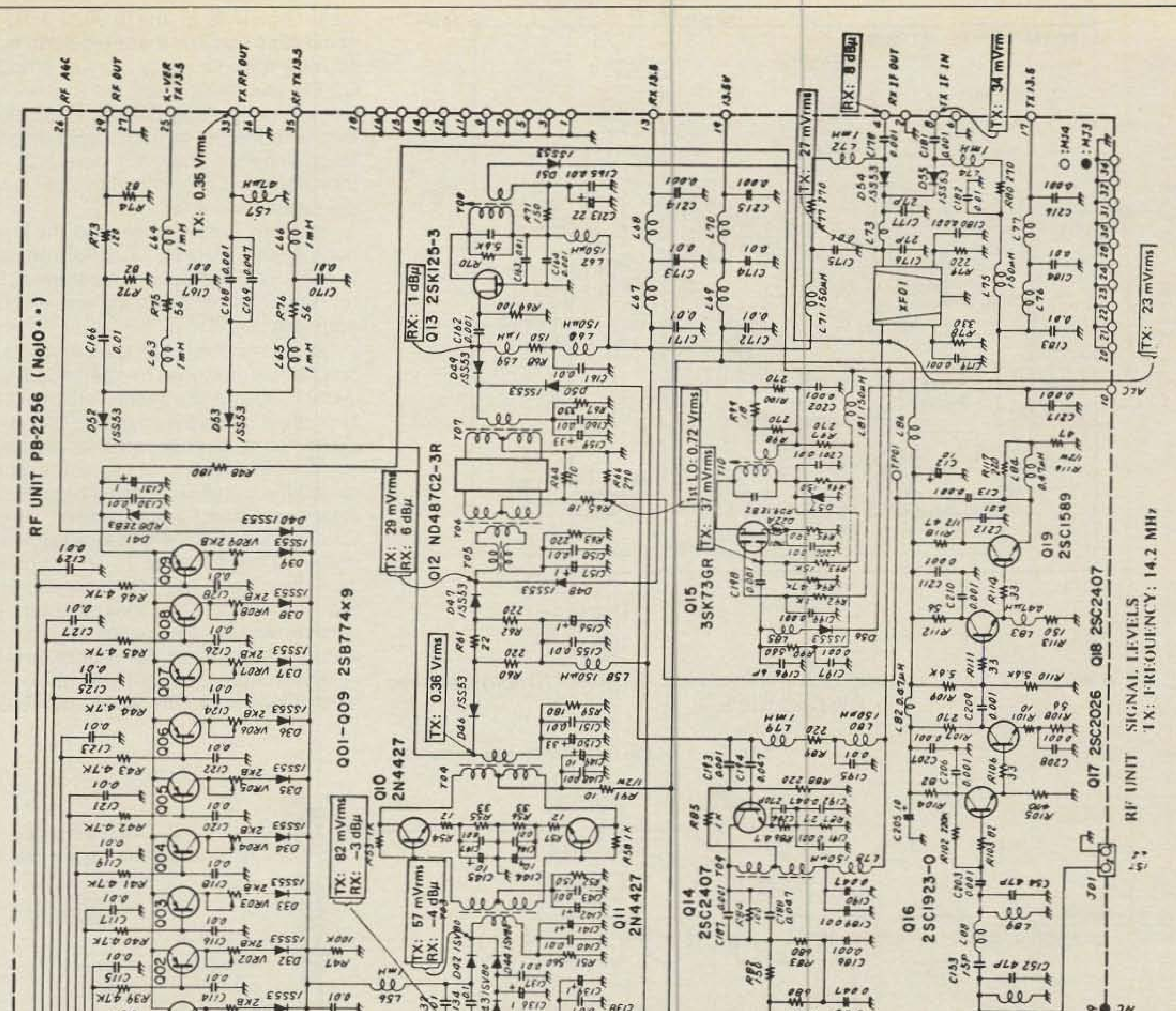



*Fig. 2– The "front end" of the FT-One. It is also an interesting example of one of the large PC boards.*

stage which is in the 8.9875 MHz i.f. chain. One can see these blocks in fig. 1, starting with the noise blanker amplifier Q9004 and looping around to the noise blanker gate stage Q9003. Presumably this is done to stretch noise impulse lengths before they are detected. The threshold level at which the noise blanker operates is variable.

If the f.m. option is installed, the broadband 8.9875 MHz i.f. signal is translated to 455 kHz, goes through a ceramic i.f. filter, and then on to limiting and discriminator stages.

On the transmit side, the amplified microphone signal goes to a balanced modulator (Q4031 in the middle left side of fig. 1) where it modulates the 8.9875 MHz i.f. signal. S.s.b. is produced after crystal filter XF4001. The s.s.b. signal is either routed through the r.f. speech processor stages or directly to transmit mixers Q9035 and Q9036 where it is translated to the 73 MHz i.f. The 73 MHz signal is then mixed with the first local oscillator signal to produce the desired output frequency, which then passes through one of the nine bandpass filters, as used in the receive mode, which cover 1.8 to 30.0 MHz. Essentially, the whole process is

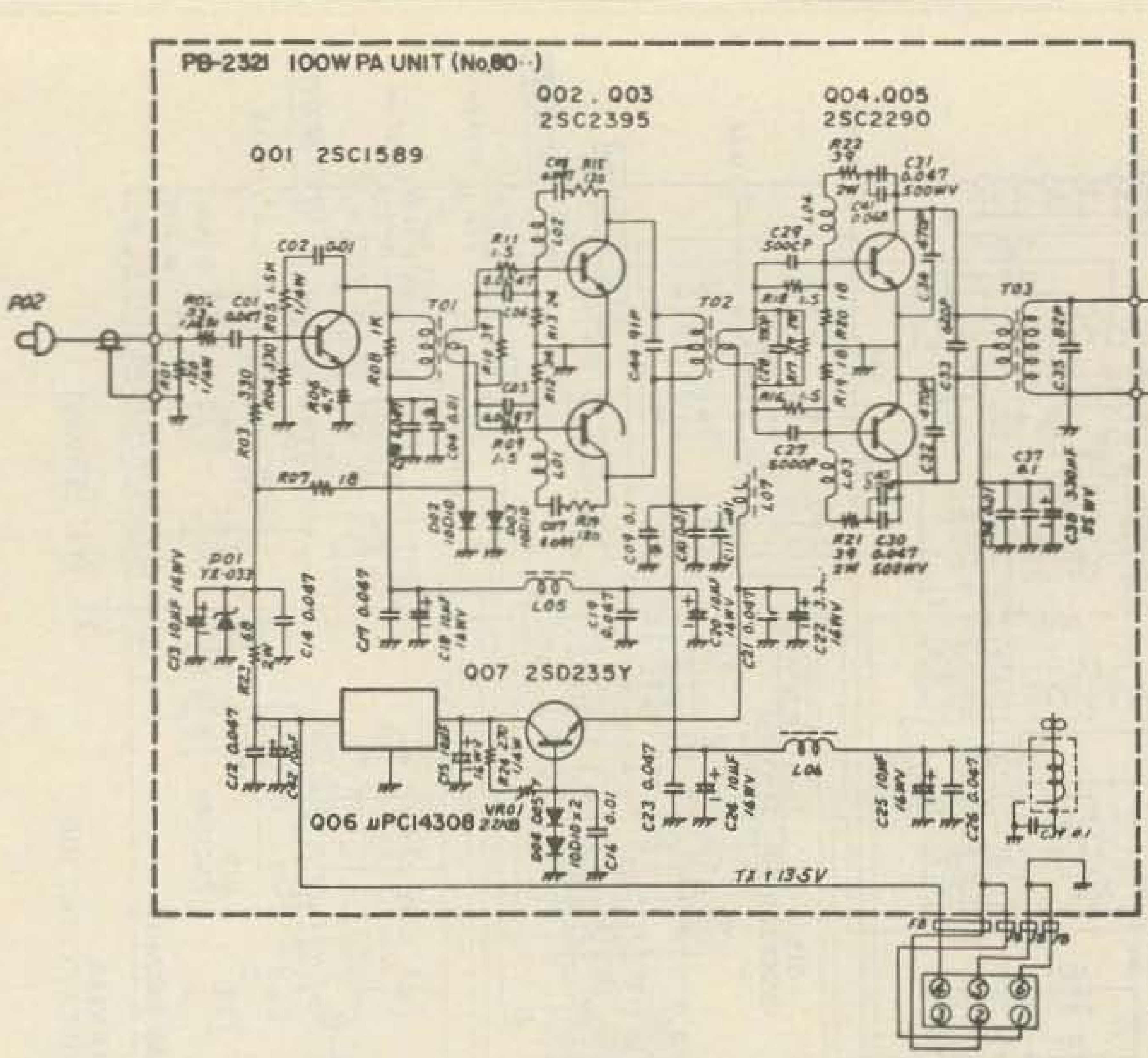
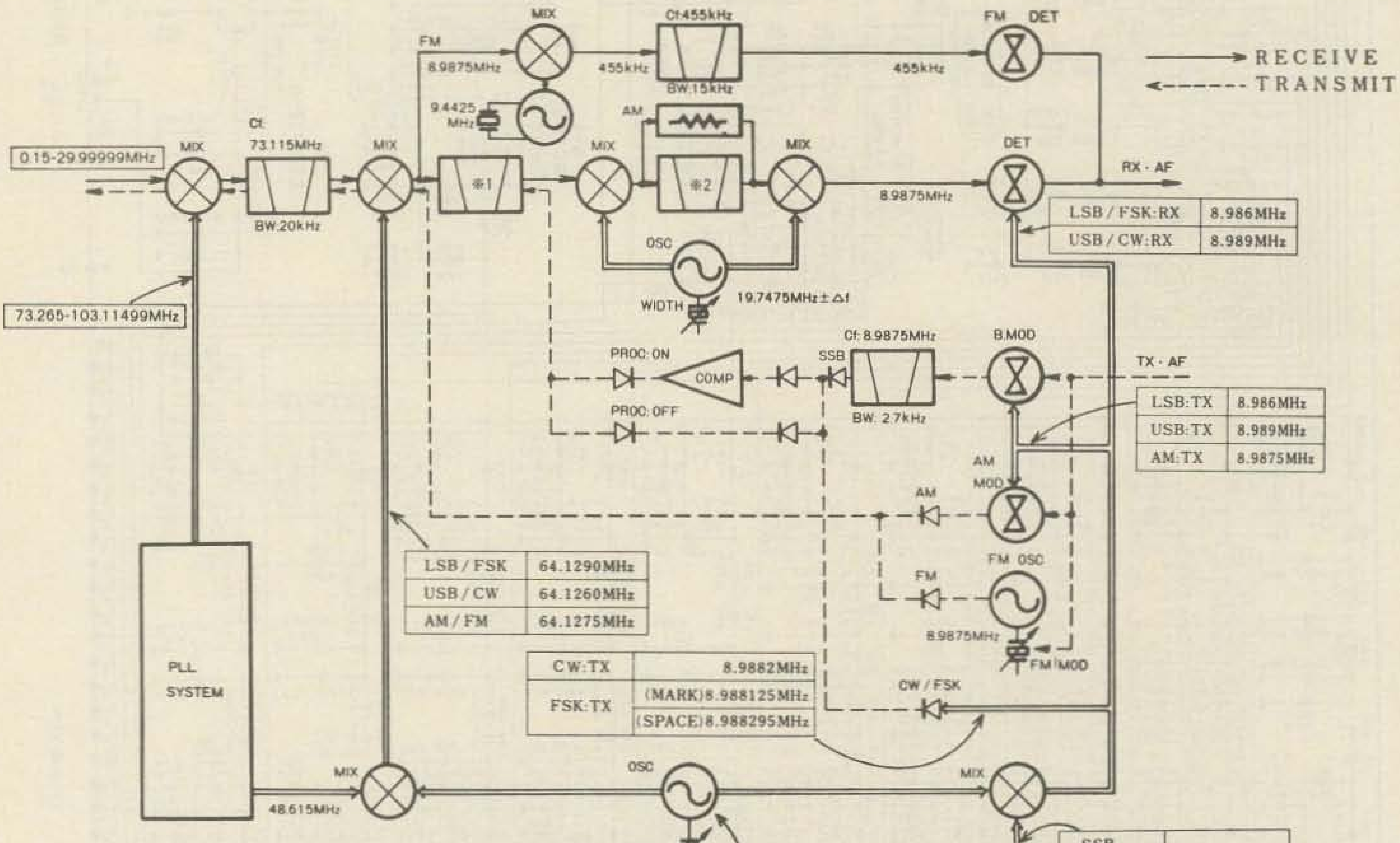



*Fig. 3– The 100 watt power amplifier unit. It is followed by a bank of 10 relay-switched low-pass filters.*

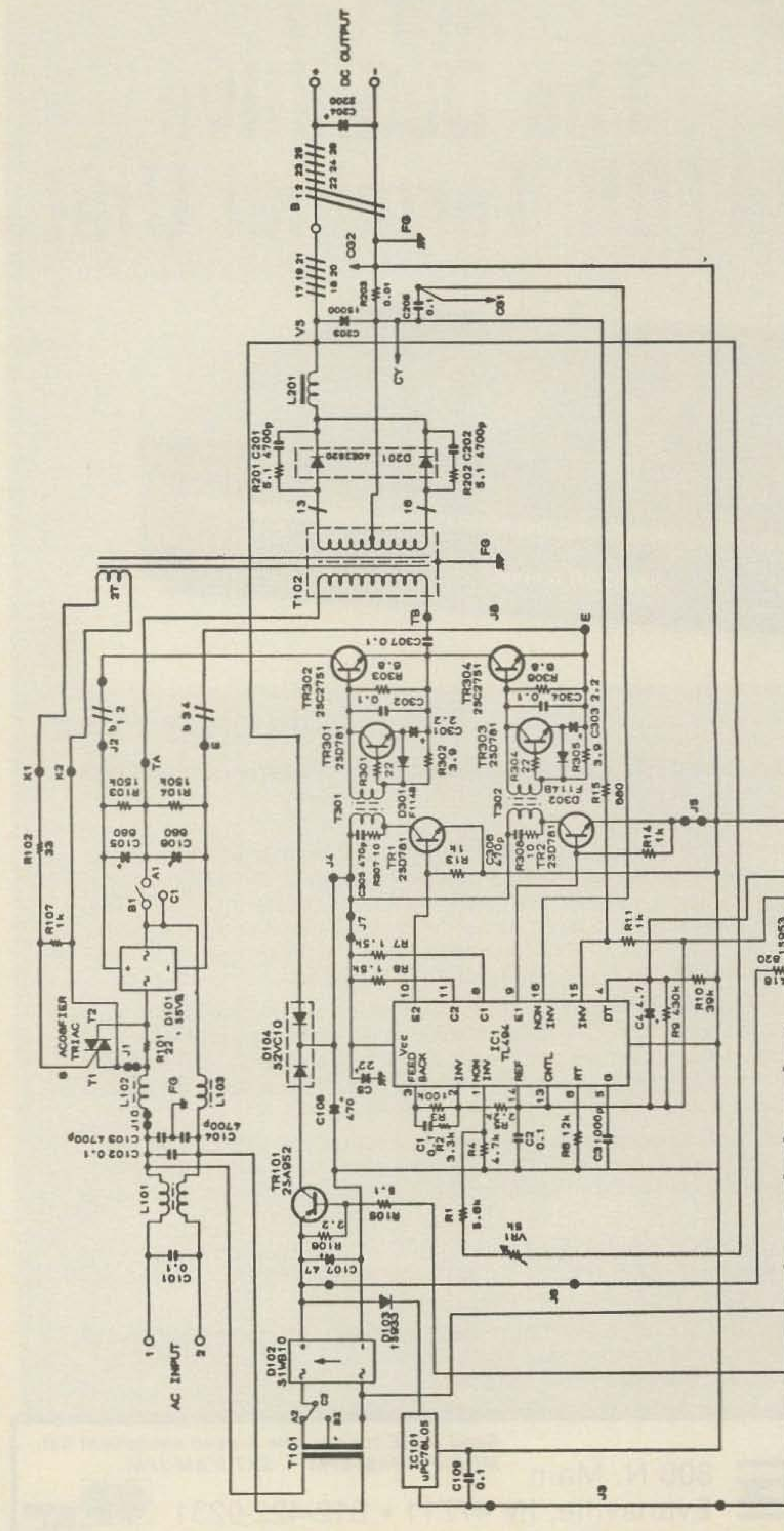
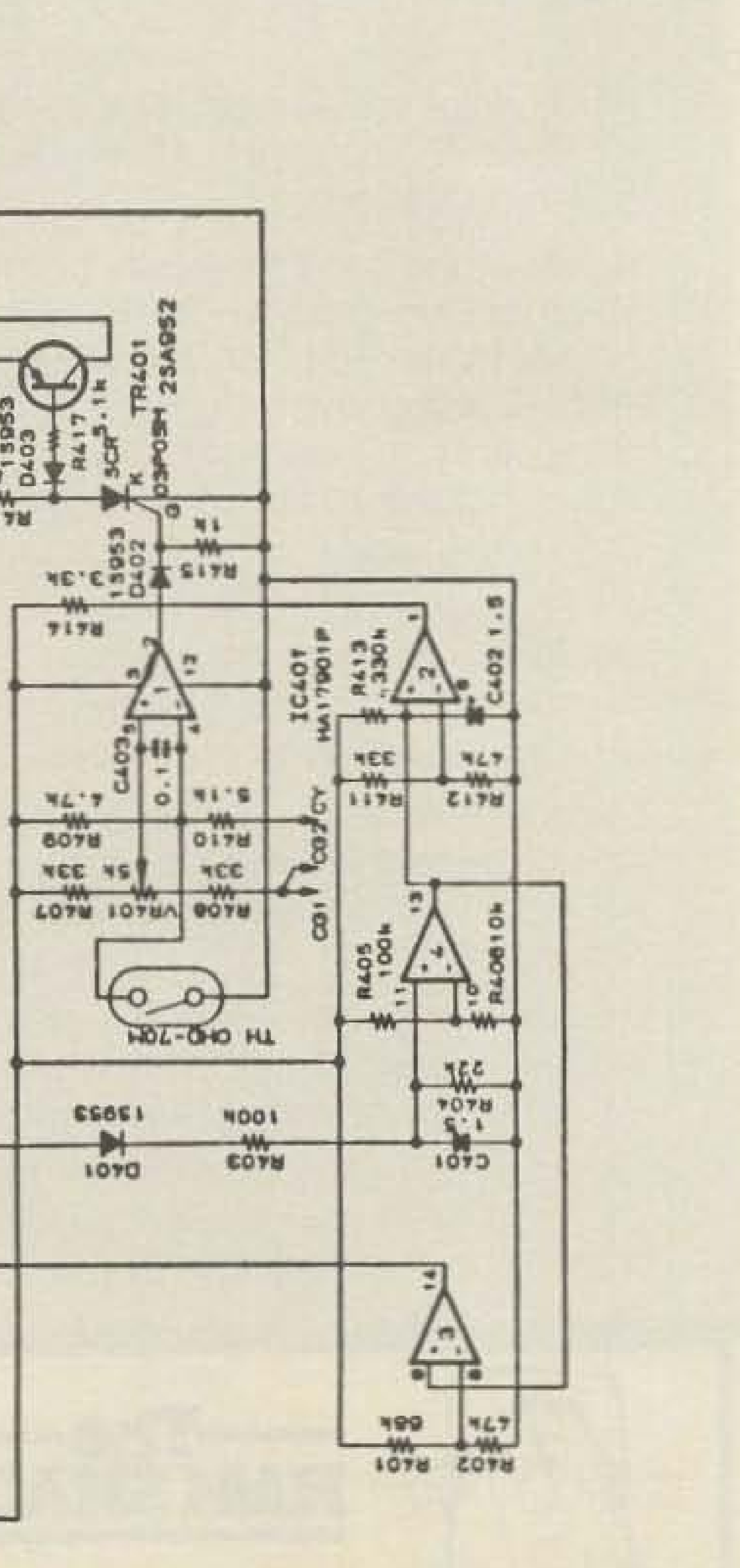
*Fig. 4– FT-One frequency relationships.*




CRYSTAL FILTER DATA(☆OPTION)

| | MODE | Cf | BW |
|---|---|---|---|
| ✱1 | SSB / CW(W) / FSK(W) | 8.9875MHz | 2.7kHz |
| | CW(M) / FSK(N)☆ | 8.9882MHz | 600Hz |
| | CW(N)☆ | 8.9882MHz | 300Hz |
| | AM☆ | 8.9875MHz | 6kHz |
| ✱2 | SSB / CW(W) / FSK(W) | 10.76MHz | 2.8kHz |
| | CW(M) / CW(N) / FSK(N)☆ | 10.7593MHz | 800Hz |

*Fig. 5– The FT-One is one of the first amateur transceivers to incorporate a switching-type power supply. They probably will be very common in the future in amateur gear.*

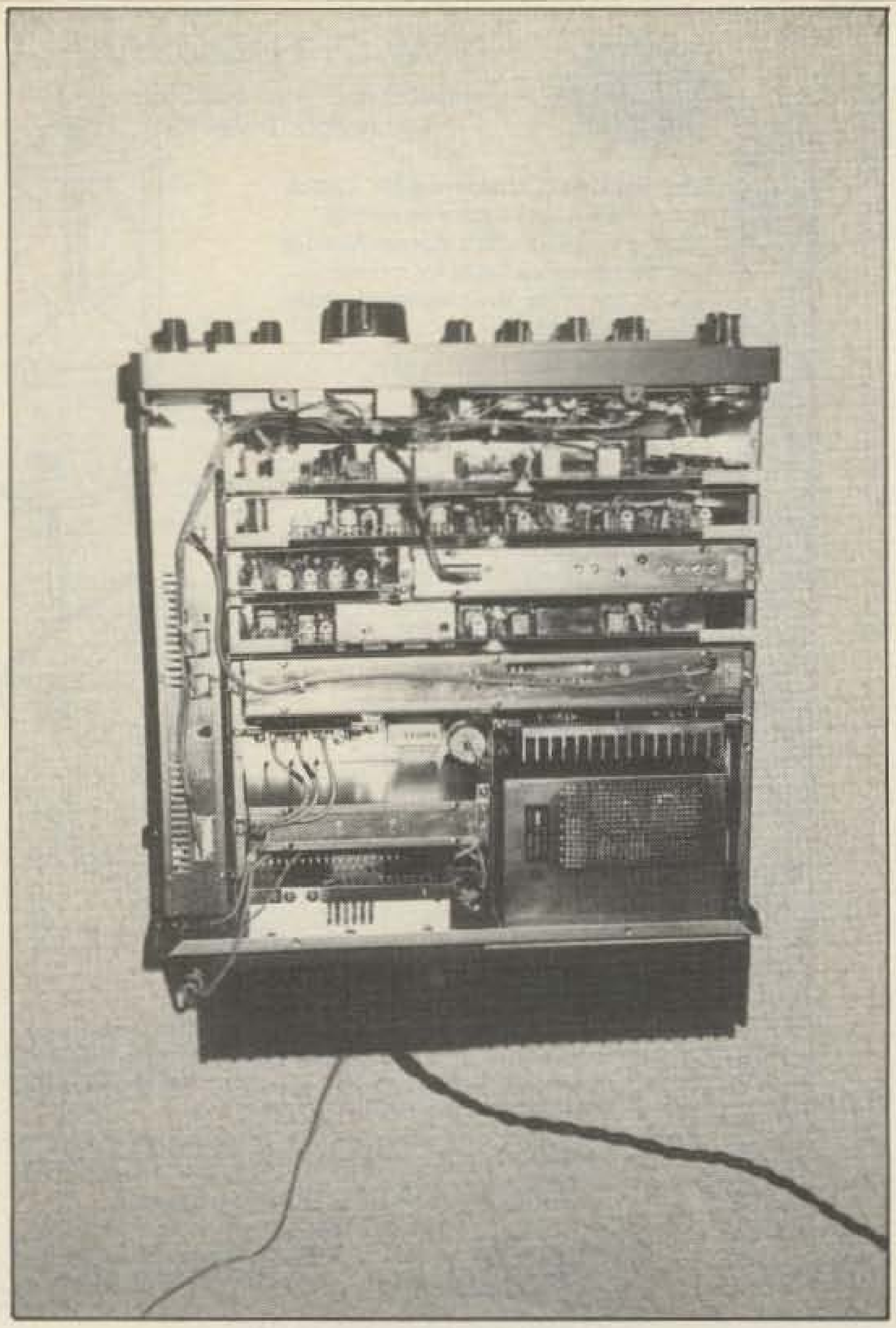




just the reverse of the signal flow path on receive. However, the low-level signal must now be amplified to the 100 watt level, and this is accomplished by the stages of the PA unit as shown in fig. 3. The output of these stages is routed through one of nine relay-selected lowpass filters.

The cut-off frequency of each of the six-pole lowpass filters corresponds to the upper frequency limit of the bandpass filters preceding the PA unit. The signal finally goes through a directional coupler unit (to provide s.w.r. readout and signal voltage for the excessive s.w.r. protection circuitry) and to the antenna switching relay.

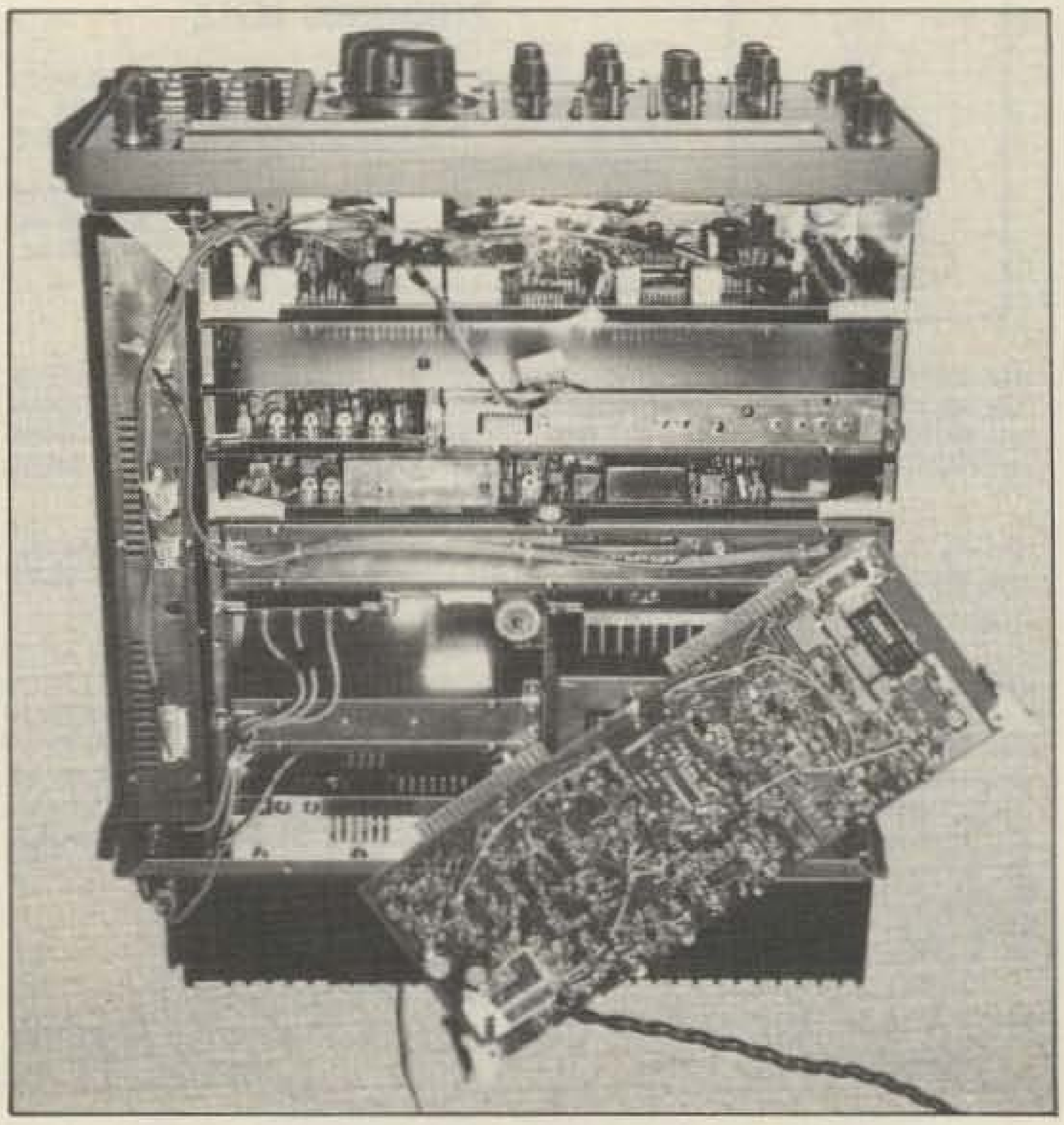
The r.f. speech-processor circuit, when in use, uses a clever bit of circuit switching such that the generated s.s.b. signal is clipped and then filtering is provided by the s.s.b. filter, XF9005, used in the receive chain. Thus, the need is obviated to have another s.s.b. filter dedicated solely to speech-processor filtering as is done in some designs.

On c.w., FSK, and a.m., the final signal paths starting with the 9 MHz i.f. amplifiers are the same, although the initial signal generation does not use the same balanced modulator path as for s.s.b. C.w. and FSK signals are provided by frequency offsets introduced into the second local oscillator stage. The a.m. modulation path does include speech processing in the form of a limiter stage.



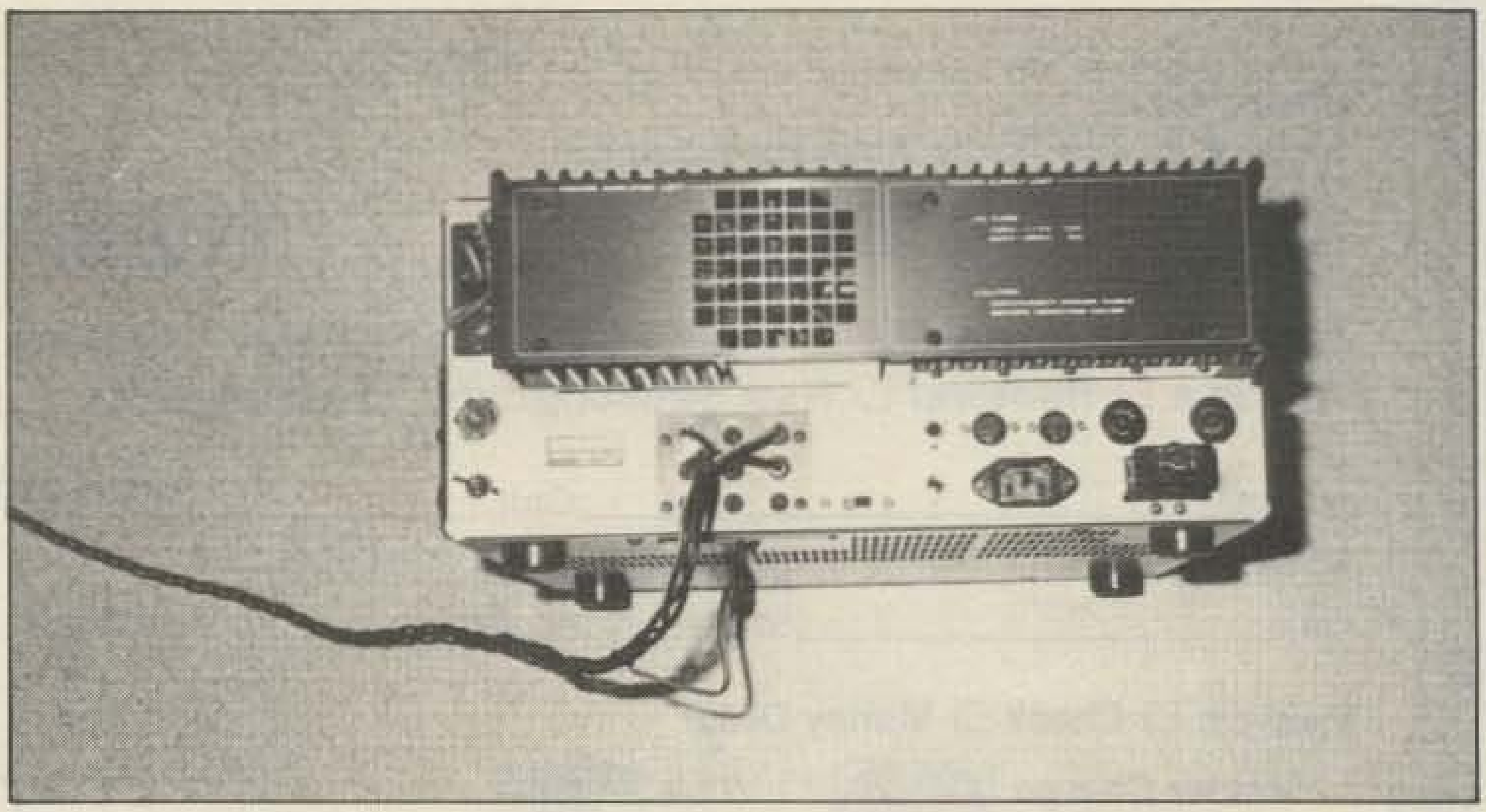
*Taking the top cover off the transceiver, one sees an impressive assembly of large PC boards and shielded enclosures. The power-supply compartment is on the lower right, and the PA compartment is on the lower left. Normally one will have to take the top cover off once to reach various adjustments if one wants to tailor sidetone volume and pitch, AF monitor level, some VOX adjustments, etc., to individual preferences.*

*An example of one of the large PC boards which can be easily removed for any possible service work.*



A better idea of the frequency relationships within the FT-One can be seen from fig. 4. If one studies it a bit, one can see the various signal relationships for different modes of operation, which oscillators (indicated as being variable) affect functions such as carrier shift, variable bandwidth tuning, f.m. modulation, FSK shift, etc. The heart of the system is, of course, the PLL block shown in fig. 4. Basically, it provides a frequency stepped 73.11500 to 103.11499 MHz output to serve as the first local oscillator signal and a fixed 48.615 MHz signal which is further mixed to provide a second local oscillator signal. Rather than present a complicated block diagram of the PLL unit, suffice it to say that it is composed of four frequency loops with crystal oscillator reference signals with finally an external control unit selecting one of the six VCO's into which the first local oscillator frequency range is divided. The reason for having six VCO's is to keep the noise output of the PLL unit as low as possible and as linear as possible. The PLL unit in turn is controlled by a Control Unit (fig. 1). This unit receives commands from the tuning-knob optocouplers, keyboard switches, microphone scan switches, and various other switches, and, in turn, via a microprocessor, it sends out commands to the PLL for which frequency steps it should use, which bandpass and lowpass filters it should select, and what frequency it should display on the digital frequency readout.

The foregoing presents only a small glimpse at the circuitry within the FT-One. A final note might be made of the built-in power supply, since the FT-One is one of the first amateur transceivers to use a switching-type power supply. The diagram of the supply is shown in fig. 5. It looks, and is, rather complex, but essentially it switches at 50 kHz and produces a square-wave voltage which is rectified by a half-wave rectifier, shown to the right of fig. 5, and then filtered using a classical choke-input LC filter. Because of the small ferrite-core inductors needed at 50 kHz, the greater filtering effect per mF of filter capacitance, regulation feedback loops allowed by the switching mode of operation, etc., the overall result is a pow-



*The FT-One has provisions for a wide variety of external connections, but the rear panel is not crowded with excessive connectors. All connectors are standard.*

er supply which is more compact and efficient, and which provides better regulation than a conventional power supply. The only real disadvantage with this type of design is that unless the supply is most carefully filtered and shielded, the harmonics generated by the switching action will enter equipment leads and cause havoc.

## Construction

Housing a complex transceiver such as the FT-One would present any engineer with quite a few problems. Obviously, the housing has to be rugged, very good shielding must be provided between boards (and even circuits on the same boards), and yet the whole assembly must be made reasonably accessible for servicing. As the photographs with the top cover of the FT-One removed show, a basic frame is used which then houses large, individually removable PC boards and fix-mounted individually shielded enclosures. Some of the PC boards also have individually shielded sections on them.

The PC boards are easily removed by disengaging lever clamps which hold them in place. Connectors are used to facilitate the complete removal of the PC boards. The final amplifier, switching power supply, synthesizer circuits, and various oscillator circuits are all individually shielded. The construction is very impressive overall as to neatness, apparent ease of servicing, and quality of the parts used. The outside wrap-around steel shell covering has no perforations on the top half, thus providing good protection against various outside elements. The front panel is of solid die-cast aluminum. The rear panel, as can be seen in one of the photographs, mounts a large heat-sink which is effective for both the power supply and final-amplifier modules. The flush-mounted fan for the final-amplifier module can also be seen. Below the heat sink there are a variety of connectors, the function of which should satisfy just about any installation situation. There are provisions for an external receiver or receive-only antenna, PTT, speaker, a.f. out for recording, i.f. out for a monitor scope, phone-patch connections, key or paddle connections, linear-amplifier control connections, transverter drive and control connections, etc. One interesting jack is marked **AUX**, and Yaesu says it provides a special clocking signal for use only with "special" Yaesu accessories. I wonder what they have on the drawing board?

The FT-One is not light. It weighs in at about 42 lbs. However, the impression one gets is that it is a solid, well-constructed 42 lbs. worth of transceiver. Its weight and shipping dimensions are such that it can be sent by Parcel Post or UPS.

*(to be continued)*

# CQ REVIEWS:

BY JOHN J. SCHULTZ*, W4FA

# The Yaesu FT-One
## All-Mode Solid-State General-Coverage Transceiver
## Part II

*We conclude our review of the Yaesu FT-One this month by starting with bench checks, an in-depth look at what the unit actually does and did. The complexity and sophistication of current amateur radio equipment can be truly amazing when one stops to consider the physical size of the gear being described. It wasn't too long ago, for example, that to duplicate the functions (if possible) of the FT-One would in effect require a couple of 6 foot racks and many thousands of discrete components. —K2EEK*

The Yaesu FT-One transceiver.

Some very early model FT-One's were reputed to have problems with synthesizer noise and miscellaneous audio problems. Of course, especially noise, if not held low enough, means that the full potential of the steep-skirted i.f. filters cannot be realized and that very weak signals will be masked. Therefore, one of the first checks made was for synthesizer noise output. As far as could be determined, synthesizer noise was greater than 100 dB down, which is certainly state of the art. Apparently, if there was ever a problem in this area (as well as others) Yaesu has taken care of it.

On the receive side, the FT-One deserves very high marks with one exception: The sensitivity below 1.8 MHz is very poor, making the receive capability on LW/MW usable for only local reception, unless possibly one has a mile-long Beverage antenna available for such reception. However, above 1.8 MHz receive performance glows. Throughout the range s.s.b. sensitivity was less than 0.5 microvolt and a.m. sensitivity was less than 2.0 microvolt (both for 10 dB S + N/N ratio) at s.s.b./a.m. bandwidths. The noise floor was in the order of − 130 dB (s.s.b. bandwidth). The third-order intercept point plotted out as about + 14 dBm. The dynamic range was an excellent 95 dB using s.s.b. bandwidth and correspondingly higher using c.w. bandwidths.

The s.s.b. selectivity varied from 2.3 kHz at − 6 dB to 4.0 kHz at − 60 dB for a shape factor of about 1.7. Using the variable bandwidth feature, the bandwidth could be reduced to 400 Hz. The optional c.w. filters are very sharp, and using the 300 Hz c.w. filter and the variable-bandwidth feature, one can bring the overall selectivity down to 80 Hz or less. The a.f. peak/notch filter is almost a bit too sharp (about 10 Hz at − 6 dB), but it does a good job. Most operators who use c.w. just occasionally will probably find that the combination of the s.s.b. filter and the a.f. peak/notch filter will provide all the selectivity they need, while real c.w. or FSK buffs will certainly not be able to resist having one of the c.w. filters because of the versatility they provide with the variable-bandwidth tuning feature. The optional a.m. and f.m. i.f. filters were installed in the FT-One tested, but their characteristics were not measured. Operational results would indicate that they easily meet their specifications. I.f. and image rejection were exceptional, measuring out at − 80 to − 90 dB.

Rather than seek out any spurious responses on receive in the conventional manner, the FT-One was set up to "self-destruct." As will be covered later, the FT-One can be set up to frequency scan with the scanning action automatically halting when a signal is detected which exceeds a threshold level established by the setting of the r.f. gain control. In its most sensitive position setting, this translates to a signal of less than S1. Therefore, the FT-One was set up to scan 150 kHz to 30 MHz in a slow-scan mode, which took a total of 48 minutes! Not once did the FT-One stop on any spurious signal as it dutifully covered the entire range continuously in 100 Hz steps—an outstanding bit of performance.

On the transmit side, all the usual measurements for spurious radiation, carrier

*c/o CQ Magazine

**Power output into 50 ohm dummy load vs frequency**

| Frequency | Power |
|---|---|
| 1.8 MHz | 100 watts |
| 3.0 MHz | 108 watts |
| 5.0 MHz | 110 watts |
| 7.0 MHz | 110 watts |
| 8.0 MHz | 110 watts |
| 11 MHz | 100 watts |
| 16 MHz | 107 watts |
| 21 MHz | 106 watts |
| 27 MHz | 100 watts |
| 29 MHz | 95 watts |
| 29.9 MHz | 95 watts |

**Typical power output for complex impedance loads**

| | X1 = 0 | X1 = 25 | Xc = 0 | Xc = 25 |
|---|---|---|---|---|
| R = 50 | 100 | 67 | 100 | 87 |
| R = 100 | 92 | 94 | 92 | 100 |
| R = 25 | 98 | 67 | 98 | 93 |

*Table II– Power output measurements.*

suppression, frequency stability, and sideband suppression showed the FT-One to be well within its specifications. The third-order IMD products measured on s.s.b. were better than claimed, usually varying from −36 to −39 dB below peak output. The harmonic radiation measured was significantly better than claimed at an almost uniform −70 dB from 160–10 meters. Power output measurements are shown in Table II. The transmitter was tested over the entire 1.8–30 MHz transmit range, and as can be seen, there is remarkedly little variation from the nominal output of 100 watts. Table II also shows power output variation with the FT-One working into various reactive loads to simulate different s.w.r.'s. The various loads listed simulate both theoretical s.w.r.'s of up to 1:2 derived from resistive loads and "real world" s.w.r.'s up to 1:1.5 derived from resistive/reactive loads. As can be seen from the table, in the worst-case situation the power output reduced itself to 67 watts.

## Operating Impressions

The FT-One is a very sophisticated transceiver with a wide range of tuning and selectivity possibilities. However, it is basically easy to learn to operate if one approaches the situation step by step.

The transceiver is completely "no-tune" except for the main frequency setting. Such setting can be done either via the main tuning knob or via keyboard entries. Taking the main tuning knob alternative first, one can depress various pushbuttons such that one full rotation of the knob spans either 2 kHz, 20 kHz, or 10 MHz. In the latter mode, the knob acts essentially as a bandswitch. The tuning is absolutely continuous between 150 kHz and 30 MHz on receive. There are no strange ambiguities as one tunes throughout the entire range. As one tunes from 4,000.0 MHz to 4,000.1 MHz, for instance, one will hear a slight mechanical click, since internal relays have selected a different low-pass filter but reception is continuous. The digital frequency display is absolutely stable and flicker-free.

The RIT function (clarify) has the rather wide range of ±9.9 kHz. At first it was thought that such a wide range would produce tuning difficulties especially when using a narrow bandwidth c.w. i.f. filter. However, in reality that is not the case because of the variable main tuning rates which can be selected. In fact, the clarify function can be used as a short-term frequency memory, especially on c.w., since by manipulating the **CLAR** pushbutton, one can either recall the main frequency which is displayed or the offset frequency which one has tuned. One can also select to use the offset frequency for receive-only or transceive operation. The tuning "feel" of the main tuning knob is very smooth, although I would rate it a slight step below that on the FT-107. The analog scale coupled to the tuning knob shaft does not provide any absolute frequency readout, but nonetheless, there are some very useful relative tuning indications if one is tuning between two closely located stations (frequency-wise). For instance, if one uses the slowest tuning rate of 2 kHz per knob revolution, the approximate ⅜ inch distance between markings on the analog scale represents a quite accurate 100 Hz! It can be a useful aid in deciding which filter options to select.

The filter options themselves are all quite wide-ranging. The FT-One tested included all the available options, and I couldn't find any reasonable QRM situation on s.s.b, c.w., or RTTY which could not be handled using the filter options plus the standard variable bandwidth/shift tuning. The versatility of the latter feature is best illustrated by fig. 6. Two concentric tuning controls are arranged with a skirt masking arrangement such that one can visually see what relative bandwidth has been set and whether the i.f. passband has been shifted higher or lower than the nominal i.f. frequency. The arrangement works very well indeed!

The a.f. peak/notch filter is essentially the same one used on the FT-107. The notch is so sharp, however, that one has to use the same tuning procedure as on the FT-107. That is, if one wants to notch out an interfering tone, one first peaks it and then sets the peak/notch switch to notch. Once one gets used to it, the filter proves to be quite helpful. The various other controls—a.g.c. selection, separate r.f. and a.f. gain controls, noise blanker threshold adjustment, etc.—provide all the flexibility one could need. The noise blanker is very effective against pulse interference such as that produced by the "woodpecker."

Overall, the receive performance of the FT-One can be rated as excellent. Even under the worst of weekend QRM conditions, I never found it necessary to use the r.f. attenuator to prevent overload. Signals appear to pop out of a quiet background. The S-meter action is very smooth with S9, representing 50 microvolts almost exactly throughout the 1.8–30 MHz range. The only thing that deters the receive performance from getting an absolute top rating is blower noise. The blower runs continuously, and although one tends to forget it when listening to a station, its noise is annoying when one is searching out a very weak station. An optional modification kit (Fan-One) converts the fan to a demand-type. This kit is now available and should cost less than $10.

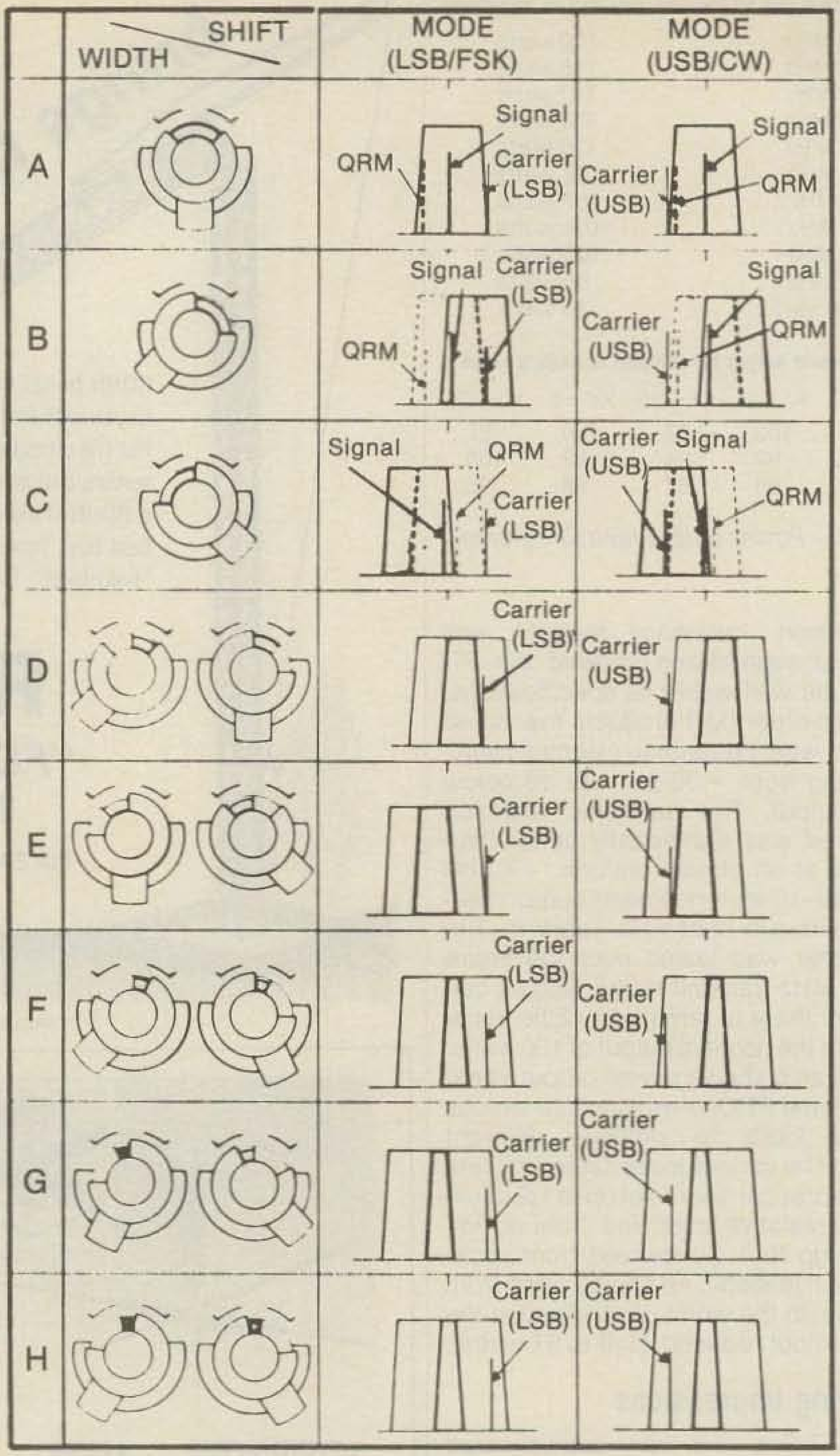



*Fig. 6– All of the basic possibilities offered by the variable bandwidth, variable i.f. shift controls are illustrated by this diagram.*

On the transmit side, the FT-One leaves nothing to be desired. There is, of course, no tuning. The dual metering system is very handy and does away with the need for any external metering on, for example, an antenna tuner. One can use the multi-function meter to read reflected power in order to adjust a tuner, and the meter dedicated to read a.l.c. on transmit allows one to very accurately adjust the drive, microphone gain, and r.f. speech compressor controls. One can monitor the microphone signal via a sidetone circuit, but only before the speech-processing action. The processing is of the same excellent type previously used by Yaesu, so at least they didn't try to improve what already had been perfected.

The first station worked with the FT-One was an SKØ in the middle of a deep pileup. He gave an S9 report to the barefoot FT-One being used with a dipole and even commented on the good speech quality of the processor! Talk about wanting to shut down rather than try to follow that act. However, many other stations did indeed comment on the good modulation produced by the FT-One. The microphone used was one of the new Heil Sound HC-5 types. VOX operation is very smooth. The VOX time delay control is front-panel mounted but the other VOX controls have to be accessed under the top cover.

The FT-One does have true full break-in operation on c.w. which does operate very smoothly. Apparently, the start of a keyed character is buffered and stored for a very brief period of time to allow the transceiver to switch between receive and transmit. The keying waveform has rather sharp rise and fall times of about 1.5 milliseconds, which provides a slightly hard keying characteristic. In any case, at the speeds I could manage, there was absolutely no hint of the start of any transmitted character being lost. The FT-One does have a built-in sidetone oscillator which can be adjusted both as to volume and pitch. The optional built-in keyer, which is built around a Curtis 8044 IC as shown in fig. 7, is a very handy convenience item, and a front-panel control allows for continuous adjustment of the keying speed from roughly a few wpm to 30+ wpm.

The basic receive and transmit performance of the FT-One is remarkable enough, but the versatility of the transceiver really becomes evident when one exercises the frequency control possibilities. In essence, the FT-One incorporates the equivalent of 10 fully independent v.f.o.'s which can be set on any receive frequency from 150 kHz to 30 MHz and/or any transmit frequency from 1.8 to 30 MHz (in the case of a transceiver that has been modified for its full transmit range). The operation of the 10 v.f.o.'s is easy enough in practice, but a bit difficult to describe since one tends to associate the v.f.o. possibilities with "memory" channels rather than with true, independent v.f.o.'s. Perhaps the best way to visualize the v.f.o. scheme is to imagine 10 v.f.o. boxes, each with its own tuning knob, sitting on top of the FT-One and then a selector switch which can choose any v.f.o., and then further switching which determines if one selected v.f.o. will be used for receive and another selected v.f.o. used for transmit (or vice versa).

There are two v.f.o. selector switches labeled **VFO A** and **VFO B** and each switch has 10 positions. To provide a simple example, one has to imagine that a further switch is set to select **VFO A.** If the **VFO A** switch is set to "**1**," it will automatically store in **VFO** "**1**" memory whatever frequency is selected by the main tuning knob (remember that the main tuning knob can tune at any one of three fre-

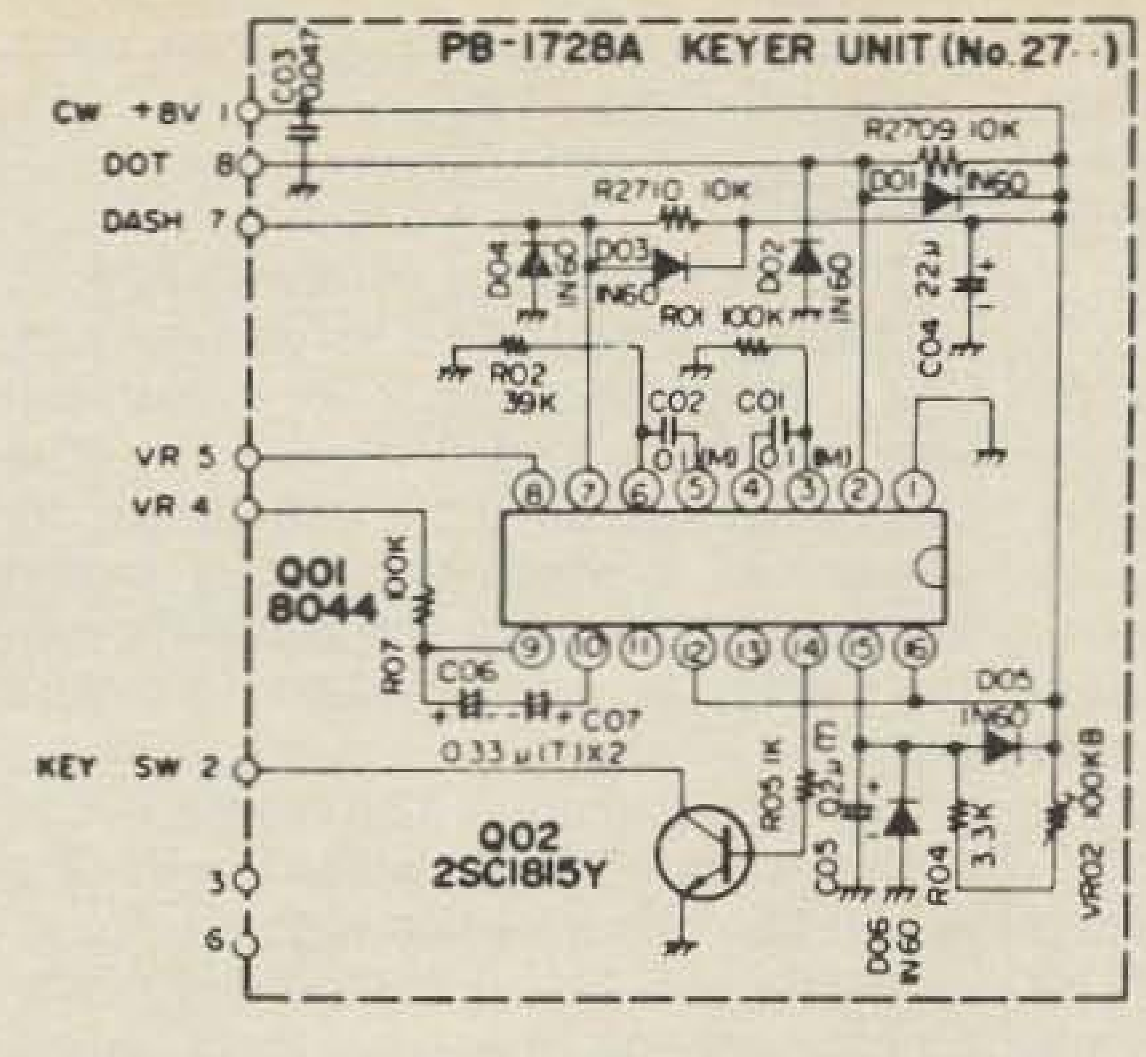



*Fig. 7– The very neat, small optional keyer board available for the FT-One. The circuit is based on a Curtis 8044 Keyer IC.*

quency rates). There is no need to press any sort of "memory" store switch. In a similar manner, if the **VFO A** switch is moved to any other v.f.o. number, that v.f.o. is set at the frequency last set by the main tuning knob when that particular v.f.o. number was last selected. The v.f.o. number selected is also displayed on a small digital "channel" readout. Therefore, one can set any of the 10 v.f.o.'s to any desired frequencies, and by a simple rotation of the **VFO A** knob one can scan each v.f.o. frequency. Frequencies set by the **VFO A** switch are also automatically duplicated by the **VFO B** selector switch. If one, for instance, sets the **VFO A** switch to "**1**" and "records" a frequency of 3.505 MHz, and "records" a frequency of 28.625 MHz with the **VFO A** switch set to "**2**," these frequencies will be duplicated in the **VFO B** switch positions "**1**" and "**2**." The fun starts when one realizes that the **VFO A** and/or **VFO B** switch can set the transceive frequency or independent receive/transmit or independent transmit/receive frequencies. Full crossband operation, even using break-in on c.w., is possible.

Why should the FT-One provide this capability? In reality, not many of us are likely to crossband from 80 to 10 meters. In reality, the FT-One provides an extremely good base for h.f. enthusiasts to get involved in v.h.f. operation with a fair minimum of additional equipment. The transverter provisions incorporated in the FT-One, f.m. modulation possibility, frequency scanning, crossband receive/transmit operation, etc., all point to an excellent basis for expansion into sophisticated base-station v.h.f. operation. The scanning capability, for instance, is a convenience feature on h.f., but really comes into its own when one wishes to quickly scan a v.h.f. band for activity.

The keyboard entry features of the FT-One deserve special mention. In essence, complete frequency control is possible via keyboard commands, and it is pure operating pleasure to use them. To switch to keyboard command a rotary selector switch is used. The **VFO A** and **VFO B** switches are then disabled. One can set the transceiver on any desired frequency by keyboard entries for any one of the 10 v.f.o. channels. For instance, to set v.f.o. channel 1 on 14.206.5 MHz, one enters a key sequence of **1 MR 1 4 MHz 2 0 6 5 DIAL.** Subsequent changes do not require a full keyboard entry but just basic corrections. If the frequency were to be changed to 14.020.0 MHz, one would simply enter **0 2 0 0 DIAL.** To switch between memories, one enters the number of the memory (0 to 9) and depresses the **MR** button. The small, red digital display will indicate the memory channel (0–9) which has been recalled and the clarifier offset, if any, which had been chosen for that v.f.o. memory setting. The latter simply avoids confusion since it alerts the operator that the frequency displayed on the main display has to be modified by a frequency offset which was chosen. A transceive pushbutton (marked **TRCV)** allows one to command which memory v.f.o. will be used for receive and which one will be used for transmit or to choose transceive operation for each v.f.o. memory.

The scanning pushbuttons are divided into a group for fast up/down scan or slow up/down scan. Using fast scan one can cover about 2 MHz in about 10 seconds (100 kHz steps). Using slow scan one can cover about 100 kHz in 10 seconds (100 Hz steps). If one selects slow scan, one can also select an automatic mode whereby the scanning action will stop when a signal is encountered that exceeds a signal-level threshold established by the r.f. gain control. Translated a bit, all that means is that if automatic scan is selected and the r.f. gain run "open," scanning will stop at less than S1 level signals; if the r.f. gain is backed off about a third, scanning will stop when an S9 is encountered.

The flexibility provided by the 10 memory v.f.o.'s is a bit difficult to describe. One can, of course, use some memories for fixed frequencies of interest, other memories for split frequency operation within a band, other memories for transceive **VFO A/B** operation within a band, etc. About the only feature I could find lacking with the keyboard operation was a memory carry-forward frequency transfer. That is, if one were using v.f.o. memory 5, for instance, and found a station of interest on 21.030.0 MHz in QSO, it would be handy to have a button to press which would store 21.030.0 in both memory 5 and 6 and then use memory 6 to continue tuning. This would avoid having both to switch to memory 6 and enter the frequency information in memory 6. I suspect a few hours at the drawing board and a handful of IC's would provide the solution.

Memory frequencies can be retained when the transceiver is turned off by means of a small built-in power supply (back panel switched in or out). An optional RAM board provides for frequency retention if one lives in an area that has frequent power interruptions or if one would like to retain memory frequencies while transporting the FT-One.

## Manuals

The FT-One comes complete with an operating manual and a service manual. The operating manual is very clear and very well illustrated. There is very little that can be said about the operating manual except to suggest that one should take the time to read and digest its contents if one is to get maximum pleasure out of an FT-One.

The service manual also deserves high marks. Each PC board within the FT-One is carefully described as regards circuitry details, PC board component placements, voltage measurements, alignment instructions, transistor/IC lead identities, etc. In fact, I was about to hail the manual as some sort of standard until I discovered that there was no harness wiring diagram in the manual! There was no way to trace the interconnections between the PC boards. A quick letter to Yaesu did produce the interconnection diagram with a note that later manuals had been corrected.

The service manual clearly describes how to modify the FT-One for 1.8 to 30 MHz continuous transmit as well as receive coverage. Nothing more is involved other than the placement of a few wire jumpers.

## Accessories

There are not many accessories available for the FT-One simply because they are not needed. Nonetheless, as was mentioned before, I would recommend the keyer option for convenience and one or more of the c.w. bandwidth crystal filters if one is particularly interested in that mode. The f.m. option allows for 10 meter f.m. operation as well as v.h.f. f.m. operation. The RAM option would only be advisable when power outages are common or when one frequently has to move the transceiver.

## Summary

The FT-One is a tremendously interesting, extremely high-performance transceiver with all sorts of advanced features. In fact, after many hours of using it and studying its circuitry, I'm still not sure that I haven't missed some feature related to its tremendous versatility. It is not inexpensive, but then again, one cannot imagine any transceiver being available in the near future which will incorporate any really significant advances over the FT-One except perhaps for a few more dB here or there of improved receive and/or transmit performance. For all practical intentions, however, the FT-One, like the Collins KWM-380, probably represents a plateau in transceiver development until the next generation of transceivers having no analog controls appears.

From a straight dollars and cents viewpoint, the only thing one might want to debate when considering the purchase of an FT-One is whether there is any possible advantage to going to an alternative separate amateur-band-only transceiver plus general-coverage receiver configuration. The latter approach provides a bit more operating flexibility, but station size and wiring complexity are increased, and the cost of good, optional c.w. filters for both the transceiver and general-coverage receiver can be expensive.

Hopefully, a follow-up article can be developed which will describe in greater detail practical operating experiences with the FT-One and which will expand on the tremendous versatility of the FT-One transceiver, particularly as regards its foundation as a full-featured h.f. transceiver which can be expanded for direct v.h.f. communications and/or v.h.f./u.h.f. satellite communications.