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Heath Model IM-2320 Digital Multimeter

ICOM IC-u2AT 2-Meter Hand-Held Transceiver

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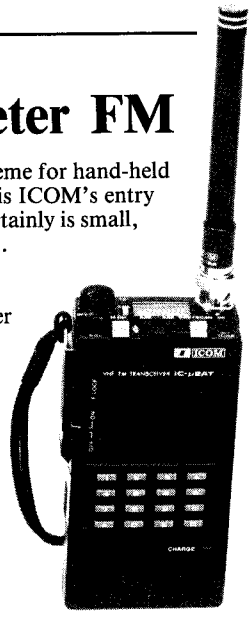
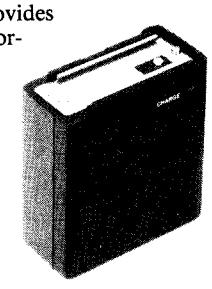
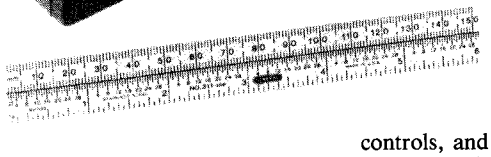
ICOM IC-μ2AT 2-Meter FM Hand-Held Transceiver

"Just how small can we make it?" seems to be the theme for hand-held transceiver manufacturers these days. The IC-μ2AT is ICOM's entry into the tiny-little-hand-held market. While the rig certainly is small, its features rival those of many full-size hand-helds.







Features

The rig has a wide frequency range; the transmitter covers 140-149.995 MHz and the receiver covers 140-163 MHz. The high power output level can be anywhere from 1.2 W to 2.6 W, depending on the battery pack in use. A dual-tone multifrequency (DTMF) keypad and a subaudible tone encoder are included as standard equipment.

An internal battery provides power to retain memory information when the transceiver is turned off. The owner's manual states that the battery should last one to two years, and that when the battery is discharged the rig will still operate normally, but will not retain memory information. ICOM recommends that the battery be replaced by an authorized service center, and also specifically warns against disassembling the transceiver for any reason. The days of "no user-serviceable parts inside" have definitely come to Amateur Radio, at least as far as pocket-size hand-helds are concerned.

Controls and Indicators

See Fig 1. The operating frequency is selected through three UP/DN switches on the top of the transceiver. Each switch controls a different tuning range step; the switches change the frequency in 1-MHz, 100-kHz and 5-kHz increments. Pushing the switch in one direction moves the frequency *up* by the selected increment; pushing in the other direction moves the frequency *down*. The 5-kHz UP/DN switch also functions as a SCAN switch. In SCAN, the frequency moves up or down in 5-kHz increments. There is no memory scan. The Memory CHannel control selects the next memory, either up or down.

Frequency, memory-channel number and field-strength/power level information are shown on a small liquid-crystal display located between the antenna connector and the on/OFF VOLume control. Four digits indicate the operating frequency: A frequency of 145.450 MHz is shown as "5.45," and a frequency of 146.745 MHz is shown as "6.74⁵." A group of small dots to the left of the first digit indicate which band segment you are on: one dot for 140-150 MHz, two dots for 150-160 MHz and three dots for 160-163 MHz. The five-section LCD bar-indicator shows received signal strength and the transmitter power level, either high or low.

A press-on/press-off switch on the left side of the μ2AT controls a light for the display. The light stays on as long as you are using the controls, and a timer turns the light off if there is no switch activity for 5 seconds. The light switch is also used with the UP/DN switches to change offset frequency, or to reset the central processor unit (CPU). The frequency offset can be changed from the 600 kHz default to any frequency as long as the transmit frequency falls within the 140-149.995 MHz range. The new offset applies to *all* the operating frequencies from then on, and the new offset is retained even after the power is turned off. The standard 600-kHz offset must be reset, if once changed.

A single-control on/OFF VOLume knob, a separate SQUELch control, a TX LED, a TONE ON/OFF switch and a CHK push-button switch complete the top-panel control complement. The CHK control is interesting; when it is pressed, the display and the receive frequency switch to the transmit offset frequency selected by the rear panel offset control. This is a handy way to quickly check the input frequency of a repeater, or to confirm that the offset switch is correctly set without transmitting. The TONE switch turns the tone encoder on; the subaudible tone is set by a six-position DIP switch on the bottom of the rig that is accessible only when the battery pack is removed. There are 32 built-in subaudible tones.

The μ2AT has 10 memories for operating frequencies, but the repeater offset is not part of the stored memory information. Offset is controlled manually by a +DUPlex/SIMplex/−DUPlex switch on the rear panel of the unit—a system that will be familiar to anyone who has ever used an ICOM IC-2AT. Having to change the offset when flipping through the memories seems like a minor annoyance compared to the convenience of having memories at all. The HIGH/LOW power switch is located

ICOM IC-μ2AT 2-Meter FM Hand-Held Transceiver, Serial No. 03372

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Transceiver—144-147.995 MHz (guaranteed); receiver 140-163 MHz; transmitter 140-149.995 MHz.	As specified.
Mode of operation: 16K0F3E.	As specified.
Frequency display: Four-digit LCD.	As specified.
Frequency resolution: 5 kHz.	As specified.
Frequency stability: ±15 PPM at 0°C to 60°C.	As specified.
Transmitter	*Transmitter Dynamic Testing*
Power output: 1.0 W high, 0.1 W low.	2.2 W, high; 0.11 W, low at 148.0 MHz (with BP-22).
Spurious signal and harmonic suppression: More than 60 dB.	More than 70 dB. See spectral photo.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity: Less than 0.25 μV (−12 dBμ) for 12 dB signal + noise + distortion/signal + distortion.	0.16 μV at 146.0 MHz.
Squelch sensitivity: Less than 0.1 μV (−20 dBμ)	0.08 μV min, 0.24 μV max.
Receiver audio output at 10% total harmonic distortion: More than 0.25 W.	0.29 W.
Color: Black.	
Size (height, width, depth): 4.6 × 2.3 × 1.1 in.	
Weight: 12 oz.	

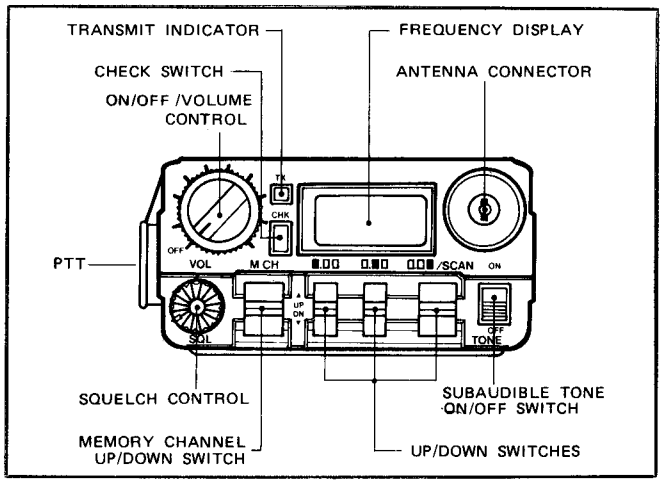


Fig 1—ICOM IC-μ2AT top-panel controls and indicators.

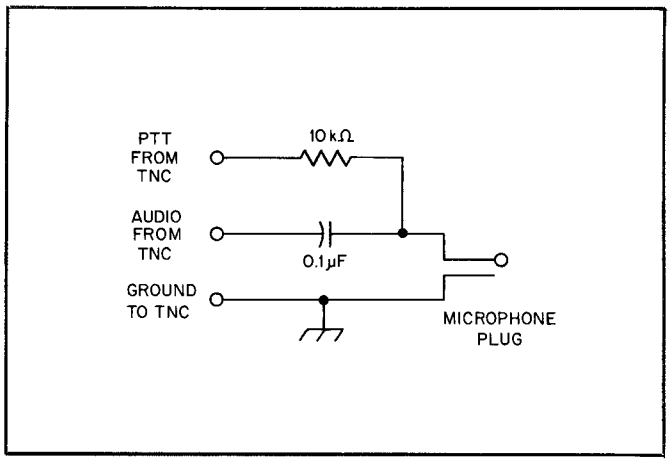


Fig 2—Packet-radio TNC interface for the ICOM IC-μ2AT and IC-2AT.

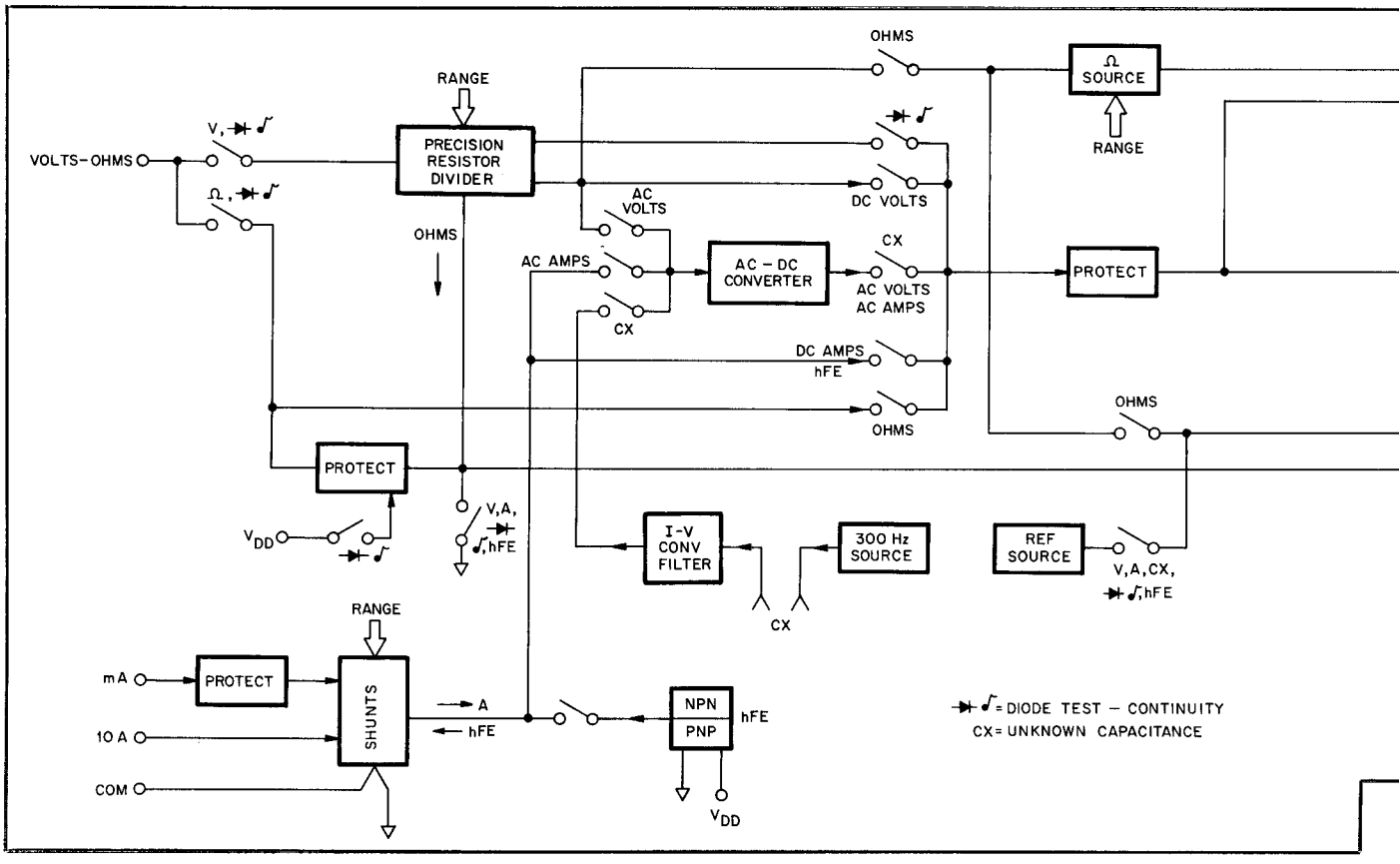


Fig 3—Block diagram of the IM-2320 Digital Multimeter.

on the rear panel near the offset selector switch.

In addition to the display light switch and the PTT switch on the left side of the μ2AT, there is a Frequency LOCK switch near the PTT switch. The F.LOCK switch disables the top-panel controls so that the frequency cannot be changed, but it does not lock the PTT to keep it from being pressed accidentally.

Battery Power

With the BP-21 (120 mAh) battery pack, shown installed on the transceiver in the lead photo, the μ2AT stands just over 4½ inches tall. ICOM claims that this battery pack produces a transmitter output of 1.2 W on high power, and that it allows operation for 2 hours.[1] The larger BP-22 (270 mAh) battery pack extends the unit to 5¾ inches, provides output of 1.6 W and allows you to operate for 4.5 hours. I found the operating times listed for the battery packs to be on the conservative side; the rig has a special "battery saver" mode that kicks in if there is no signal received or no switch operation for 30 seconds. This cuts current consumption to a minimum (6 mA, according to the manual). The trickle charger supplied with the review unit charged either battery pack in 15 hours, and the receiver *will* operate while the battery is being charged.

[1]ICOM bases their time estimates on a duty cycle of 10% transmit, 10% receive and 80% standby.

Accessories

For longer battery life, or higher power, ICOM offers the BP-23 long-life battery pack (600 mAh) that provides a 1.6-W transmitter output and operation for 10 hours, and a BP-24 high-power pack (also 600 mAh) that provides an output of 2.6 W and operation for eight hours. An alkaline battery holder (BP-20)

is available; ICOM claims 1.4 W transmitter output with alkaline batteries. A dc-to-dc converter (DC-25) converts 13.8 V to 9.4 V for the rig, and you can connect the DC-25 to your automobile cigar-lighter socket with a special cable (IC-CP1). Although the furnished trickle charger can charge the battery pack in 15 hours, an optional desk-top quick charger (BC-50) can put a full charge on the battery pack in one hour.

Base-station or mobile users can purchase a speaker/mic or a headset (either VOX or PTT-switch headsets are available), and a belt clip and carrying case are available for portable use. The μ2AT uses the same type of two-pin microphone and speaker jacks used on the IC-2AT, so speaker/mics and headsets designed for the IC-2AT should also work with the μ2AT. An external antenna can be attached easily because ICOM has used a standard BNC connector for the antenna connection.

Operation

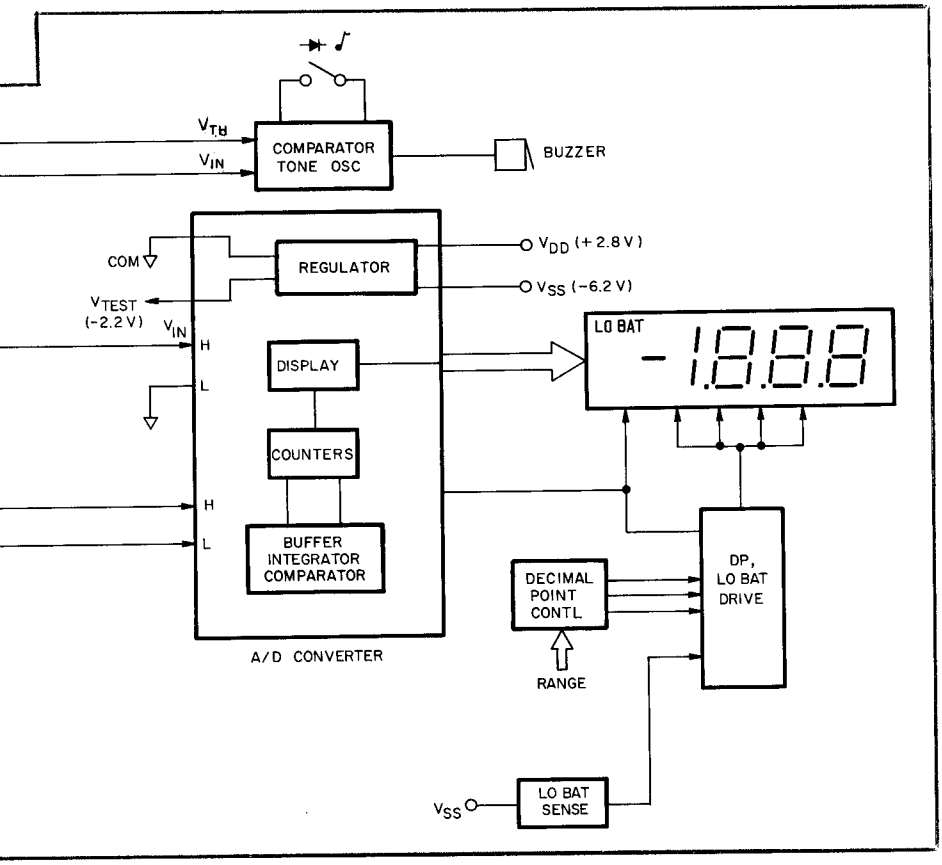
I really enjoyed this little rig! I took it just about everywhere with me during the three-week review period. I especially appreciated the extra frequency coverage of the receiver on a winter trip to the Adirondacks—I could get instant weather updates from the 162-MHz NOAA weather radio service.

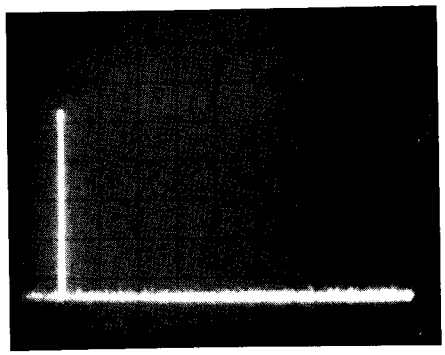
The μ2AT is pleasant to use. The frequency control switches are not too small, and the rig itself has a very solid, comfortable feel in your hand. I think the rig is actually a bit *too* small with the BP-21 battery pack; I used it mainly with the larger BP-22 pack. The display light is particularly convenient for night mobile use, as are the memories. I could work most repeaters from my car using just the "rubber duck" antenna; when I connected the rig to my ground-plane antenna at home, I could hear repeaters from all over the area and could easily work the W1AW repeater 15 or so miles away.

Connecting the μ2AT for use on packet radio was easy; I was able to use the same keying circuit I used for the IC-2AT. I had to add an ac-coupling capacitor when I used the rig with an AEA PK-232. The circuit is shown in Fig 2. The rig worked well on packet.

While the μ2AT does not have *all* the bells and whistles of some of the larger hand-held rigs, it is amazing what ICOM has managed to cram into this tiny package. Its features are well thought out and easy to use. It's hard to imagine that anyone would be unhappy with this rig.

Manufacturer: ICOM America, Inc, 2380-116th Ave NE, Bellevue, WA 98004, tel 206-454-7619. Price class: μ2AT, $329, BP-22 battery pack, $38, BP-23 battery pack, $47, BP-24 battery pack, $49, DC-25 dc-to-dc converter, $24.—*Bruce S. Hale, KB1MW*





Spectral display of the IC-μ2AT operating at 144.000 MHz with approximately 2.2 W output power. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. The fundamental has been reduced in amplitude approximately 26 dB by means of a notch filter to prevent spectrum analyzer overload. All harmonics and spurious emissions are at least 70 dB below peak fundamental output. The IC-μ2AT complies with current FCC specifications for spectral purity.

HEATH MODEL IM-2320 DIGITAL MULTIMETER

I love kits! Of course, I just like to build things, but I feel that kits are challenging and worthwhile for the average builder. Heath Co has always offered a line of peripheral and accessory items that are not only useful in the shack, but give the builder a way of understanding what is "going on" in the equipment. In their normal kit development process, Heath goes through a "proofbuild" phase. The first 10 or so kits for any design are built by volunteers who report any and all problems they encounter, as well as their opinions of the items after construction. When Heath offered me the opportunity to participate in their kit proofing for the IM-2320 Digital Multimeter (DMM), I jumped at the chance.

The IM-2320 is a kit version of the SM-2320 Digital Multimeter that Heath has provided in wired and tested form for some time. It is similar in appearance to most of the hand-held DMMs that have appeared over the past few years. I have never looked inside one of these units to see what's inside, so I was interested in how they are put together. I am very impressed with what I found in this unit. The '2320 includes two circuit boards. Both boards are of excellent quality—solder masked, silk screened and with *gold plated traces*. I was surprised to find that gold plating or flashing is normal practice in the DMM business. Gold does not tarnish and corrode, and provides long life for the switch contacts.

The IM-2320 provides seven different measurement capabilities: dc and ac volts, dc and ac current, resistance, capacitance and transistor gain (h_{FE}). In addition, there is a diode tester and a continuity checker that provides an audible tone if the test-point resistance is 200 Ω or less. The ranges for each

Table 1
Heath IM-2320 Digital Multimeter Specifications

Dc Voltage

Range	Resolution	Accuracy *	Overvoltage Protection	Input Impedance
200 mV	100 μV	0.5% of reading + 1 digit.	Dc: 500 V. Ac: 350 V.	10 MΩ.
2 V	1 mV		Dc: 1000 V. Ac: 750 V.	
20 V	10 mV			
200 V	100 mV			
1000 V	1 V			

Ac Voltage

Range	Resolution	Accuracy **	Overvoltage Protection	Input Impedance
200 mV	100 μV	±(1.25% of reading + 4 digits). 40 Hz to 1 kHz.	Dc: 500 V. Ac: 350 V.	10 MΩ, less than 100 pF.
2 V	1 mV	±(1.25% of reading + 4 digits). 40 to 400 Hz.	Dc: 100 V. Ac: 750 V.	
20 V	10 mV			
200 V	100 mV			
750 V	1 V			

Dc Current

Range	Resolution	Accuracy *	Voltage Burden	Overload Protection
200 μA	0.1 μA	±(1.0% of reading + 1 digit).	250 mV maximum.	250 mA (250 V) fast-blow fuse.
20 mA	10 μA			
200 mA	100 μA			
10 A	10 mA	±(2.0% of reading + 3 digits).	700 mV maximum.	

Ac Current

Range	Resolution	Accuracy *	Voltage Burden	Overload Protection
20 mA	10 μA	±(1.5% of reading + 3 digits). 40 Hz to 1 kHz	250 mV maximum.	250 mA (250 V) fast-blow fuse.
200 mA	100 μA			
10 A	10 mA	±(2.5% of reading + 4 digits). 40 Hz to 400 Hz.	700 mV maximum.	

Resistance

Range	Resolution	Accuracy *	Maximum Test Current	Maximum Open-Circuit Voltage	Overload Protection
200 Ω	0.1 Ω	±(0.75% of reading + 4 digits).	2 mA.	2.6 V.	250 V dc/V ac.
2 kΩ	1 Ω	±(0.75% of reading + 1 digit).	250 μA.	1.0 V	
20 kΩ	10 Ω		50 μA.		
200 kΩ	100 Ω		5 μA.		
2 MΩ	1 kΩ		500 nA.		
20 MΩ	10 kΩ	±(2.0% of reading + 5 digits).	50 nA.		

Capacitance

Range	Resolution	Accuracy ***	Test Frequency
2 nF	1 pF	±(2.0% of reading + 4 digits).	300 Hz
20 nF	10 pF		
200 nF	100 pF		
2 μF	1 nF		
20 μF	10 nF		

*Add 0.5% if calibrated with supplied reference.
**Add 1.0% if calibrated with supplied reference.
***Add 1.5% if calibrated with supplied reference.

function and the accuracy specifications are shown in Table 1.

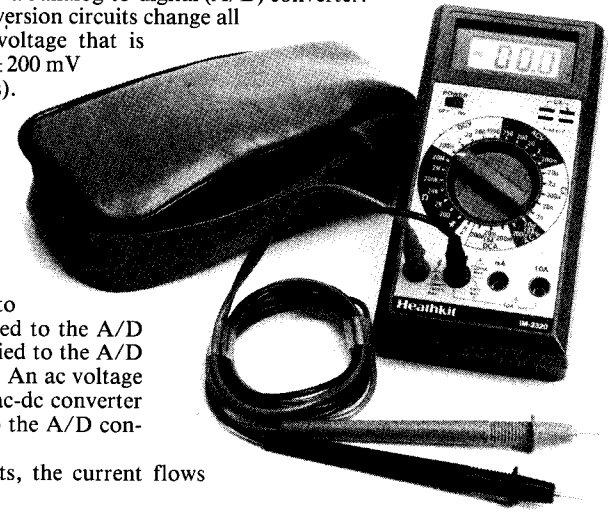
The Kit

The kit includes several packets of parts, separated according to board assignments. All electronic parts are of excellent quality. The 1% precision resistors I received with my kit were of a rather dark gray color, and consequently it was difficult to read the color codes. Heath has advised me that the resistor color has been changed in the production kits to make identification easier.

The front circuit board is smaller than the rear board, and mounts to the rear board by means of the function-selector switch. Connections between the two boards are effected through the function-selector switch and a few interconnecting wires. The piezoelectric buzzer mounts on the front circuit board. The liquid-crystal display (LCD) mounts on a small pedestal that is secured to the rear board and positions the display properly in the front panel of the case. The LCD is driven through a conductive black "foam" connector from the IC on the rear board to the actual display. There are very few instructions about this assembly procedure, and I was a little concerned about putting this item together. My fears were groundless, however—it works great!

Circuit Description

Fig 3 shows a block diagram of the DMM. All inputs to be measured are directed through the function range switches to scaling networks or to conversion circuits, and then to the input of an analog-to-digital (A/D) converter. The switching, scaling and conversion circuits change all inputs to a proportional dc voltage that is usable by the A/D converter (±200 mV for all functions except ohms). The A/D converter uses a dual-slope ramp technique to convert dc voltage to a digital display in a single MOS/LSI integrated circuit.



For voltage measurements, the precision resistance divider circuit scales the input to a 0 to 200 mV level before it is applied to the A/D converter. A dc voltage is applied to the A/D converter directly after scaling. An ac voltage is routed, after scaling, to an ac-dc converter and the dc output is applied to the A/D converter input.

For dc current measurements, the current flows