Product Review Column from *QST* Magazine

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Flesher Corporation TU-300 And -470 RTTY TUs

ICOM IC-R70 Communications Receiver

Yaesu FT-230R 2-Meter FM Transceiver

Product Review

Conducted By Paul K. Pagel,* N1FB

Yaesu FT-230R 2-Meter FM Transceiver

The Yaesu FT-230R is a microprocessor (μP)-controlled, synthesized fm transceiver that packs 25 W of output power (at least) and is designed for use with a 13.8-V dc negative-ground supply. Front-panel layout is superb; the most often used controls are in easy reach. Because of the small size of the radio, the controls are close together yet far enough apart to avoid accidental operation of another control. Five '230 models are produced, one for the American market and the others for the rest of the world.

Yaesu FT-230R VHF FM Transceiver Serial No. 2F 050470

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 144.00 to 147.995 MHz in 5- and 10-kHz steps.	143.500 to 148.495 MHz in 5- and 10-kHz steps.
Mode of operation: Fm.	
Readout: Five-digit LCD array.	
S-meter: Horizontal bar meter.	
Receiver sensitivity: 1 μV for 30 dB S/N.	0.27 μV for 20 dB.
Audio output power (8-Ω load): 1 W.	1.32 W.
Transmitter rf power output: 25 W.	30 W.
Spurious suppression: Better than 60 dB.	See Fig. 1.
Current drain: Receive, 0.3 A; transmit, 5.0 A.	Receive, 0.21 A; transmit, 5.85 A.
Size (HWD): 2 × 5.9 × 6.8 in. (51 × 150 × 173 mm).	
Weight: 2.9 lb (1.3 kg).	

Features

The '230 is equipped with a microphone, a fused power cord, a mounting bracket, a removable wire stand and an SO-239 connector on the rear panel. A large heat sink takes up most of the back panel. The rest of the space is occupied by the power connector, a 1/8-inch jack for an external speaker, a tone burst ON/OFF control and a control for the frequency scanner.

A frequency coverage of 143.500 to 148.495 MHz surpasses the rated specifications. With the five-digit display, a resolution of 0.1 kHz is achieved. (When the display shows 5.545.0, the actual frequency is *145*.545.0 MHz; the first two digits are assumed.) The front-panel-mounted VOLUME control doubles as the ON/OFF switch, and an outer ring on the same knob sets the SQUELCH level. A rotary switch selects the repeater offsets of ±600 kHz, and simplex operation. TONE CALL and TONE SQUELCH controls are located on the front panel. (In the European models, a HIGH/LOW [25/3W] power switch replaces the TONE SQUELCH control.) Red and green LEDs indicate a transmit condition or an opened squelch, respectively. A horizontal meter indicates power output on a scale of 0 to 10 and received signal strength. The MIC jack accepts microphone audio input and control lines for the PTT switch and frequency scanner. The μP and frequency controls occupy the rest of the front panel.

The Microprocessor

In addition to the small size, the most attractive aspect of this transceiver is the microprocessor. While operating frequencies *can* be selected using the 1-inch-diameter click-stop tuning dial, why not take advantage of all the conveniences a four-bit μP can provide? With switches on the microphone and on the front and back panels, the operator can make full use of the frequency-selection flexibility of this rig. Ten memory channels are available; each will recall a repeater offset of ±600 kHz or will store transmit and receive frequencies for simplex operation. To load the memories, the desired frequency is selected using the main dial, one button is pressed and the necessary information is entered, erasing whatever frequency was stored previously in that channel. A scanner, controlled by UP and DOWN buttons on the microphone, will zip through the 4-MHz frequency range in 45 seconds when using the 10-kHz steps provided by the PLL frequency synthesizer. A 5-kHz step rate may be used, doubling the scan time. The scanner can also go through the memory channels; a front-panel button selects the scanner range. The scan will stop for five seconds for any of three commands: a clear frequency, a busy frequency — when the squelch is opened — or manually, by pushing the UP, DOWN or PTT buttons on the microphone. The scanner is activated by holding the UP or DOWN buttons for more than 1/2 second. If pressed for less than 1/2 second, these same buttons will advance the synthesizer one step — 5 or 10 kHz. The microphone has a LOCK switch that disables the frequency-selector buttons.

Other Specifics

Two VFOs are selected by an A/B button on the front panel. The VFOs may be used with the memory channels to cover unusual repeater pairs. In this mode, the receive frequency is fixed and controlled by the memory channels, and the main VFO dial selects the transmit frequency. When this function is activated (by pressing two buttons on the front panel), a small bar appears on the LCD. A priority channel is available, the desired frequency being checked every five seconds during operation. The scanner will stop on the priority frequency if it is busy or clear, depending on how the scanner is set. A lithium battery is provided to retain the last function and frequency selected prior to disconnecting the transceiver from a power source. Whenever a major function is varied, or if the scan locks for five seconds, a beep sounds, alerting the operator to the change in status.

The manual is easy to read; approximately half of its 52 pages are devoted to control operations, installation and operating instructions. A thorough maintenance and alignment section is included.

Impressions

The FT-230R feels right at home in a car. I took the rig on several trips around the northeastern U.S. With a 1/4-wavelength whip on the roof of my car, I was easily able to work repeaters 50 miles away. The high-power output

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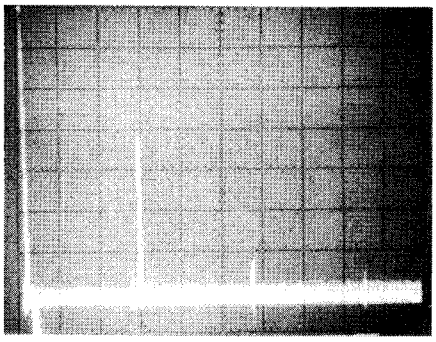

Fig. 1 — Worst-case spectral display of the FT-230R. Vertical divisions are each 10 dB; horizontal divisions are each 50 MHz. Output power is approximately 30 W at a frequency of 148 MHz. All spurious signals are at least 62 dB below peak fundamental output. The fundamental has been reduced in amplitude approximately 32 dB by means of notch cavities; this prevents analyzer overload. The FT-230R complies with current FCC specifications for spectral purity.

is a big plus. Transmit audio quality was never criticized. All front-panel controls have a decisive feel to them, and the status-change beep was a help while I was concentrating on my driving. Before a trip, I cut out portions of an *ARRL Repeater Director* and taped them in my atlas next to the various cities I would be passing through. It was a simple matter, when coming close to a metropolitan area, to load up the 10 memories with the appropriate frequencies and offsets. The μP memory feature was a blessing here. All further frequency control was performed through manipulations of the microphone buttons, making my driving quite a bit safer.

I noticed several minor drawbacks when using the rig. The sound from the built-in, bottom-mounted speaker tends to be mushy. While this is no trouble when the rig is used as a base station, careful listening is required when driving at highway speeds. The large LCD is easy to see, although in bright daylight the digits are unreadable when viewed at an angle. I never found the priority channel feature to be of use. If I had a favorite net or repeater frequency, though, it would be indispensable. The rig draws a hefty amount of current commensurate with its high power. It is unfortunate that the American version has no low-power setting. With such high power, the heat sink gets *hot*. Air should be permitted to flow past the rear of the rig. I found that out-of-band transmission can occur, but only when the simplex mode is selected.

The FT-230R is an excellent 2-meter rig. If you're looking for small size and high power, this rig may be for you. The Yaesu FT-230R is available from Yaesu Electronics Corp., P.O. Box 49, Paramount, CA 90723. Price class is $300. — *Leo D. Kluger, WB2TRN*

FLESHER CORPORATION TU-300 AND -470 RTTY TUs

☐ One of the more popular RTTY terminal units (TU) to have entered the Amateur Radio ranks is the Flesher TU-170.[1,2] RTTY buffs found this unit to be an economical and highly effective modem, and many are still in use today. But there were many '170 users who craved a little more in the way of operating features. The TU-300 and -470 should fill this need.

My TU-300 review was on its way to be typeset when I received news of the birth of the TU-470. After I spoke with Joe Elliott of the Flesher Corporation, we agreed it would be a good idea to combine the reviews of the two units because of their similarity.

To a great extent, the circuitry of the two units is the same. Some circuit changes, a different board layout, a built-in loop supply, and a front-panel face lift distinguish the '470 from the '300. It comes with all the plug-in boards that are options with the TU-300. Perhaps the most distinguishing characteristic of the '470 is that it is not available in kit form. Only wired and tested units are available from Flesher.

Description

The TU-300 and -470 are each housed in a smooth-lined, heavy-duty, blue-gray steel cabinet. The units are powered from the ac line by a built-in, triple-voltage-regulated power supply. A series of five function-indicator LEDs and a 10-segment LED bar graph display occupy the upper-right portion of the front panel. The lower front-panel section supports a neat row of flag-type push-button switches.

The bar-graph display is used as a signal strength indicator and provides a relative filter-output level indication. Most of the five LED indicator functions are self-explanatory: POWER, ac power on; SEND shows the TU-300 is in the transmit mode; RDA (receive data available) indicates the presence of a signal and closure of the autostart relay; MARK/SPACE, illuminated when a signal is present at the respective filter output when in the receive mode and during transmit, indicates the presence of the appropriate tone at the afsk input.

Up Front

TU-300 front-panel push-button switch functions include: POWER ON/OFF, OPERATE/STANDBY, RECeive/SEND, REVERSE SHIFT SEND/REC, and AUDIO FREQUENCY-SHIFT 170 HZ, 425 HZ, 850 HZ. The '470 has added RTTY/CW and FILTER NARROW switches. In the STANDBY position, the demodulator output is locked in the MARK state and the autostart relay is energized. It takes approximately one second for the relay to drop out after restoring the switch to the OPERATE position.

With the REC/SEND switch in the REC position, the filters selected by the FREQUENCY SHIFT switch are enabled and the demodulator output placed on the RS-232C and TTL output lines. In the SEND position, the demodulator output is locked in the MARK condition, the afsk audio output is enabled and a pair of auxiliary switch contacts is closed. (Access to these contacts is made via a 25-pin connector on the rear panel.)

Locking the REVERSE SHIFT REC switch reverses the MARK and SPACE assignments of the selected audio frequencies. The SEND switch section reverses the output frequency assignments to the MARK and SPACE afsk inputs. The two switches are used when receiving or transmitting "upside down." (Convention calls for the use of lsb when using afsk on the hf bands.)

Mutually exclusive switches are used to select the FREQUENCY SHIFT used. In each case, the switch selects a separate filter board for the SPACE frequency, MARK remaining at 2125 Hz. For 170-Hz shift, a 2295-Hz filter is chosen, a 2550-Hz filter for 425-Hz shift, and a 2975-Hz filter for 850-Hz shift. For the '300, remember that the individual boards should be installed for the shifts desired, but MARK-only copy is possible for any of the shifts for which no SPACE frequency filter is present. All boards are installed in the '470.

The RTTY/CW switch of the '470 selects either mode of operation. The cw demodulator has a center frequency of 750 Hz. That corresponds closely to what most transceivers use nowadays for the audio pitch delivered when a cw signal is centered correctly in the filter passband. As the cw demodulator board's center frequency is adjustable, some deviation from the nominal 750-Hz figure is possible.

A FILTER NARROW switch on the '470 inserts a 170-Hz shift preselector filter that has a bandwidth of approximately 350 Hz. This filter is

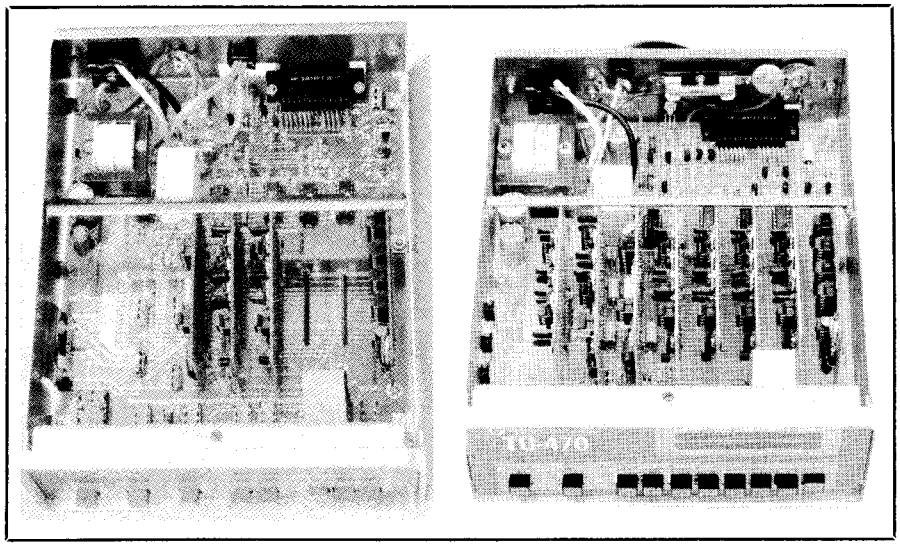

Fig. 2 — Views of the attractive interiors of the TU-300 and TU-470. The TU power transformer is at the left rear of the cabinet; the autostart relay is to the right of the transformer. All ICs are socketed.

[1]"Flesher Corporation TU-170 RTTY Terminal," *Product Review*, March 1979 *QST*, p. 42.

[2]The successor to the TU-170 is the TU-170A, announced in December 1982.

disabled when any frequency shift other than 170 Hz is used and should be manually disabled when using the cw demodulator feature. The manufacturer does not recommend the filter be used for 300-baud operation.

Bringing Up the Rear

The TU-300 and -470 rear panels are similar. On the '300 rear panel there is a DB-25 socket for I/O connections (a mating plug is supplied), a four-pin plug for use with the optional external loop supply, a grounding post, entry point for the ac line cord, and a three-conductor auxiliary ac socket that will provide autostart-relay-controlled 117-V ac line power to an external device such as a printer. The four-pin plug is absent from the '470 rear panel. A 1/4-inch key jack is located in the upper-left corner instead. It is used as the 20- or 60-mA loop output connector. Loop current is determined by the use of a jumper.

Other Differences

Some control pin function differences exist between the two TUs. Pin 23 of P1 on the '300 (now, more appropriately, S1 on the '470) is unused. In the '470, a SEND-P line has been added here. This is essentially a dupe of SEND-N, but where SEND-N is a TTL level, SEND-P is a bipolar ±3-V "RS-232C" level. XMIT-P and XMIT-N provide transistor keying for positive or negative PTT or cw key lines. These functions take the place of the mechanical SW1/SW2 function of the TU-300. XMIT-P/N are keyed by the front panel SEND/RECeive switch, the SEND-N or SEND-P inputs.

TU-300 Assembly

There are bound to be a number of readers who have constructed the TU-170 and are familiar with the (shall I say "concise"?) assembly instructions. In contrast, the '300 assembly manuals are quite detailed.

It took me a little over 6-1/2 hours to build the TU-300. Before construction began, information from some addenda sheets had to be transferred to a couple of the manuals (of which there are four, not counting the optional afsk unit: an operator's manual, and assembly manuals for the main/display, filter and demodulator boards.) These changes have been incorporated into the later editions of the manuals.

The main circuit board has provisions for a plug-in demodulator board, four filter boards, the optional afsk board and two expansion slots. Such construction makes assembly/disassembly and troubleshooting easy. You'll find that the plug-in boards can be installed backward, so be careful and pay attention to the illustrations. If you're installing the optional afsk unit, leave one end of D1 (at the gate of the output FET) lifted from each of the filter boards. Otherwise, you'll have to unsolder it later.

The unit I received called for some below-the-board changes to be made for better autostart/antispace action. I added these after first determining that the circuit was working normally otherwise. Later production units have these changes included.

During the review period, I received notice that a cw-demodulator option had been developed. This board is placed into one of the expansion slots on the main board. This option also requires the mounting of a front-panel switch for which a panel hole and space have been provided.

Low-tone kits for the 1275- and 1445-Hz frequencies are available, too. This option is not meant to be a modification for existing filter boards, however. Flesher recommends the filter boards be constructed initially with your choice of high or low tones.

Component quality is excellent. The pc boards are all glass-epoxy types, double-sided with plated-through holes, solder masked and with screened parts locations. A metal bracket fitted between the chassis side rails is slotted to accept the edges of the plug-in boards and secure them, as well as provide some additional structural strength to the overall assembly. The front panel/chassis assembly slides into the wrap-around steel cabinet and is secured by two screws at the rear. The complete unit is as rugged as it is attractive.

Alignment

This procedure consists simply of adjusting three potentiometers on each of the filter boards for maximum response. A number of alignment methods are offered, the first requiring no test equipment whatsoever! With this method, the output of the optional afsk unit is connected to the demodulator input by placing a wire jumper between two pins on the DB-25 connector. Since the tones produced by the afsk unit are crystal-controlled, they are smack on the nose — 2125 and 2295 Hz (measured with an Optoelectronics 7010A frequency counter) — with the 170-Hz filter in use. The afsk output adjustment potentiometer is set to produce a usable indication on the front-panel LED bar graph display, and the three potentiometers on the individual filter boards are adjusted for a maximum display. The SEND/REC switch is used to select the proper filter and tone. This is possible because, during assembly, certain selection diodes have not been soldered in place.

If you have a VTVM or an oscilloscope, I'd recommend you use it during alignment because you can obtain a finer degree of filter tuning, but I doubt you'd notice the results in on-the-air use. Should you not have ordered the afsk unit, you'll have to supply the proper tone frequencies to the demodulator. You can use an audio generator or you may try using the marker signal from your receiver or transceiver. Just make sure you have the proper input frequencies.

Once the filters are aligned, solder the remaining diodes in place and assemble the case. You're now ready to put the '300 to work. Since the '470 is up and ready to run when you get it, no alignment should be necessary. There are alignment instructions in the manual for each of the boards should you ever need to perform those tasks.

On Line

The rear panel TU connectors provide for interconnection among the station radio equipment, a 20- or 60-mA current loop teleprinter (with the optional '300 loop supply), and a computer or other device requiring RS-232C or TTL levels. A TTL-compatible SEND control pin permits placing the TU in the transmit mode by external control. The cw key input (for required station identification) is TTL compatible, too. The latter provides a shift of 100 Hz.

If you're not planning on using the loop supply, the manufacturer recommends the supply be disabled. Instructions for accomplishing this are given in the manual. The purpose of this is to eliminate excessive heat build-up in the chassis from power dissipated by the loop-keying transistor. The manufacturer also recommends the key-down time for the loop supply not exceed 15 minutes.

You'll find the TUs easy to use. Receiver tuning is done while observing the MARK and SPACE LEDs, and the LED bar graph indicator. Tuning is adjusted for a maximum display on the bar graph, with alternating action on the MARK/SPACE LEDs. (I would have liked to have had a bit more resolution on the bar-graph display at the upper end of its range.)

If you wish, you can connect an oscilloscope to observe the RTTY cross pattern. While not an absolute necessity, it provides you with a fine-tuning indicator and permits observation of selective fading of the incoming signal. (If you've got visitors in the shack, they're sure to be impressed!) The display consists of two ellipses rather than a perfect cross, but it is still quite usable.

Unlike the TU-170 and TU-470, there is no threshold adjustment in the '300; it is fixed. Under most conditions, the fixed level is such that good copy is obtained, but under some signal conditions, one might consider altering the threshold level to provide better copy. The TU-470 has an internal threshold-level adjustment potentiometer. It is R64 and is accessible through a hole in the right-hand side of the cabinet.

The TUs proved themselves to be good performers. I'm sure either will run rings around some others you've used, both commercial and "homebrewed."

The TU-300 and TU-470 are available from the Flesher Corp., P.O. Box 976, Topeka, KS 66601, tel. 913-234-0198. Kit price classes: TU-300, $300; optional afsk unit, $40; loop supply, $48; filters, $30 each; TU-470, $500. — *Paul K. Pagel, N1FB*

ICOM IC-R70 COMMUNICATIONS RECEIVER

☐ I was especially interested in reviewing the ICOM IC-R70 receiver because of my long-term interest in high-performance receiver design. Therefore, I did not hesitate to say "yes" when the review editor, N1FB, asked if I'd volunteer my time for the project! Over the years I have evaluated more inferior commercial receivers than good or excellent ones. It is difficult to rule out subjectivity when a person with an rf-engineering background lays hands on a piece of gear he or she did not design. But for the purpose of reviewing a product it is essential that we stick to the performance facts and ignore what we might have done differently in designing the unit. I like to compare the performance

ICOM IC-R70 Receiver, Serial No. 01234

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 0.1 to 30 MHz, general coverage or ham-band only, via switch.	As specified.
Modes of operation: cw, ssb and a-m; fm when optional fm module used.	As specified.
Frequency readout: six-digit blue luminescent display.	3/8-inch digits. Has 2-digit mode indicator also. Skirt of tuning knob has analog increments to match the programmed frequency tuning rate of the receiver.
kHz per turn of knob: 1 kHz, 10 kHz or 100 kHz (tuning rate switch selected).	As specified.
Backlash: Not specified.	None discernible.
RIT range: Greater than ±800 Hz.	±1000 Hz.
S meter response (μV/S9): Not specified.	All amateur hf bands and 1.8 MHz; −61 dBm (200 μV); preamp off.
AF/i-f notch filter depth: Not specified.	Approximately 70 dB.
Receiver sensitivity (preamplifier on): cw, ssb, RTTY — less than 0.15 μV for 10-dB S + N/N. For a-m — less than 0.5 μV for 10-dB S + N/N above 1.6 MHz.	*80 m* / *20 m* Noise floor (MDS) dBm: −130 / −130 Blocking DR (dB): 90.5 / 94.5 Two-tone 3rd-order IMD (dB): 94 / 87.5 3rd-order intercept (dBm): +11 / +12.5
Frequency stability: Less than 250 Hz from one minute after on to 60 minutes.	Less than 50 Hz.
Audio output (8-Ω load): Greater than 2 W.	2.25 W.
Noise blanker: Dual timing mode (selectable) for normal pulses and OTHR QRM.	Satisfactory.
Synthesizer noise: Not specified.	Not measured, but very low noise in terms of reciprocal mixing, even when strong signals are nearby in frequency.
Color: Black.	
Size (HWD): 4-3/8 × 11-1/4 × 10-7/8 in. (110 × 285 × 275 mm).	
Weight: 10.3 lb (4.85 kg).	
Power requirements: 117- or 234-V ac at 50-60 Hz, 30 VA.	As specified.

against the cost and circuit complexity. That is, if a large number of components are used in the product, it stands to reason that performance in keeping with the price tag should be easy to realize. Basically, it is how the parts are used that determines the relative quality of the product. Two ingredients are essential: (1) knowledge of the amateur's operating and equipment-performance needs, and (2) competent design engineering.[3] It appears to me that the criteria were met with respect to the IC-R70 receiver. I would definitely rate this unit as a clean, high-performance box.

Significant Operating Features

1) General coverage (0.1-30.0 MHz) or ham-band only (1.8-28 MHz, including the WARC bands), at the push of a switch.

2) Quadruple superheterodyne circuit with continuously variable bandwidth control.

3) Filters for a-m, ssb, RTTY and cw are standard equipment.

4) Selectable preamplifier (panel switch).

5) Selectable tuning rate of 1 kHz, 100 Hz or 10 Hz per step.

6) Two internal VFOs. Can be used independently in any chosen band.

7) Band-pass tuning.

8) No preselector to peak (contains broadband front-end filters), thereby permitting rapid UP-DOWN band changing by means of panel buttons.

9) A panel switch permits turning on a monitor for the transmitter signal, thus enabling the operator to check the actual signal quality.

10) Variable-frequency notch filter.

11) Front-panel RTTY mode switch automatically selects the cw (500 Hz) and ssb (2.3 kHz) i-f filters for RTTY reception. Both filters are used for RTTY.

12) VFO memory switch permits retaining the programmed VFO frequencies even when the main power switch is turned off. There are numerous other features, but those mentioned should be of special interest to prospective buyers.

[3]D. DeMaw and W. Hayward, "Modern Receivers and Transceivers — What Ails Them?" *QST*, Jan. 1983.

Circuit Highlights

The following features are probably of interest to the performance-conscious amateur or engineer:

1) Drift: 250-Hz maximum first hour; less than 50 Hz after one-hour warmup.

2) Passband tuning is ±500 Hz for ssb, cw and RTTY; ±2.7 kHz for a-m.

3) A 250-Hz cw filter (FL-63) is available as an option. A 500-Hz cw filter is supplied with the receiver.

4) An internal frequency-adjust control permits the operator to align the PLL oscillator to WWV at 10 MHz.

5) A panadaptor/scope monitor jack is located on the rear of the chassis. It samples the 70-MHz i-f at the first mixer output.

6) The selectable preamp is broadband and has a gain of 10 dB. The attenuator (same switch) reduces the signal by 20 dB.

7) A DBM (diode ring) is used as the first mixer. The i-f of this mixer is 70 MHz. A monolithic filter follows the mixer.

The PLL contains three phase-locked loops. Output from the first is 13.15 to 23.14 MHz, with 10-kHz steps. The loop output is divided by 100 and used for the reference frequency of the second loop. The LO frequency for the first loop is 20.48 MHz.

The second-loop output is from 30.8515 to 30.9514 MHz, with 10-Hz steps. The local oscillator is a VXO from which the output is tripled to 30.72 MHz.

The third (main) loop has an output from 70.4515 to 100.4514 MHz. This output is used as the first LO for the receiver. Four VCOs are employed to divide the LO frequency range into four segments.

Performance Impressions

I put on my demon's mask, smiled sardonically and subjected the IC-R70 to the customary W1FB receiver-torture test — just two blocks from the 1-kW, multiband onslaught of W1AW. I fully expected to see the excellent receiver dynamic range negated by reciprocal mixing problems resulting from synthesizer output noise. I was amazed to note that no discernible evidence of the malady existed, even a few kilohertz away from the W1AW 80-meter frequency!

Why check this on 80 meters? Well, I once terminated my 80-meter vertical antenna in 50 ohms and measured the W1AW energy across the resistor with a Tektronix 453 scope: The rf level was 5 V peak to peak! It is not nearly so high on the other hf bands. So, 80 meters has always been my most difficult challenge with respect to keeping receivers from "crunching" at my QTH. I did not observe blocking, cross-modulation or excessive IMD responses while testing the receiver on 80 meters (or any other band), and I was able to copy weak cw signals as close to the W1AW frequency as 5 kHz. There was no apparent performance degradation when I switched in the 10-dB preamp, and that *was* a surprise!

If I were to "pick nits" about the performance, I would mention that the agc tends to lock up more readily from strong signals in the passband than is characteristic of some other receivers I have used. Also, the audio-output signal becomes distorted at room-listening level and higher when using the speaker (see note 3), even though the af channel is rated for a minimum of 2-W output. This malady seems to afflict most of the solid-state receivers we have tested, but it is not a problem when headphones are used or when the audio-speaker level is moderate. If you weren't born with "golden ears" you may not observe this condition. I'm just a grouch about audio quality, even in communications receivers.

I was delighted to note an absence of agc-caused clicky signals. The attack time is entirely acceptable, and the decay time can be controlled by means of a panel switch to provide fast or slow agc. There is also an agc-disable switch position, which comes in handy when a big signal does lock up the agc circuit and desenses the receiver.

Noise-blanker operation is good, and there is no appreciable deterioration of the receiver dynamic range observed when it is actuated. I am favorably impressed, because many receivers completely "fold up" at my QTH when the blankers are turned on.

This receiver should be fine for amateur use. It would also be a good choice as a laboratory-grade instrument. I'd like to own it for that purpose myself!

Price class: IC-R70, $750. Available from ICOM America, Inc., 2112 116th Ave. N.E., Bellevue, WA 98004.

— *Doug DeMaw, W1FB*