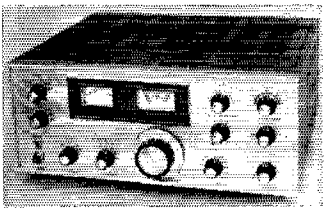
Recent Equipment

To acquaint you with the technical features of current amateur gear.

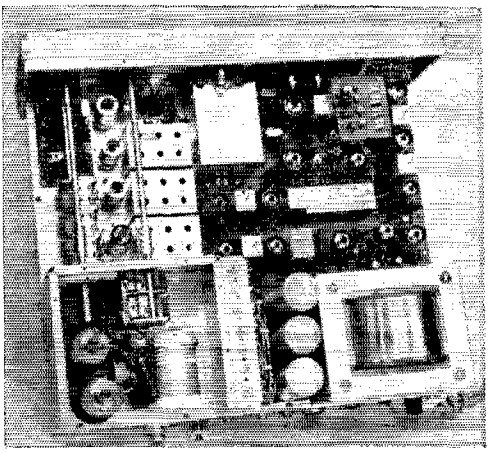
The Yaesu FT-DX-400 Transceiver



THE FT-DX-400 transceiver is a Japanese import with maximum power-input ratings of 500 watts p.e.p. on s.s.b., 400 watts on c.w., and 125 watts p.e.p. on a.m. (carrier and one sideband). Normal tuning ranges are 3500–4000 kc., 7000–7500 kc., 14,000–14,500 kc., 21,000–21,500 kc., 28,000–28,500 kc., 28,500–29,000 kc., 29,000–29,500 kc., and 29,500 kc.–30,000 kc.

Transmitting Channel

Referring to the block diagram of Fig. 1, the microphone signal is amplified in two stages (12AX7), and then combined in a 7360 balanced modulator with the 3.18-Mc. signal from one of two crystal-controlled carrier oscillators (12AU7), the selection (by the mode switch) depending on whether upper or lower sideband output is desired. The carrier is balanced out in the modulator, and the resulting 3.18-Mc. d.s.b. suppressed-carrier signal from the modulator is fed through a crystal filter to strip off the undesired sideband. After amplification in one stage (6BA6), the 3.18-Mc. s.s.b. signal is fed to the first transmitting mixer (6CB6), where it is combined with a signal from a v.f.o. covering the range of 8.9 to 8.4 Mc. to produce a signal in the range of 5.72 to 5.22 Mc. in the output of the mixer.



Top view of the FT-DX-400. At the left-hand end of the chassis are the crystal-calibrator components, the variable capacitor operated by the preselector control, and the associated tubes and coils (in separate shielded boxes), and the shielded compartment (cover removed) housing the final amplifier. The bracket attached to the latter contains most of the internal controls. The box at top center is the top v.f.o. shield. The elevated circuit board at top right contains crystal sockets for crystal-controlled operation. The power transformer and some of the filter capacitors occupy the lower right-hand corner. The circuit change-over relay (plug-in type) is the light rectangular object above the upper left-hand corner of the power transformer.

The v.f.o. is comprised of three stages — transistor oscillator, transistor buffer, and a 6BA6 buffer/amplifier. Provision is also made for substituting an internal transistor crystal oscillator, or an external v.f.o. (not furnished) for the internal v.f.o., the selection being made by a panel switch. The same switch selects one of four crystal frequencies (crystals not furnished) when the crystal oscillator is in use. The crystal oscillator is applied to both transmitting and receiving channels for spot-frequency work, but the external v.f.o. is applied to the transmitting channel only for independent control of transmit and receive channels.

There is also provision for offset tuning (clarifier). This is effected by a varactor diode in the v.f.o. circuit. A control on this circuit permits shifting either the receiving channel alone, or both receiving and transmitting channels simultaneously, from 0 to 5 kc. either side of the frequency indicated by the tuning dial. There is no provision for applying offset tuning to the transmitting channel only. The effect can be accomplished in a roundabout way by tuning the transceiver the desired amount away from the listening frequency, then switching in the offset tuning for receive only, and bringing the receiving channel back to the listening frequency.

The output circuit of the first mixer is tuned, and the tuning is ganged with that of the v.f.o., both circuits being controlled by the main tuning dial.

A signal in the 5.72–5.22-Mc. range is fed from the first transmitting mixer to a second transmitting mixer (6AH6) where it is combined with the signal from a crystal-controlled heterodyning oscillator (6BA6) whose frequency determines the operating band. Crystals for all amateur

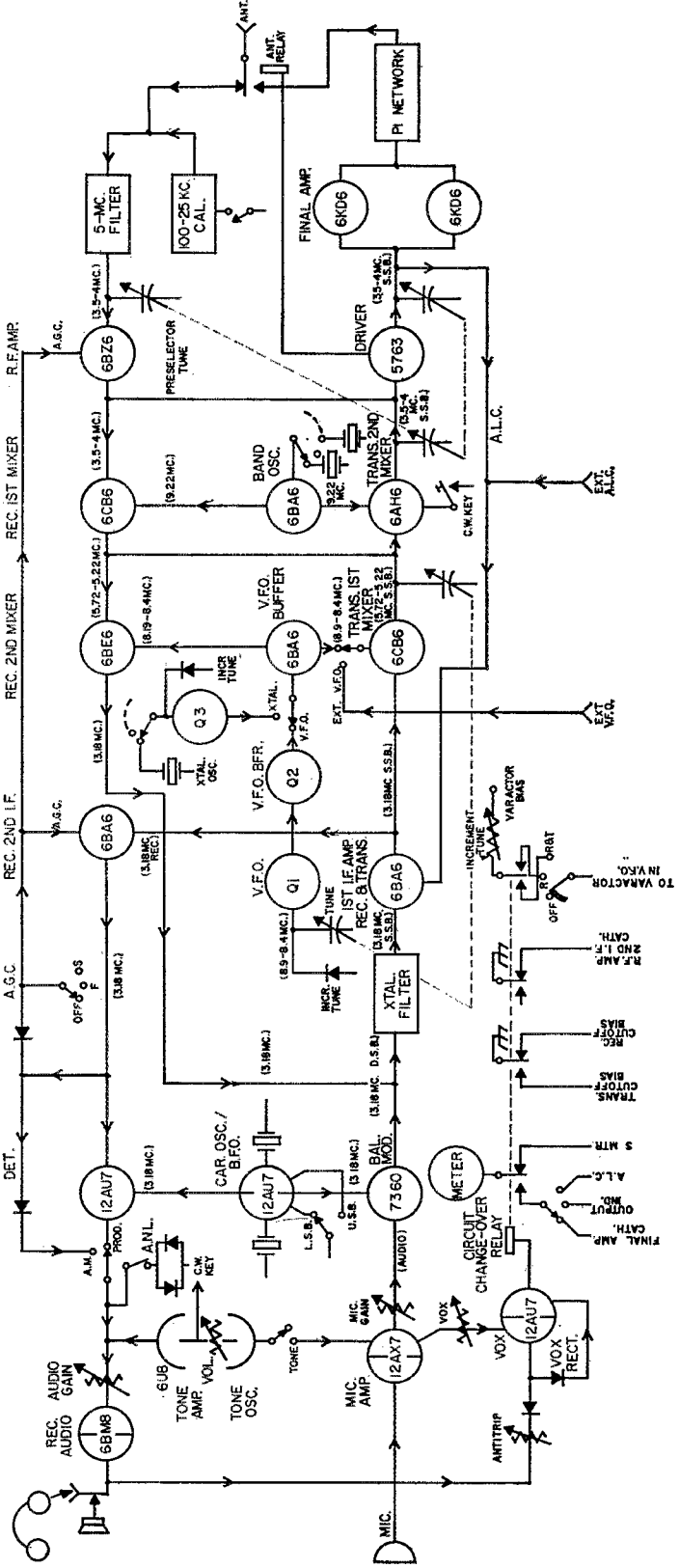


Fig. 1—Block diagram of the FT-DX-400.

bands, 80 to 10 meters inclusive, are furnished. The 10-meter band is divided into four 500-kc. segments. Trimmers across the crystals are provided for adjusting the frequencies to dial calibration. (Three extra crystal positions are available for working outside of the normal ranges.)

Using the 80-meter band as an example, a 9.22-Mc. signal from the band oscillator combines with a signal in the 5.72–5.22-Mc. range to produce a signal in the 3.5–4-Mc. range in the output of the second mixer. This signal is then amplified in a 5763 driver and fed to the final amplifier (parallel 6DK6s with pi-network output for a 50- to 120-ohm load). The output circuit of the driver is tuned. (The tuning system of this stage will be explained presently.)

The driver and final are neutralized, the band switch connecting in an appropriate neutralizing capacitance for each band. Final-amplifier bias is adjustable by an internal control.

The a.l.c. system is more or less of the usual form. The a.l.c. signal, generated when the final amplifier is overdriven, is coupled out from the grid circuit, rectified, and fed back as additional bias to the grid of the first i.f. amplifier to reduce its gain. A jack is provided for feeding in the a.l.c. signal from a following linear amplifier.

C.W. Operation

For c.w. operation, the mode switch actuates a diode switch which removes a loading capacitor shunting one of the carrier-oscillator crystals to move the carrier into the passband of the crystal filter. (This also lowers the beat note for better c.w. reception.) Another section of the mode switch unbalances the modulator to allow the carrier to ride through.

Still another section of the mode switch turns on an 800-cycle tone oscillator/amplifier (6U8) which feeds a side-tone signal to the receiver audio system for monitoring. A separate control (internal) permits the tone signal to be set to the desired level in respect to the audio level set by the receiving audio gain control. (With the tone control set, the tone level rides up and down with adjustment of the audio gain control.)

The transmitting channel is keyed in the second-mixer and final-amplifier stages by the blocked-grid method. The tone amplifier is keyed simultaneously in the same manner.

A.M. Operation

On a.m., the carrier frequency is shifted, and the modulator unbalanced, as for c.w. operation. An internal control is provided for adjusting the carrier level. The filter band width is not sufficient to accommodate both sidebands, and the lower sideband is largely attenuated, resulting in essentially s.s.b. with carrier.

Receiving Channel

A trap at the input of the receiving channel suppresses direct feedthrough of signals in the 5.72–5.22-Mc. range. The input and output circuits of the r.f. amplifier (6BZ6) are tuned. The r.f.-amplifier *input* tuning control is ganged with those of the transmitting second-mixer output circuit and the driver output circuit. These circuits are tuned simultaneously by the panel preselector control. The *output* circuit of the 6BZ6 is the same tuned circuit used in the output of the transmitting second mixer, one tube or the other being cut off by the change-over relay. Thus, on receive, the preselector control tunes both input and output circuits of the 6BZ6; on transmit, this control tunes the output circuits of the transmitter second mixer and the driver. Setting for maximum drive to the final amplifier automatically tunes the receiver r.f. stage. Or, the process may be reversed.

Still using the 80-meter band as an example, a signal in the 3.5–4-Mc. range is fed from the r.f. amplifier to a first receiving mixer (6CB6), where it is combined with the 9.22-Mc. signal from the band oscillator to produce a signal in the range of 5.72 to 5.22 Mc. in the output of the mixer. A common output circuit is used for the first receiving mixer and the first transmitting mixer, again one tube or the other being cut off by the change-over relay. Thus, on receive, the main dial tunes both the v.f.o., and the output of the first receiving mixer; on transmit, it controls the v.f.o. and the output circuit of the first transmitting mixer.

The signal in the 5.72–5.22-Mc. range is then fed to a second receiver mixer (6BE6). Here it is combined with a signal from the v.f.o. (8.9–8.4 Mc.) to produce a signal at 3.18 Mc. in the output of the mixer. The 3.18-Mc. signal is fed through the crystal filter and first i.f. amplifier (which are common to both receiving and transmitting channels) to the second receiving i.f. amplifier (another 6BA6). The signal is then fed to a product detector (12AU7), a diode detector, and an a.g.c. rectifier. A switch at the input to the two-stage receiving audio amplifier (6BM8) selects either the product detector for s.s.b. or c.w. reception, or the diode detector for a.m. A shunt diode noise limiter can be switched across the input to the audio amplifier.

A.g.c. is applied to the grids of the r.f. amplifier, and the second i.f. amplifier. The a.g.c. switch has positions for off, and fast or slow release. The manual r.f. gain control, applied to the same stages, is in the common cathode circuit.

Crystal Calibrator

The crystal calibrator is rather elaborate. It has four transistors which comprise a 100-kc. oscillator, amplifier, and a 25-kc. multivibrator that may be switched in to give additional markers at 25-kc. intervals.

Change-Over System

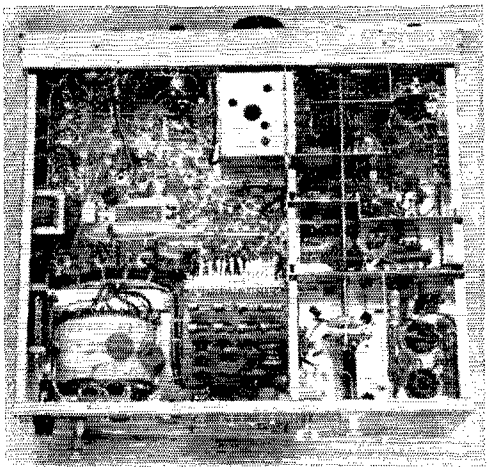
Separate relays are used for switching the antenna and switching circuitry. The circuit relay opens the cathode circuits of the receiving r.f. and second i.f. amplifiers on transmit; shifts cutoff bias from the driver and both transmitting mixers on receive, to the two receiving mixers on transmit; shifts the meter from the S-meter circuit on receive (the S meter is backward-

reading), to read final-amplifier cathode current, monitor a.l.c., or indicate relative r.f. output on transmit, depending on how the meter switch is set. This relay also applies cutoff bias to the carrier oscillator on receive when using a.m., and switches the incremental tuning when this feature is in use.

The coil of the circuit relay is in the plate circuit of the VOX relay tube, and may be energized by a voice signal from the VOX amplifier/rectifier, by the mode switch in the MOX position, or by a p.t.t. switch at the microphone for voice operation. On c.w., this relay can be actuated by an external foot switch (not provided) connected to the three-circuit plug at the key jack for c.w. operation. For break-in operation, the foot switch may be replaced by the back contact of a keying relay, or of a relay in a "Tattoo" system. Regardless of the system selected, a standard two-circuit key plug cannot be used. The plug must be of the three-circuit type (plug furnished).

In the VOX system, an audio signal from the output of the microphone amplifier is rectified and fed as positive bias to the grid of a VOX amplifier/relay driver (12AU7). The VOX level is adjustable by an internal control. Signals from the receiving audio system are prevented from tripping the VOX relay by rectifying the output signal from this source and applying it as back bias to the VOX rectifier. The threshold level is adjustable by an interior control.

The antenna relay is actuated indirectly by the circuit relay. The former is in the plate-supply circuit of the driver stage, which is biased off on receive, as mentioned earlier. When the circuit relay removes the cutoff bias, the antenna relay is actuated by driver plate current. The antenna relay is also actuated by the function switch in the calibrate position to disconnect the antenna and remove outside signals while using the crystal calibrator.



Bottom view of the FT-DX-400. The aluminum box at top center is the bottom v.f.o. shield. Immediately to the right is a row of trimmers for the band-oscillator crystals to permit accurate alignment against the calibrator. The band switch is right of center with the antenna relay below. The sockets of the final-amplifier tubes may be seen in the lower right-hand corner. The power supply occupies the lower left-hand corner.

Yaesu FT-DX-400 Transceiver

Height: 6¼ inches.
Width: 15¾ inches.
Depth: 13¾ inches.
Weight: Approx. 50 lbs.
Input: 117 or 220 volts, 50/60 cycles a.c.
Price Class: $600.
Manufacturer: Yaesu Munsen Co. Ltd., Tokyo, Japan.
U..S Distributor: Spectronics, Box 356, Los Alamitos, Calif. 90720.

Power Supply

A single power supply furnishes all operating voltages. The dual primaries may be connected in parallel for 115-volt operation, or in series for 230-volt input. Taps are provided for line-voltage adjustment. Aside from the heater windings (two), there are three secondaries. One provides 800 volts for the final amplifier. Another provides 300 volts and 150 volts for the other tube stages, while a third winding provides biasing voltages. Silicon rectifiers are used throughout. A 105-volt tap, regulated by a 0C3A supplies the balanced modulator, band oscillator, tone oscillator and carrier oscillators. The transistor stages are supplied by 9 volts from a two-transistor voltage regulator operating from the 105-volt tap.

Mechanical

The chassis is of heavy steel. The aluminum panel is approximately 3/32 inch thick and is set in a heavy die-cast aluminum frame.

The panel is further strengthened by a heavy cast bezel for the meter and dial windows. The cabinet is of heavy slotted steel, with a chassis opening at the rear. The lid (also slotted) is removable by releasing two clasps along the front edge. The cabinet is finished in crystalline slate grey. The panel is in natural aluminum. The controls are black with chrome inserts.

The tuning knob drives the tuning capacitor through a gear train. The dial, on the tuning-capacitor shaft, is calibrated from 0 to 500 in black, and from 500 to 1000 in red. The red scale is used for the 3500–4000 range and for the 28,500–29,000, and 29,500–30,000-kc. segments of the 10-meter band. The dial has calibration marks every 10 kc. The tuning knob is calibrated from 0 to 50 in black, and 50 to 100 in red, with a mark every kilocycle. It takes two revolutions of the knob to cover 100 kc., the black numbers applying to the first revolution, while the red numbers apply to the second revolution. Some operators may find this a bit confusing, since it is necessary to watch both the dial and the knob skirt at the same time to keep track of whether you should be reading black or red. The friction

(*Continued on page 128*)

Recent Equipment

(Continued from page 43)

on the tuning knob is adjustable by a lever. If desired, the friction can be increased to the point of locking the control.

On the inside, about 75 percent of the components are on etched circuit boards. The majority of components on these boards are plainly labeled with numbers corresponding to those in the circuit diagram.

Performance

Important manufacturer's specifications are as follows:

Receiver sensitivity — 0.5 μv. s/n 20 db., 14-Mc. s.s.b.

Receiver selectivity — 2.3 kc. at — 6 db.
— 3.7 kc. at — 55 db.

Image rejection — 50 db.

Carrier suppression — more than 40 db.

Sideband suppression — more than 50 db. at 1000 cycles.

Distortion products — more than –25 db.

Laboratory measurements at A.R.R.L. showed that these specifications were met.

The measured c.w. output power at rated 440 watts input varied from 200 watts to 280 watts. P.e.p. output on s.s.b. was about the same, with the unit tuned according to instructions.

In response to the popular demand for high power in a small package, the design of the unit follows a recent trend toward taking advantage of the short duty cycle of s.s.b. and c.w. operation. Such design does not permit the sort of book-on-the-key testing to which many of us have been accustomed in the past. The instruction book outlines a tuning procedure and other precautions which should be taken literally, if permanent damage to the tubes in the final amplifier is to be avoided. A specified limit of 5 seconds key down on c.w. (c.w. tune-up procedure is used for s.s.b. as well), at maximum rated input appears to be well justified.

TVI shielding is on a par with most other similar units that have been tested. A low-pass filter will undoubtedly be advisable in all but strong-signal areas.

In c.w. operation, any intentional shaping of the keying characteristic is not evident from the diagram. A scope pattern shows that there is some incidental shaping on "make" (probably sufficient to avoid serious complaint), but no shaping at all was detectable on "break." Clicks were quite severe out to 5 kc. or so either side of the carrier.

In using the crystal calibrator, it was noticed that the calibrator signal shifted three or four hundred cycles when the 25-kc. m.v. was switched in. At first, it was assumed that the loading of the m.v. shifted the frequency of the 100-kc. oscillator. Closer examination, however, showed that most of the shift was caused by a change in v.f.o. frequency, apparently as a result of increased load on the transistor power source. Thus, it appears that the calibrator cannot be depended on for close frequency checks.

— *W1TS*