Product Review Column from *QST* Magazine

March 1988

ICOM IC-375A 220-MHz Multimode Transceiver

RF-Concepts RFC 2-23 and RFC 3-22 Solid-State 144- and 220-MHz Amplifiers

Conducted By Mark Wilson, AA2Z
Senior Assistant Technical Editor

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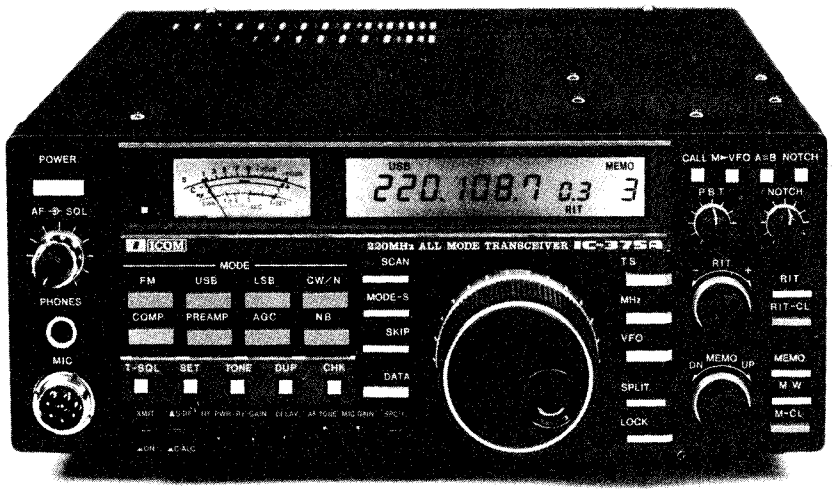
ICOM fulfills many a VHFer's wish with the IC-375A. Part of ICOM's new line of compact 25-W VHF transceivers, the IC-375A was the first 220-MHz multimode transceiver on the market. Until now, VHFers who prefer separate transceivers for each band had to find some other way (usually a low-band transceiver and transverter) to get on 220-MHz SSB and CW.

The IC-375A features 25 W output, FM, SSB and CW operation, coverage of the entire 220-MHz band (and then some), built-in ac-operated power supply, a fast TR turnaround DATA mode, memories and scanning, passband tuning and notch filter, and full-break-in CW operation. The operating features and functions of the IC-375A are virtually identical to those of the ICOM IC-275A reviewed in October 1987 *QST*. See the IC-275A review for a detailed description of many of the controls and connections listed in Table 1.



Frequency Control

Like its 2-meter counterpart, the IC-375A features VFO A/B selection, 99 tunable memories, four useful memory scanning modes, RIT and the ability to enter virtually any repeater frequency split. A 1.6-MHz split is standard, but it is easy to program any split from 1 kHz through 9.999 MHz using the SET control. In the DUPlex mode, the frequency display shows the actual transmit and receive frequencies.

Receiver

The IC-375A receiver covers 216 to 236 MHz. Unfortunately, there isn't a whole lot to listen to outside the amateur band. In the 216-220 MHz range, you can hear low-power wildlife tracking telemetry beacons and tone and data transmissions from inland waterway buoys. The range above 225 MHz (all the way to 400 MHz) is assigned to the military and mostly used by aircraft. If the receiver coverage went a little lower, to 215.750 MHz, you could listen to TV Channel 13 aural carriers to monitor propagation.

A band-pass filter followed by a 3SK121 dual-gate GaAsFET RF amplifier, more filtering and a singly balanced JFET mixer (employing a pair of 2SK125s) contribute to solid receiver performance. The dynamic-range figures detailed in Table 2 are similar to those of many current HF transceivers. An outboard preamp is desirable for weak-signal work, however, because the IC-375A has a receiver noise figure in the 4-dB range.

The IC-375A receiver is a multiple-conversion superheterodyne design. In the

Table 1
IC-375A Controls and Connections

Front Panel

General

POWER switch
SPEECH synthesizer switch (for optional UT-36 synthesizer)
Mode switches
DATA switch
CW DELAY control
S-RF/C ALC meter switch
XMIT transmit/receive switch
XMIT and RECV indicator lights

Frequency Control

Main tuning knob
SCAN start/stop switch
MODE-selective scan switch
SKIP scan switch
Dial LOCK switch
TS tuning step switch
MHz select switch
RIT frequency control
RIT on/off switch
RIT-CLear switch
VFO (A/B) switch
VFO A=B equalizing switch
VFO SPLIT switch
DUPlex switch
Duplex CHECK switch
Memory > VFO switch
Memory write switch
MEMory read switch
MEMORY DN/UP channel selector
Memory-CLear switch
CALL channel switch

Transmitter

MIC connector (8 pins)
MIC GAIN control
RF PWR control
COMP speech processor switch
TONE-SQUELCH switch (for optional UT-34 tone squelch unit)
Tone SET switch
TONE on/off switch

Receiver

PHONES jack (¼ inch)
AGC switch
AF gain control
AF TONE control
RF GAIN control
SQUELCH control
NOTCH filter switch
NOTCH filter control
PASS BAND TUNING control
NOISE BLANKER switch
PREAMP on/off switch (for optional AG-25 external preamp)

Rear Panel

ANTENNA connector (SO-239)
KEY jack (1/8 inch)
EXT SPEAKER jack (1/8 inch)
GND terminal
Ac power jack (CEE-22)
DC 13.8V jack (Molex)
Fuse holder
ACCESSORY jack (8-pin DIN)
AQS jack (multipin) for digital communications
REMOTE control jack (1/8 inch)
TX-METER—RF/SWR switch
CW BK-IN—OFF/SEMI/FULL switch
CW SIDETONE level control
Speech COMPRESSOR LEVEL control
MIC TONE control

Table 2
ICOM IC-375A 220-MHz Multimode Transceiver, Serial no. 01040

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 216-236 MHz. Specifications guaranteed from 220-225 MHz.	As specified.
Modes of operation: FM, USB, LSB, CW.	As specified.
Frequency display: 7-digit LCD, black on an orange background, 3/8-inch-high digits.	
Frequency resolution: 100 Hz.	As specified.
Transmitter	*Transmitter Dynamic Testing*
Transmitter output power: 2.5 to 25 W adjustable.	2.5 to 30.4 W.
Spurious-signal and harmonic output: Greater than 60 dB below peak power output.	−70 dB (see Fig 1).
Third-order intermodulation distortion products: Not specified.	See Fig 2.
Keying waveform: Not specified.	See Fig 3.
Transmit-receive turnaround time (PTT release to 90% output with an S9 signal): Not specified.	With the DATA switch on: FM, 1.2 ms; SSB, 46 ms (see Fig 4).
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity:	
SSB and CW: less than 0.1 μV for 10 dB S/N.	Minimum discernible signal (noise floor), (dBm): −136.5 (2.3 kHz filter)
FM: less than 0.18 μV for 12 dB SINAD; less than 0.28 μV for 20 dB quieting.	0.15 μV for 12 dB SINAD. 0.23 μV for 20 dB quieting.
Receiver dynamic range: Not specified.	Blocking dynamic range (dB): 107.5 Two-tone, third-order intermodulation distortion dynamic range (dB): 87.5 Third-order input intercept (dBm): −3.75
S-meter sensitivity (μV for S-9 reading): Not specified	4.0. Note: S meter was not accurate; 10-dB increase in signal input resulted in 20-dB increase on meter.
Squelch sensitivity: FM: less than 0.14 μV; SSB/CW: 0.56 μV.	FM: 0.065 μV min, 0.24 μV max; SSB/CW: 0.45 μV min, >1 mV max.
Receiver audio output at 10% THD: More than 2 W.	2.0 W.
Color: Black.	
Size (height, width, depth): 4.25 × 9.6 × 11.6 inches.	
Weight: 13.7 lb.	

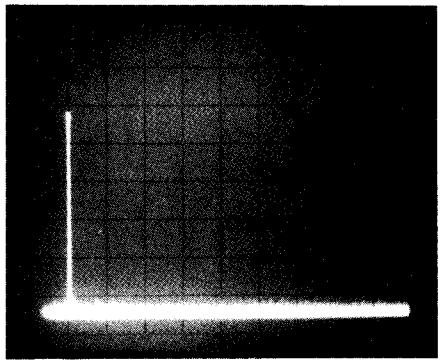


Fig 1—Spectral display of the IC-375A. Horizontal divisions are each 100 MHz; vertical divisions are each 10 dB. Output power is approximately 28 W at 222 MHz. The fundamental has been reduced in amplitude approximately 22 dB by means of notch cavities to prevent analyzer overload. All harmonics and spurious emissions are at least 70 dB below peak fundamental output. The IC-375A complies with current FCC specifications for spectral purity.

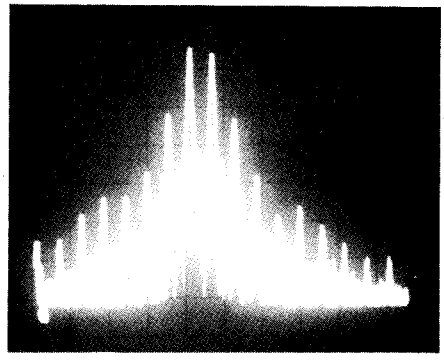


Fig 2—Spectral display of the IC-375A during two-tone intermodulation distortion (IMD) testing. The transceiver is being operated at 28-W PEP output at 222 MHz. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz. Third-order products are approximately 22 dB below PEP output, and fifth-order products are approximately 37 dB down.

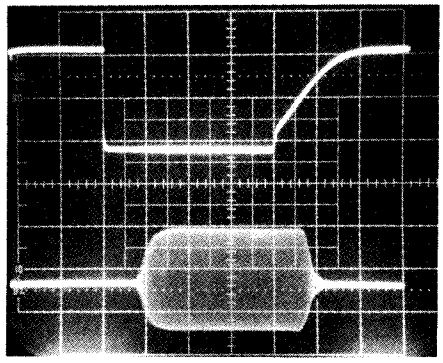


Fig 3—CW keying waveform of the IC-375A. The upper trace is the actual key closure; the lower trace is the RF envelope. Each horizontal division is 5 ms.

SSB and CW modes, it uses four conversions, with IFs at approximately 70 MHz, 9 MHz, 455 kHz and 9 MHz. For FM, three conversions are used with IFs at approximately 70 MHz, 9 MHz and 455 kHz.

The first thing I noticed when listening to the IC-375A is that the receiver sounds very quiet in the SSB and CW modes. The level of hiss and white noise is noticeably lower than what you might expect to hear, and this quietness gives the impression that the receiver is deaf. Of course, lab measurements and on-the-air listening prove otherwise! In an A/B comparison, the IC-375A heard all but the weakest signals I copied with my usual transverter/low-band transceiver combination. Addition of an external Advanced Receiver Research GaAsFET preamplifier made the weaker signals easier to copy, however.

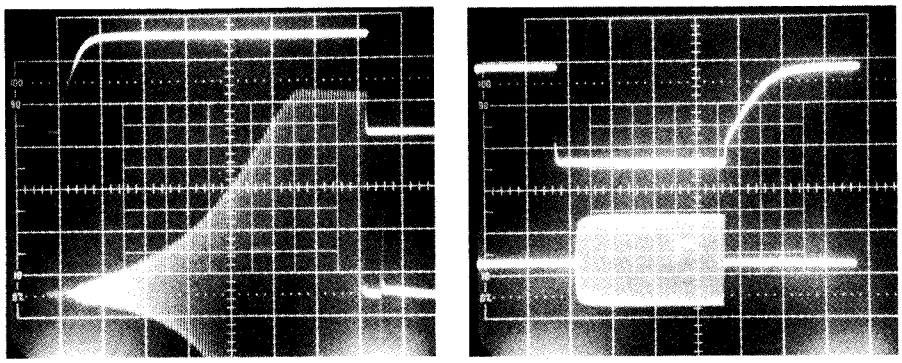
Lab testing turned up a quirk that we also noticed in the 2-meter IC-275A: The S meter is not accurate. A 10-dB increase in signal input results in a 20-dB increase in meter reading. The S meter is *very* generous.

For CW operators, a 500-Hz filter is optional. The review unit was not equipped with this filter.

Transmitter

Transmitter measurements are shown in Table 2 and Figs 1, 2 and 3. Power output easily meets ICOM's 25-W specification. The harmonics and spurious emissions, at 70 dB down from the carrier level (Fig 1), are better by a wide margin than required by FCC regulations.

Transmitter intermodulation-distortion (IMD) testing, however, was a bit disappointing. The third-order IMD products are down only 22 dB (referenced to a single tone), and the higher-order products are fairly strong. See Fig 2. This could create a wide SSB signal, which could bother local stations. For comparison, a typical HF transmitter might have third-order IMD products 35 to 40 dB down, and



(A) (B)

Fig 4—Receiver recovery (turnaround) time waveforms for the IC-375A. The receiver AGC is set to FAST. The photo at A shows the turnaround time in the USB mode using the DATA feature. This combination might be used for AMTOR operation. Each horizontal division is 10 ms. The upper trace shows PTT release. The lower trace is receiver audio output. The receiver is tuned to an S1 signal. Upon key opening, the delay from opening to 90% audio output is measured. The turnaround time is 46 ms. Note that audio will be usable by most communications terminal units before 90% audio output is reached. The photo at B shows a similar measurement, but in the FM mode using the DATA feature. This combination might be used for packet-radio operation. Each horizontal division is 5 ms. Turnaround time is 1.2 ms.

correspondingly lower higher-order products. Many VHF and UHF transmitters and amplifiers need improvement in this area.

The IC-375A includes a speech compressor and a microphone tone control. By careful adjustment of the rear-panel MIC TONE and COMP LEVEL controls, it is possible to get very-good-sounding audio from ICOM's standard hand microphone. You'll need to be able to listen to your signal in a second receiver, or have a local friend listen, to make the most of these adjustments.

CW operators get the choice of semi- or full-break-in (QSK) operation. While some operators prefer QSK operation on HF, it really isn't all that useful on VHF. If you do like QSK, remember that you won't be able to use it with your average 220-MHz power amplifier and/or outboard preamplifier setup. Fig 3 shows the IC-375A's CW keying waveshape. Rise and fall times are a bit sharp, but the signal sounds fine on the air.

As with the 2-meter model, transceiver turnaround times are exceptionally fast thanks to the DATA mode feature. With a TR turnaround time of 1.2 ms in the FM mode (DATA feature enabled), the '375 should be especially attractive to packet-radio operators. In the SSB mode (DATA feature enabled), turnaround is 46 ms. See Fig 4. AMTOR and RTTY operation are covered in the manual.

Manual

The IC-375A manual is detailed and well written. In it, you'll find a wealth of information about operating the radio. Use of every control is explained and information is given for all of the rear-panel connectors. Information on controlling the IC-375A with a personal computer (using ICOM's "communication interface-V" system) is sketchy, though. There is no information about what you can do once you get the computer hooked up. ICOM includes a complete schematic diagram of the IC-375A, but I couldn't find a block diagram in the manual.

Hookup and Operation

The only problems encountered in hooking up the IC-375A in my station resulted from incompatible connectors. For example, the key jack is a 1/8-inch phone jack instead of the 1/4-inch type used on the rest of my equipment. The control line for an external power amplifier is found on the eight-pin ACC(1) jack (a matching plug is not supplied). Note that the amplifier control line is rated for a maximum of 20 V dc. This shouldn't be a problem with most solid-state amplifiers, but be sure to check the keying voltage on tube-type amplifiers before using them with the IC-375A.

I used the IC-375A for casual operation and during the ARRL September VHF QSO Party. Most of the time I used it with an external RF Concepts 120-W solid-state power amplifier. The receiver worked well during the contest on CW, SSB and FM, although there weren't too many rock-crushing signals on the air. I heard plenty of stations, even without an external preamplifier. Reports received during the contest and during the weekly 220-MHz SSB Pack Rats net indicate that the transmitted audio sounds fine.

Manufacturer: ICOM America, Inc, 2380-116th Ave NE, Bellevue, WA 98004, tel 206-454-7619. Price class: $1400.

RF-CONCEPTS RFC 2-23 AND RFC 3-22 SOLID-STATE 144- AND 220-MHz AMPLIFIERS

Reviewed by Bruce S. Hale, KB1MW

***Brick** 1: a handy-sized unit of building or paving material typically being rectangular and about 2¼ × 3¾ × 8 inches and of moist clay hardened by heat*
2: a good-hearted person
3: a rectangular compressed mass (as of ice cream)
4: a semisoft cheese with numerous small holes, smooth texture, and usually mild flavor[1]

I wonder who first used the term "brick" to refer to a small solid-state amplifier. They're not semisoft or full of holes (we won't talk about semiconductor theory), but it's an appropriate term. What can you say about a brick? It just sits there, holding the wall up. A good solid-state brick should just sit there and *work*. These RF Concepts amps are good bricks; you put watts in and you get more watts out.

The RF Concepts RFC 2-23 is a 144-MHz amplifier and the RFC 3-22 is for 220 MHz. Except for frequency range and power output, the two units are virtually identical. Both work on SSB, CW and FM. They are linear amplifiers—the front-panel FM/SSB switch changes the TR-relay dropout time. The relay drops out instantly in FM, but there is a slight delay (adjustable) in the SSB mode so that the relay doesn't drop out between words and syllables.

Both amplifiers accept input power in the range 200 mW to 5 W, but maximum usable drive is about 2 W. The RFC 2-23 puts out 30 W with 2-W drive, and the RFC 3-22 delivers 20 W with 2-W drive. The amplifiers each draw about 4 A at 13.8 V dc at maximum output. They feature automatic SWR protection shutdown circuits. If the amps sense SWR over 3:1 at the output, they automatically shut down to protect their output transistors.

Transmit-receive switching is fully automatic; an RF sensor in the amp switches the TR relay when you transmit. There is no provision for manually controlling the TR relay from the transceiver.

All of these factors contribute to the "brick-like" qualities of the amplifiers. You supply voltage and connect the feed lines, and you're done. The rear-panel power connection is made through a two-pin polarized connector; RF Concepts supplies a 6-foot cable with matching connector and fuse. RF input and output connections are handled by a pair of SO-239 jacks.

Both amplifiers are equipped with gallium-arsenide FET (GaAsFET) preamplifiers. The preamp is activated by a

[1]Webster's Ninth New Collegiate Dictionary (Merriam-Webster, Inc, Springfield, MA, 1983), p 178.

Table 3

RF Concepts RFC 2-23 144-MHz Amplifier, Serial no. 2-0254

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: 143-149 MHz.	Tested from 144 to 148 MHz.
Modes of operation: FM, CW, SSB.	As specified. Also works on packet radio.
Power output: 30 W with 2-W drive. Input power: 0.2 to 5 W.	34.9-W output for 2-W drive.
Spurious signal and harmonic suppression: Not specified.	See Fig 5.
Receive preamp: 20 dB gain with 0.75-1.5 dB noise figure.	21.5 dB gain, 1.22-dB noise figure at 146 MHz.
Receive preamp 1-dB compression point: Not specified.	−11-dBm output.
Power requirement: 13.8 V dc at 4 A.	13.8 V dc at 4.15 A required at full output.
Color: Black.	
Size (height, width, depth): 2 × 3.5 × 6.5 inches.	
Weight: 5 lb.	

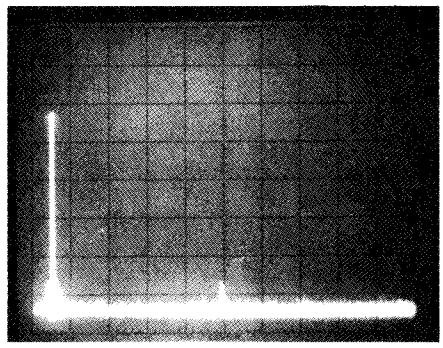


Fig 5—Spectral display of the RFC 2-23. Horizontal divisions are each 100 MHz; vertical divisions are each 10 dB. Output power is approximately 34 W at 144 MHz. The fundamental has been reduced in amplitude approximately 28 dB by means of notch cavities to prevent analyzer overload. All harmonics and spurious emissions are at least 64 dB below peak fundamental output. The RFC 2-23 complies with current FCC specifications for spectral purity.

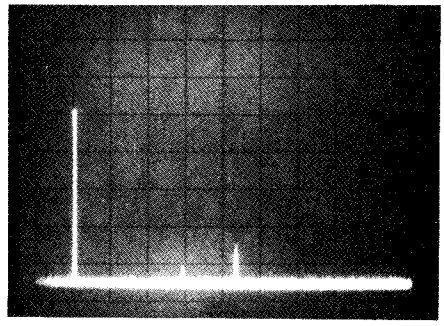


Fig 6—Spectral display of the RFC 3-22. Horizontal divisions are each 100 MHz; vertical divisions are each 10 dB. Output power is approximately 21 W at 222 MHz. The fundamental has been reduced in amplitude approximately 22 dB by means of notch cavities to prevent analyzer overload. All harmonics and spurious emissions are at least 66 dB below peak fundamental output. The RFC 3-22 complies with current FCC specifications for spectral purity.

Table 4

RF Concepts RFC 3-22 220-MHz Amplifier, Serial no. 3-1016

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: 220 to 225 MHz.	As specified.
Modes of operation: FM, CW, SSB.	As specified. Also works on packet radio.
Power output: 20 W with 2 W drive. Input power: 0.2 to 5 W.	22.8-W output for 2-W drive.
Spurious signal and harmonic suppression: Not specified.	See Fig 6.
Receive preamp: 15 dB gain with 1-1.75 dB noise figure.	22.17 dB gain, 1.47-dB noise figure at 222 MHz.
Receive preamp 1-dB compression point: Not specified.	−8-dBm output.
Power requirement: 13.8 V dc at 4 A.	13.8 V dc at 4.25 A required at full output.
Color: Black.	
Size (height, width, depth): 2 × 3.5 × 6.5 inches.	
Weight: 5 lb.	

front-panel switch, and the preamp *can* be used without the rest of the amplifier on. If you need a boost for your receiver, but don't need full-power transmit, switch on the preamp without switching the main power switch on. The preamp is automatically switched out when the amp goes from receive to transmit.

Operation

Once you've hooked up one of these amplifiers, there isn't much more to do. Front-panel switches are for SSB/FM, POWER ON/OFF and PREAMP ON/OFF. LEDs indicate when power or preamp are on, and when the amplifier is in transmit.

The preamps work very well. For example, at my house, the W1AW repeater went from S3 to S9+ when I switched on the preamp. I used the RFC 3-22 220-MHz

amplifier at my home station with a Yaesu FT-109RH hand-held, and the additional power was convenient when I was using a 220-MHz/6-meter remote station about 15 miles away. The amp handled the 5-W output from the Yaesu with no complaints.

I also used the amplifiers in my car with a pair of hand-held transceivers. I used the 220-MHz amp with a Yaesu FT-109RH, and the 2-meter version proved to be a good companion to a Yaesu FT-23R. Again, the additional power was very handy. Most of the time, I was able to use the low-power position on the hand-held to conserve battery power and still get enough power from the amplifier to access local repeaters. When I needed the full output, I switched the hand-held to high power. The preamp made it possible for me to hear repeaters full quieting in spots where they had been very noisy without it.

We did have a problem with the review RFC 3-22 220-MHz amplifier during initial lab testing: Spurious emissions did not meet FCC requirements, the unit introduced about 10 dB of loss with the power switch off and the preamplifier exhibited unusually low gain and high noise figure. We returned the amplifier to RF Concepts; they promptly repaired it under warranty and returned it free of charge. The problem was traced to a faulty relay, which RF Concepts replaced with a better part. Our review unit was from an early production run; current production units use the better relay.

These amps are real bricks (good-hearted, not semisoft). They do their work, they don't eat much (current) and they don't complain. They make excellent additions to any ham shack or mobile VHF installation.

Manufacturer: RF Concepts, 2000 Humboldt St, Reno, NV 89509, tel 702-827-0133. Price class: RFC 2-23, $112; RFC 3-22, $112.

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

☐ In order to present the most objective reviews, ARRL purchases equipment "off-the-shelf" from Amateur Radio dealers. [ARRL receives no remuneration for items presented in the Product Review or New Products columns.—Ed.]

The following ARRL-purchased Product Review equipment is for sale to the highest bidder. Prices quoted are minimum acceptable bids and reflect a discount from the purchase price.

Sealed bids must be submitted by mail and be postmarked on or before March 27, 1988. Bids postmarked after the closing date will not be considered. Bids will be opened seven days after the closing postmark date. In the case of equal high bids, the high bid bearing the earliest postmark will be declared the successful bidder.

Please clearly identify the item you wish to bid on, using the manufacturer's name, model number or other identification number if specified. Each item requires a separate bid and envelope. Shipping charges will be paid by the successful bidder, FOB Newington. The successful bidder will be advised by mail of the successful bid. No other notifications will be made, and no information will be given by telephone to anyone regarding final price or identity of the successful bidder.

Please send your bids to Kathy McGrath, Product Bids, ARRL, 225 Main St, Newington, CT 06111.

Yaesu FT-23R 2-meter FM hand-held transceiver, s/n 6N073075 (see Product Review, Dec 1987 *QST*). Minimum bid $173.

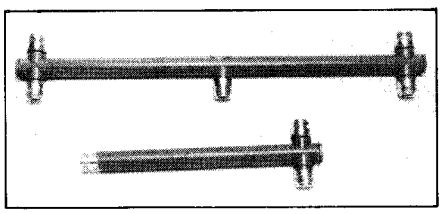
AEA PK-232™ multimode data communications terminal, s/n 03097 (see Product Review, Jan 1988 *QST*). Minimum bid $200.

Kenwood R-5000 general-coverage receiver, s/n 8020070, with YK-88C and YK-88A-1 filters (sold as a package only, see Product Review, Feb 1988 *QST*). Minimum bid $553.

New Products

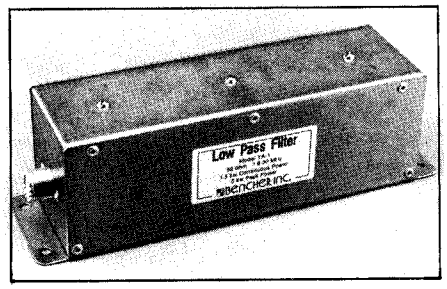
ANTENNA SPECIALISTS RF POWER DIVIDERS

☐ The Antenna Specialists Co, Cleveland, Ohio, has introduced RF power dividers in three frequency ranges for continuous coverage from 144 through 960 MHz. The dividers are available in two- and four-port designs, and can be used for phasing similar or different antennas in a variety of applications. All-copper construction is used; input and output connectors are type-N. SWR is rated at 1.5:1 or less, and the dividers are rated to handle 500 W. For more information, contact The Antenna Specialists Co, 30500 Bruce Industrial Pkwy, Cleveland, OH 44139-3996, tel 216-349-8400—*Rus Healy, NJ2L.*



BENCHER LOW-PASS FILTER

☐ The Bencher YA-1 low-pass transmitter filter is designed to attenuate harmonic radiation by at least 80 dB at and above 54 MHz. Passband frequency range: 1.8 through 30 MHz. The filter has 52-Ω input and output impedances, and is rated to handle 1.5 kW of continuous RF, and 5 kW peak power. For more information, contact Bencher, Inc, 333 West Lake St, Chicago, IL 60606, tel 312-263-1808 —*Rus Healy, NJ2L*



A & A ENGINEERING 8-BIT A/D AM DEMODULATOR

☐ To support Elmer Schwittek's (K2LAF) MULTIFAX™ WEFAX program for the IBM® PC, A & A Engineering has developed an updated demodulator/ADC (analog-to-digital converter) circuit and incorporated it in their no. 206 series kits. This new demodulator overcomes some filter-ringing problems present in the earlier design, and provides more gain in the amplifier stage.

Stas, W6UCM (who owns A & A Engineering), reports that HF WEFAXers are also using the A/D converter section of the demodulator/ADC board to enhance HF WEFAX pictures. In answer to requests from these users for 4-bit A/D conversion capability, A & A Engineering designed the new board to provide 8-bit conversion. Presently, no known WEFAX programs use the full 8-bit capability of this board, but the room for expansion is there. An optional AGC board will soon be offered as an add-on to this demodulator.

To order, or for more information, contact A & A Engineering, 2521 W La Palma, Unit K, Anaheim, CA 92801, tel 714-952-2114. Price: no. 206-KIT, $49.95; no. 206-PCB (PC board only), $14.95; no. 206-ASY (assembled and tested unit), $69.95. A & A Engineering also offers a package that includes the HF WEFAX demodulator (no. 109), the AM demodulator/ADC (no. 206) and power supply (no. 133).—*Paul K. Pagel, N1FB*