Product Review Column from *QST* Magazine

July 1992

QST Compares: Mid-Priced MF/HF Linear Amplifiers
(Ameritron AL-82; Commander HF-1250; Kenwood TL-922A; Ten-Tec Centurion)

Conducted By James W. Healy, NJ2L
Assistant Technical Editor

QST Compares: Mid-Priced MF/HF Linear Amplifiers

Reviewed by Mark Wilson, AA2Z, and Rus Healy, NJ2L

When you thumb through the ads in *QST*, it's apparent that, like those of transceivers, the prices of MF/HF linear amplifiers are all over the board. At one end of the price scale is the budget-conscious Ameritron AL-811 (reviewed in February 1992 *QST*), a 600-W amplifier you can buy for about $650. Last month, we reviewed an amplifier at the other end of the scale: the $5490, microprocessor-controlled, legal-limit Alpha 87A.

Many hams are looking for something that packs more punch than the AL-811, but is more affordable than the Alpha 87A. A step up from the AL-811 are amplifiers in the $1000 to $1300 range that use a single 3-500Z triode. A step down from the Alpha 87A are legal-limit, continuous-duty-rated amplifiers in the $2400 to $3000 range that use a pair of 3CX800A7s, a single 3CX1200 or an 8877.

This month, we review four amplifiers that fall squarely into the middle of the pack: the Ameritron AL-82, Command Technologies HF-1250, Kenwood TL-922A and Ten-Tec Centurion. You can buy any of them for $1700, give or take a few dollars. Command Technologies and Ten-Tec deal direct; both units sell for $1695. Ameritron and Kenwood sell through dealers. Although the Ameritron and Kenwood units list for about $2000, they typically sell for about $1700.

AMERITRON AL-82

Ameritron's AL-82 is the only amplifier in this group that's rated at the legal limit—1500 W output. Like the Kenwood TL-922A and Ten-Tec Centurion amplifiers, the AL-82 uses a pair of relatively inexpensive, dependable 3-500Z glass-envelope triodes. The difference is that Ameritron runs significantly higher anode voltage than the others (still well within the tube ratings, of course). The AL-82 is also the only 3-500Z amplifier in this

Amplifier IMD Testing in the ARRL Lab

In each *QST* amplifier review, we publish spectral photos showing the intermodulation distortion (IMD) products generated by the amplifier. These photos clearly illustrate amplifier linearity. A perfectly linear amplifier reproduces only the two input tones; real amplifiers generate IMD products (spaced the same distance apart as the input tones) as a result of imperfect linearity. The higher the IMD-product levels, the poorer the linearity.

To perform an IMD test, we apply two signals, 1.2 kHz apart, to the amplifier input. With the amplifier properly tuned and driven to its rated input or output power, we measure the spectral output and photograph it.

Sounds simple, right? Hook up an SSB transmitter to the amplifier, inject the two-tone signal into the radio's mike jack, drive the amplifier to rated output and take the photo.

It's not that easy.

If we were to test amplifiers this way, you'd see the combined effects of the transmitter's IMD and the amplifier's IMD. But what we *want* to see is *only the amplifier's* IMD response. In theory, if the transmitter IMD was *much* better than the amplifier's IMD, the test would be valid. In practice, however, ham transmitters aren't clean enough to be used in such tests.

To make our IMD tests as useful as they can be, we designed and constructed a special test setup in the ARRL Lab (see Fig A). The heart of this system is the hybrid combiner. The combiner allows us to mix *CW* signals 1.2 kHz apart from the two drivers to provide a pure two-tone signal at the amplifier input. Then, when we look at the amplifier's spectral output during the two-tone test, we know we're seeing the amplifier's IMD products, not those of the test setup.

The one drawback to this test method is that the combiner is a single-frequency device; ours is designed for the 14-MHz band. Presently that's the only band on which we test MF/HF amplifiers for two-tone IMD. In the future, we plan to add such capability for at least the 50- and 144-MHz amateur bands, where amplifier IMD is also an important performance issue.—*Rus Healy, NJ2L*

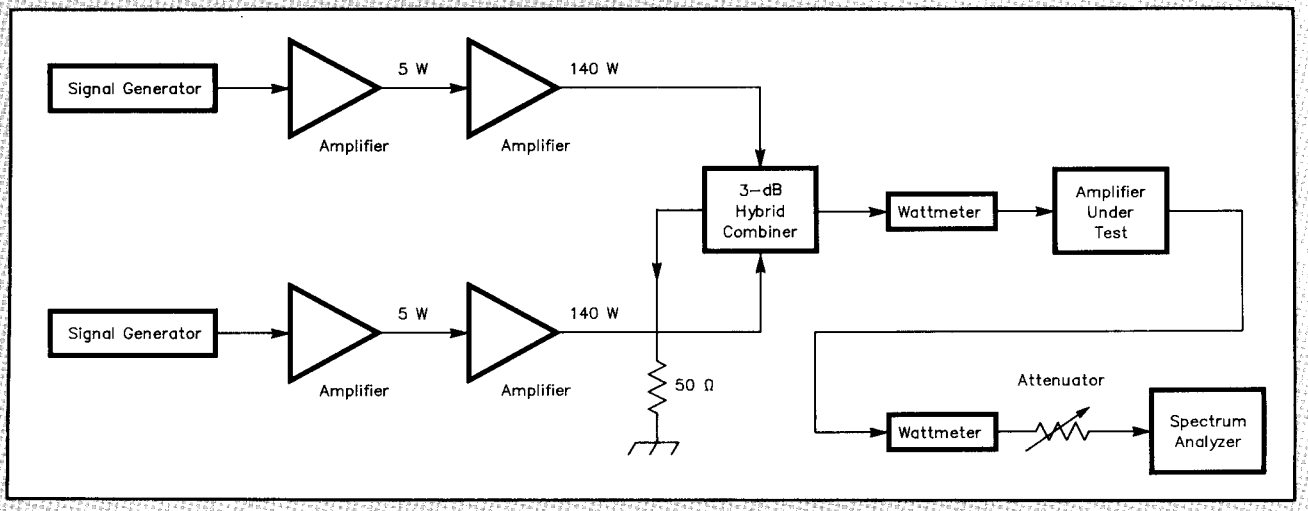


Fig A—The system used in the ARRL Lab for testing MF/HF amplifier intermodulation distortion (IMD).

Table 1
Ameritron AL-82 MF/HF Linear Amplifier, Serial No. 1279

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 1.8-2.0, 3.3-4.4, 6.3-8.3, 9.5-15.5, 15.5-21.5, 24-29 MHz.*	Operation on amateur bands as specified; not tested elsewhere.
Power output: 1500 W continuous for 30 minutes below 18 MHz. Not specified above 18 MHz.	See Table 2. Passes 30-minute key-down test at 1.5 kW output at 7 MHz.
Driving power required: Typically 100 W for full output; 130 W maximum.	88-130 W for full output, depending on frequency.
Input SWR: 1.2:1 at resonance; 2:1 SWR bandwidth, 20%.	As specified.
Spurious signal and harmonic suppression: Not specified.	Meets FCC specifications.
Intermodulation distortion: Better than 34 dB below rated output.	As specified. See Fig 1.
Primary power requirements: 240 V ac at 13 A max.	Not measured.

Size (height, width, depth): 10 × 17 × 18.5 inches. Weight: 77 pounds. Color: Black.

*The FCC-specified maximum legal output on the 30-meter band for US amateurs is 200 W PEP. As shipped from the factory, the AL-82 cannot operate on 10 and 12 meters; enabling operation on these bands requires information furnished by Ameritron upon presentation of a valid amateur license (see text).

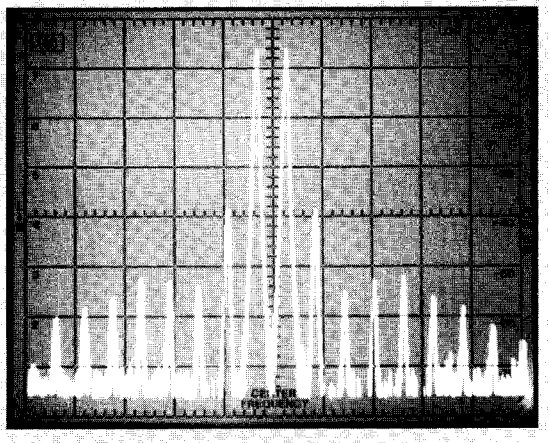


Fig 1—Worst-case spectral display of the Ameritron AL-82 amplifier during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 38 dB below PEP output, and fifth-order products are approximately 54 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The amplifier was being operated at 1500 W PEP output at 14 MHz.

Table 2
Ameritron AL-82 Test Results

Frequency (MHz)	*Drive Power (W)*	*Anode Voltage (kV)*	*Anode Current (mA)*	*Grid Current (mA)*	*Power Output (W)*	*Harmonics/ Spurious (dBc)*
1.9	130	3.1	770	210	1450	–60
3.75	110	3.1	725	210	1500	–55
7.0	90	3.2	700	190	1500	–53
14.0	110	3.1	790	205	1500	–58
18.07	115	3.2	720	180	1500	–55
21.25	88	3.1	775	210	1500	–50
24.89	130	3.1	875	220	1475	–60
29.0	112	3.2	770	205	1500	–58

test that uses a pressurized chassis and glass chimneys to cool the tubes. The AL-82 is similar to the Ameritron AL-1200, another contender in this price class that uses a single 3CX1200A7 ceramic triode. We reviewed an AL-1200 in December 1985 *QST*.

The AL-82 features tuned input circuits. Input SWR is 1.5:1 or less in the ham bands, except at the very top of 160 meters where it's 1.7:1. The output network is a pi-**L** on 160 and 80 meters and a pi network on 40-10 meters. Seventeen meters is covered with the band switch in the 15-meter position; the 10-meter position is used for 12 meters. Tuning is smooth, thanks to 6:1 reduction drives on the **PLATE** tuning and **LOAD** controls.

Two front-panel meters tell you what's going on inside the box. One is dedicated to monitoring grid current (0-400 mA). The other can be switched among high voltage (0-4 kV), anode current (0-1 A), peak RF power output (0-2 kW) and ALC. When the amplifier is run into a 50-Ω resistive load, the power meter is quite accurate on the low bands, but lacks accuracy above 14 MHz. For instance, the internal wattmeter agrees within 3% with our Bird wattmeter at 2 MHz from 750 to 1500 W and within 13% at 14 MHz, but at 28 MHz, the AL-82's wattmeter reads 1100 W output with 1500 W of actual CW output. In all cases, the internal meter reads low. Just the same, it's quite useful during tune-up.

As Table 2 shows, the AL-82 makes its output rating of 1500 W on most bands, and comes very close on the others. We were able to extract 1500 W from the amplifier on 160 and 12 meters, but only at drive levels in excess of the amp's 130-W maximum rating. The AL-82 passed a 30-minute full-power key-down test on 40 meters without complaint, although the amplifier case became *very* hot (more on this later).

It's worth noting that extracting 1500 W from the AL-82 requires drive levels just beyond what many modern solid-state transceivers can provide. If 100 W is all your transceiver can muster on a good day, you'll see 1300 to 1400 W maximum from the AL-82 on some bands.

As shown in Fig 1, the AL-82's two-tone, third-order IMD products are down about 38 dB—in the same range as the Kenwood TL-922A and Ten-Tec Centurion—with the front-panel **SSB/CW** switch in the **SSB** position. Because this switch changes the amplifier bias for best efficiency on CW and best linearity on SSB, it's better to keep the switch in the **SSB** position for SSB work; flipping it to the **CW** position degrades the amplifier's third-order IMD products by about 3 dB. It's worthwhile to flip the switch to **CW** for CW operation, though, because at 1500 W output, anode current runs 5-30 mA less than when the switch is in the **SSB** position. This bias-switching trick does improve amplifier efficiency on CW.

Tubes, amplifier and standard Hypersil transformer are shipped separately to avoid damage during shipping. Easy-to-follow instructions and clear drawings make assembly a snap. The AL-82 is set up for 240-V operation as it comes from the factory. A table shows connections for other voltages from 208 to 245. You should measure the line voltage in your shack and use the closest tap. The instructions caution that operation with line voltages

in excess of the selected tap voltage can result in shortened tube life. Unlike the other amplifiers in this test, the AL-82 has no provision for 120-V ac operation. The line cord terminates in a molded plug rated at 250 V and 15 A.

Blower speed can be reduced if noise is a problem. Four settings are available. According to the instructions, the lowest speed develops sufficient airflow for standard SSB and CW operation, but the highest speed should be used for contest and RTTY operation. The blower is on the noisy side at the highest-speed setting, but we prefer to run as much air as possible past the tubes.

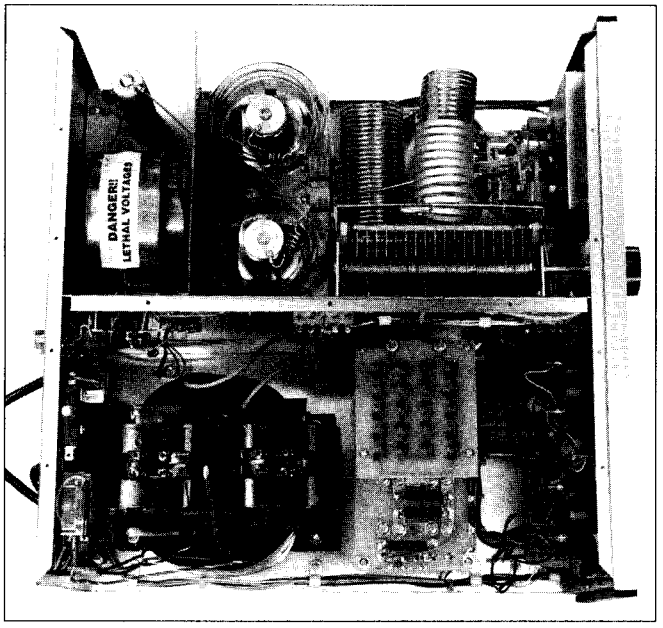
Ameritron will provide instructions to enable 10- and 12-meter operation upon receipt of a copy of a valid amateur license. Making this modification is easy and quick; it took us about 10 minutes, start to finish. We called Ameritron and faxed them a copy of the license; they promptly faxed back the 10-meter modification information.

During key-down testing, we noted that the AL-82's cabinet gets very hot to the touch. Although the cooling seems adequate for the tubes and the power-supply side of the amp stays cool, it appears that additional vent holes on the tube side of the cabinet might help. There are vent holes over only one of the tubes, so some of the exhaust air heats the cabinet before escaping.

According to the AL-82 designer, Tom Rauch, W8JI, the hole size is a trade-off. If the hole was larger, the cabinet wouldn't get so hot, but the acoustic blower noise would be considerably louder. Many customers are concerned about blower noise, so Ameritron makes the hot-air exhaust hole in the AL-82 large enough to allow adequate amplifier cooling, but small enough for acceptably low blower noise.

Our first AL-82 did not work as well on 15, 12 and 10 meters as it did on the other bands. Efficiency was low, especially on 15 meters, and on 10 meters the AL-82 took 130 W of drive for full output. On 15 meters, the amplifier put out only 1400 W at 900 mA anode current; under these conditions, anode dissipation is far in excess of the tubes' ratings.

Tom Rauch revised the AL-82 circuit to cut the plate dissipation, especially on 15, 12 and 10 meters, and to reduce the amplifier drive requirements on these bands. ARRL Lab testing of a modified unit (Table 2) indicates that the modifications work. On 15 meters, the modified amplifier puts out 1500 W with lower anode current than before, and it's significantly easier to drive on 10 meters. These modifications are built into current production units (after serial number 1240). Owners of older AL-82s can return their amplifiers to the factory for modification. Contact Ameritron for packing and shipping instructions. You'll pay shipping both ways, plus $39 for the update.



Inside the Ameriton AL-82.

During 18-MHz testing, our replacement AL-82's anode RF choke failed open. Inspection showed that the enamel insulation had been baked off several turns of the choke where the wire open-circuited. Since we still had the other amplifier, we used its choke to continue our testing, and found similar damage in a slightly different part of the choke winding, but the wire was still intact. A call to Ameritron and a check of the choke dimensions revealed that neither choke was wound to the specifications Ameritron provides to the manufacturing facility. That moved the choke's series-resonant frequencies, which are designed to be as far from the ham bands as possible, into or near the ham bands. If the amplifier is operated at or too near the choke's series-resonant frequencies, the choke will open, as ours did. Ameritron is working with the factory to solve this problem.

If your AL-82's anode choke shows signs of damage, contact Mike at the Ameritron factory (tel 601-323-8211). Ameritron will replace the choke at no charge, and they ask that you return the original choke once you receive the replacement.

The AL-82 manual is brief but very complete. Operating instructions, connection diagrams and schematics are clear and useful. Several drawings and a clear step-by-step procedure guide you through installing the transformer and tubes, setting the blower speed and selecting the proper transformer line-voltage taps. A complete parts list rounds out the documentation.

Manufacturer's suggested retail price: $1995. Warranty: 1 year, except for the 3-500Z tubes, which are warranted by their manufacturer through Ameritron. Manufacturer: Ameritron, 921 Louisville Rd, Starkville, MS 39759, tel 601-323-8211.

The Bottom Line

Ameritron AL-82: High drive requirements, blower noise and hot cabinet during operation won't deter those looking for the only one in this bunch that makes 1500 watts output.

COMMANDER HF-1250

The Commander HF-1250 is the only single-tube amplifier in this comparison. It uses a 3CX800A7 ceramic-metal triode instead of a pair of 3-500Zs. The Commander requires substantially less drive than the other amps in this test, thanks to the tube's higher gain.[1] The 3CX800A7 also requires a warm-up period (about 2 minutes), unlike the 3-500Z amplifiers. 3-500Z grids can withstand more abuse than 3CX800A7 grids, but the ceramic tube should last you a long time if you're prudent. The 3CX800A7 is a little more expensive to replace than a pair of 3-500Zs: A recent *QST* ad listed a pair of Eimac 3-500Zs for about $285, and a 3CX800A7 for about $330.

The HF-1250 is essentially a single-tube version of the excellent HF-2500 reviewed in May 1991 *QST*. Its tuned input circuits provide the lowest input SWR of the bunch: 1.4:1 at 1.8 MHz and 1.1:1 across the other bands. The output network is similar to the HF-2500—a pi network followed by a broadband 4:1 transformer. The band switch includes separate positions for 17 and 12 meters. Cooling is accomplished through a pressurized chassis and chimney. The amplifier runs cool and is smooth as silk to tune.

One of the front-panel meters is dedicated to monitoring grid current (0-100 mA). The other can be switched between high voltage (0-3 kV) and anode current (0-1 A). The amplifier includes no provisions for monitoring power output or SWR.

As Table 4 shows, the HF-1250 easily makes its CW output rating of 1000 W on all bands. It also has no problem meeting its 1250-W PEP rating for SSB operation during our SSB PEP test (see the sidebar). The amplifier easily survived a 30-minute key-down test at 750 W output with very little change in tuning and no heat buildup. (Command Technologies doesn't specify a time limit; we figured that if something was going to go amiss, it would

[1]R. Measures, "Amplifier-Driver Compatibility," *QST*, Apr 1989, pp 17, 18, 20.

Table 3

Command Technologies HF-1250 MF/HF Linear Amplifier, Serial No. 230

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 160, 80, 40, 20, 17, 15, 12 and 10-meter amateur bands.*	As specified.
Power output: 1250 W SSB, 1000 W CW, 750 W RTTY (continuous carrier).	See Table 4.
Driving power required: 50-80 W nominal.	36-55 W for 1000 W output depending on frequency.
Input SWR: Not specified.	Less than 1.4:1.
Spurious signal and harmonic suppression: Exceeds all FCC requirements.	As specified.
Intermodulation distortion: Not specified.	See Fig 2.

Primary power requirements: 100-110 V or 200-220 V at 15 A.

Size (height, width, depth): 7.75 × 18 × 16 inches. Weight: 65 pounds. Color: Gray.

*As shipped from the factory, the HF-1250 cannot operate on 10 and 12 meters; enabling operation on these bands requires information furnished by Command Technologies upon presentation of a valid amateur license (see text).

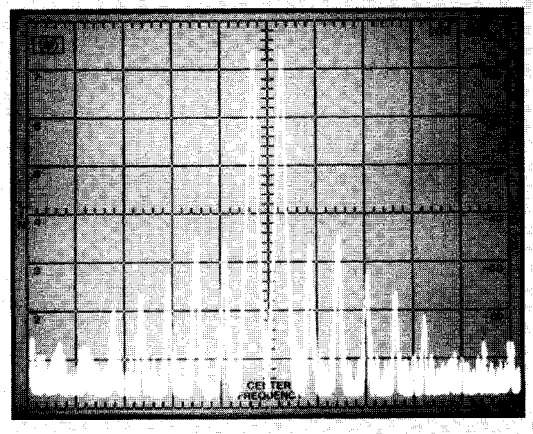
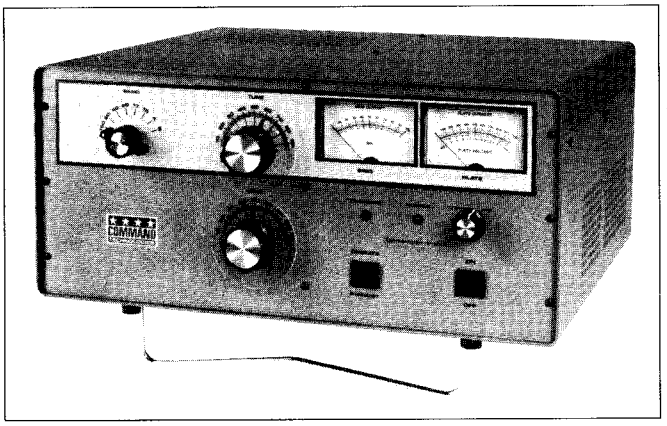


Fig 2—Worst-case spectral display of the Command Technologies HF-1250 amplifier during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 46 dB below PEP output, and fifth-order products are approximately 44 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The amplifier was being operated at 1250 W PEP output at 14 MHz.

Table 4

Command Technologies HF-1250 Test Results

Frequency (MHz)	*Drive Power (W)*	*Anode Voltage (kV)*	*Anode Current (mA)*	*Grid Current (mA)*	*Power Output (W)*	*Harmonics/ Spurious (dBc)*
1.9	38	2.3	700	31	1000	−46
3.75	38	2.3	700	24	1000	−53
7.0	36	2.3	680	28	1000	−60
14.0	55	2.3	760	27	1000	−60
18.07	45	2.3	700	36	1000	−58
21.25	45	2.3	660	33	1000	−56
24.89	40	2.3	650	28	1000	−52
29.0	40	2.3	650	34	1000	−49



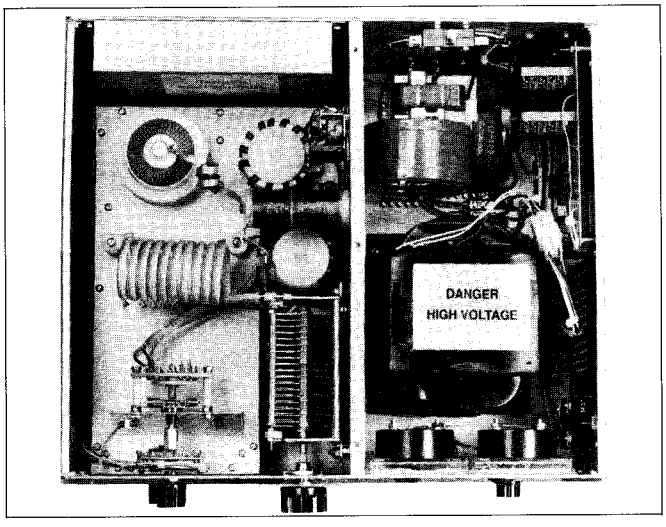
probably do so in half an hour.) As shown in Fig 2, the HF-1250's two-tone, third-order IMD products are down about 46 dB—by far the best in the bunch.

The amplifier, tube and standard Hypersil transformer are shipped separately. Transformer and tube installation are easily accomplished by following the instructions in the manual, but no drawings are included to assist you in this process. A tuning chart for each amplifier is added by hand to the manual. The documentation is clearly written and includes a schematic and complete parts list.

The HF-1250 is set up for 120-V operation as it comes from the factory. You can wire the amplifier for 240-V operation by changing the jumpers on a terminal strip accessible from the rear panel. The line cord is supplied with a 15-A, 120-V ac plug.

Command Technologies will provide instructions to enable 10- and 12-meter operation upon receipt of a copy of a valid amateur license. The modification for the HF-1250 is very easy and should take most users less than 15 minutes.

Manufacturer's price: $1695. Optional QSK circuit (factory installed), $200. Warranty: 5 years (1st year, 100% parts and labor; 2nd year, 50% parts and labor; 3rd-5th years, 25% parts and labor), except for the 3CX800A7 tube, which is warranted by its manufacturer through Command Technologies. Manufacturer: Command Technologies, 1117 W High St, Bryan, OH 43506, tel 419-636-0443.



Inside the Commander HF-1250.

The Bottom Line

Command Technologies Commander HF-1250: Rock-solid construction, the best warranty of the group, low drive requirements, great IMD performance and optional QSK make this one a favorite. Internal power metering would make it nearly unbeatable in its class.

KENWOOD TL-922A

Kenwood's TL-922A is by far the oldest design in this group. It's a classic pair of 3-500Zs from an era when legal amateur power was specified as *input* power—1 kW on CW and 2 kW PEP on SSB—and hams didn't have access to 17 and 12 meters. We first reviewed a TL-922A in September 1980 *QST*. About all that's changed is its price—it listed for $1200 back then.

The TL-922A has tuned input circuits, but the input match isn't as good as the other amplifiers in this test. Input SWR rises above 1.5:1 in at least some portion of most bands. In some cases, we had to use the internal antenna tuners in the radios we used to drive the '922 to avoid high-SWR power reduction. The output circuit is a conventional pi network. Tuning is exceptionally smooth except on 10 meters, where it's quite peaky. The amplifier's noisy TR relay is the only operational objection we have.

Cooling is provided by a quiet fan that draws air through holes in the side of the cabinet, past the tubes and power-supply components, and blows it out the back. No chimneys are used. A delay circuit keeps the fan running for about 2 minutes after the amplifier is shut off. The cooling system seems adequate. Everything remains cool, even during extended contest operation.

One of the front-panel meters is dedicated to anode current (0-1 A). The other meter can be switched among high voltage (0-4 kV), grid current (0-400 mA), and RF output. The RF output meter indicates *relative* power (the scale simply reads 0-10), and is intended as a tuning aid only.

As Table 6 shows, the TL-922 makes the least power of the group. Power output falls off on 160 meters and the higher bands. The amplifier easily passed a test of its 10-minute CW key-down rating, remaining cool throughout. Table 6 shows numbers gathered by tuning up the TL-922A to about 1000 W input on CW, according to instructions in the manual. The TL-922A made about 1100 W output with 97 W drive in our 20-meter PEP test with the amplifier tuned for 2 kW PEP input according to the procedure outlined in the manual. Before you cry, "That's not fair! Those instructions are based on legal operation under the old rules. Why not just tune for maximum output on all modes, now that it's legal?," consider this:

The front-panel SSB/CW switch changes anode voltage from about 3.1 kV for SSB to 2.2 kV for CW. (These are no-load values.) Although this switch may seem an artifact of the old power rules, the manual is *very* clear about operating CW with the amplifier switched to the higher-voltage SSB position: "DO NOT, under any circumstances OPERATE your exciter in the CW mode while the linear is in the SSB mode. Failure to heed this warning may cause immediate, extensive damage to the amplifier, repair of which will not be covered by your warranty." This warning is repeated several times.

The TL-922A's two-tone, third-order IMD products are down 38 dB at rated PEP input, like the other two 3-500Z amplifiers in this test, as shown in Fig 3.

Tubes and amplifier are shipped separately. You have to install the tubes, along with their plate caps and parasitic suppressors. Three drawings and step-by-step instructions make tube installation simple. The TL-922A is set up for 240-V ac operation as

Table 5
Kenwood TL-922A MF/HF Linear Amplifier, Serial No. 10700063

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 160, 80, 40, 20, 15 and 10-meter amateur bands.*	As specified.
Power input: 2000 W PEP on SSB, 1000 W on CW or RTTY. SSB, continuous for 30 minutes; CW and RTTY, key-down continuous for 10 minutes.	Meets key-down specifications. See Table 6.
Driving power required: 80 W nominal, 120 W maximum.	70-110 W for rated input, depending on frequency.
Input SWR: Less than 1.5:1 within amateur bands.	As specified.
Spurious signal and harmonic suppression: Not specified.	Meets FCC specifications.
Intermodulation distortion: Better than 30 dB below rated output.	See Fig 3.

Primary power requirements: 120 V ac at 28 A or 240 V ac at 14 A max.
Size (height, width, depth): 7.5 × 15.4 × 16 inches. Weight: 68 pounds.
Color: Two-tone gray.

*As shipped from the factory, the TL-922A cannot operate on 10 meters; enabling operation on these bands requires information furnished by Kenwood upon presentation of a valid amateur license (see text).

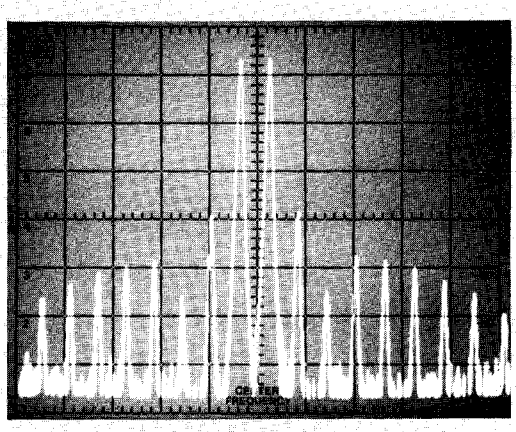
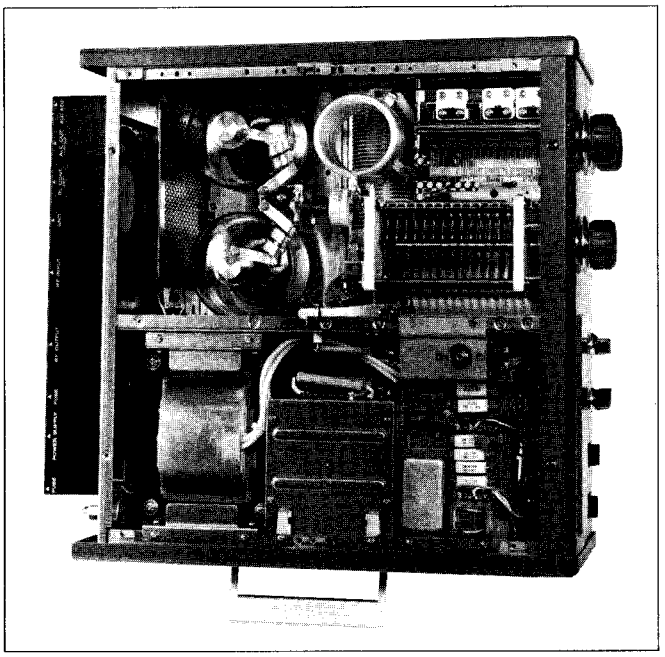


Fig 3—Worst-case spectral display of the Kenwood TL-922A amplifier during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 38 dB below PEP output, and fifth-order products are approximately 54 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The amplifier was being operated at 1120 W PEP output (2000 W PEP input) at 14 MHz.

Table 6
Kenwood TL-922A Test Results

Frequency (MHz)	*Drive Power (W)*	*Anode Voltage (kV)*	*Anode Current (mA)*	*Grid Current (mA)*	*Power Output (W)*	*Harmonics/ Spurious (dBc)*
1.9	100	1.8	540	170	670	−43
3.75	100	1.8	620	185	800	−44
7.0	105	1.8	520	180	750	−45
14.0	110	1.8	540	170	750	−52
21.25	105	1.8	500	120	650	−56
29.0	100	1.8	500	160	650	−58



Inside the Kenwood TL-922A.

it comes from the factory. (The line cord is supplied unterminated; you provide the right plug.) It's a snap to rewire it for 120-V ac operation by changing jumpers on a terminal strip easily accessible from the back panel. Changing the operating voltage on the TL-922A was easier than on any of the other units. The line cord is supplied unterminated; you provide the right plug.

Not so painless is adding 10-meter coverage. Kenwood will provide instructions and a kit of parts needed to enable 10-meter operation upon receipt of a copy of a valid amateur license. The 10-meter modification for the TL-922A was the most difficult of the bunch. It took ARRL Lab Engineer Mike Gruber, WA1SVF, several hours to disassemble the TL-922A, remove some unneeded capacitors, modify the 15-meter input coil, solder in some new capacitors, and add a required jumper to the band switch. Then, because the modification worsens the 15-meter input match, Mike spent considerably more time retuning the input network, which requires special tools and defeating the amplifier's safety interlocks.

Several people who used the TL-922A noted that the TR relay is loud compared to the other units. Considering that the TL-922A's fan is so quiet, the relay noise is an annoyance. According to the manual, "Your TL-922A contains an oversized relay for conservative operation and its action is slower than smaller relays...."

Speaking of the manual, the TL-922A's documentation is professional and complete, including several photos and illustrations, detailed operation instructions, theory of operation, a schematic and packaging instructions. The manual also includes troubleshooting instructions. Despite the quality of the owner's manual, documentation supplied with the 10-meter modification lacks clarity.

Manufacturer's suggested retail price: $1983. Warranty: 1 year parts and labor, except for the 3-500Z tubes, which are warranted by their manufacturer through Kenwood. Manufacturer: Kenwood USA Corp, Communications and Test Equipment Group, 2201 E Dominguez St, Long Beach, CA 90801, tel 310-639-4200.

The Bottom Line

Kenwood TL-922A: This aging workhorse is refined and rugged as a battleship, but lacks 17- and 12-meter coverage and is noncompetitive in the power-output arena.

TEN-TEC CENTURION

The Centurion is a recent addition to Ten-Tec's amplifier lineup that includes the solid-state, 550-W-output Hercules II and the excellent legal-limit Titan (reviewed in April 1986 *QST*). The Centurion uses a pair of 3-500Zs and is comfortably rated at 1300 W output on SSB and 1000 W output on CW. It's the only amplifier in this test with QSK as a standard feature, and it's fully compatible with Ten-Tec and other QSK-capable transceivers.

The Centurion features tuned input circuits, and its input match is excellent on most bands. The exceptions are 80 meters, where the input SWR rises to 2:1 at the top of the band, and 17 meters, where it's 1.8:1. The output circuit is a conventional pi network. Seventeen meters is covered with the band switch in the 15-meter position; the 10-meter position is used for 12 meters. Tuning is smooth, but we experienced some arcing when tuning the amplifier on the low bands. Driving a 50-Ω load, the amplifier doesn't arc once it's tuned.

A fan inside the cabinet draws air across the power transformer and blows it past the tubes. The sides and top of the cabinet are vented. No chimneys are used. The fan is quiet and pushes adequate air past the tubes.

The Centurion's metering is the most extensive of the amplifiers reviewed here. One analog front-panel meter is dedicated to monitoring anode current (0-1 A). Another can be switched among high voltage (0-4 kV), grid current (0-400 mA), forward power (0-2500 W) and reflected power (0-250 W). In addition, the Centurion includes an LED bar-graph **PEAK POWER** meter. This meter is calibrated so that the first red LED lights at 1250 W output. The Centurion's peak-reading LED wattmeter agrees fairly well (within the LED meter's relatively low resolution) with our Bird 4381. The amplifier's analog power meter is quite accurate on 160, 20 and 17 meters, but reads about 20% high on 80 and 40 meters and 10 to 15% low on 15, 12 and 10 meters.

As Table 8 shows, the Centurion easily makes its CW output rating of 1000 W on all bands. It also had no problem meeting its 1300-W PEP rating for SSB operation during our 20-meter PEP SSB test. As shown in Fig 4, two-tone, third-order IMD products are down about 38 dB, like the AL-82 and TL-922A.

Tubes and amplifier are shipped separately. You install the tubes, along with their plate caps and straps that attach them to the parasitic-suppressor PC board. Three drawings and step-by-step instructions make tube installation painless. The Centurion is set up for 220-250 V ac operation as it comes from the factory. The manual says that operation on 110-125 V is possible, but it's not recommended because the amplifier draws nearly 30 A at 120 V, which is beyond the capability of most normal house wiring. Changing to 120-V operation is not difficult, though, requiring you to move two sets of internal jumpers and change the line-cord connector. The line cord is supplied with a 250-V, 20-A power plug.

Ten-Tec will send a kit to enable 10- and 12-meter operation upon receipt of your warranty card and a copy of a valid amateur license. The modification isn't difficult. You simply replace the plug-in 15-meter input filter with a 15- to 10-meter unit and make a simple change to the band switch.

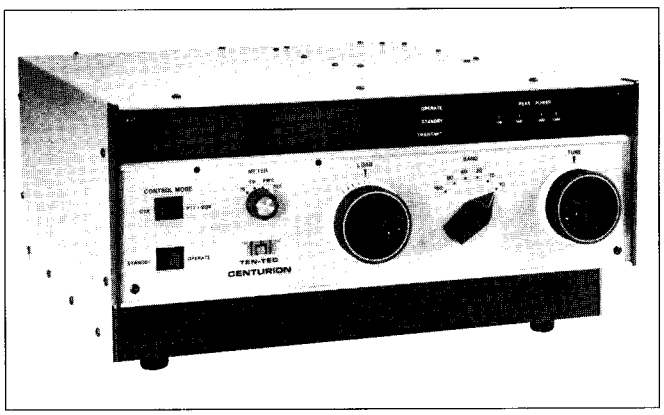


Table 7

Ten-Tec Centurion MF/HF Linear Amplifier, Serial No. 10A10091

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 1.8-2.0, 3.2-4.7, 6.5-9.0, 9.0-15.6, 16.4-24.0, 24.0-29.7 MHz.*	Operation on amateur bands as specified; not tested elsewhere.
Power output: 1300 W SSB; 1000 W CW, 50% duty cycle; 650 W RTTY and SSTV, 50% duty cycle, 10-minute transmission limit.	See Table 8.
Driving power required: 100 W for full rated output.	80-105 W for full output, depending on frequency.
Input SWR: Less than 2:1.	As specified.
Spurious signal and harmonic suppression: Better than 50 dB below rated output.	Meets FCC specifications.
Intermodulation distortion: Better than 35 dB below rated output.	As specified. See Fig 4.

Primary power requirements: 110-125 V ac at 30 A or 220-250 V ac at 15 A.

Size (height, width, depth): 7.75 × 15.5 × 20 inches. Weight: 52 pounds. Color: Gray.

*The FCC-specified maximum legal output on the 30-meter band for US amateurs is 200 W PEP. As shipped from the factory, the Centurion cannot operate on 10 and 12 meters; enabling operation on these bands requires information and parts furnished by Ten-Tec upon presentation of a valid amateur license (see text).

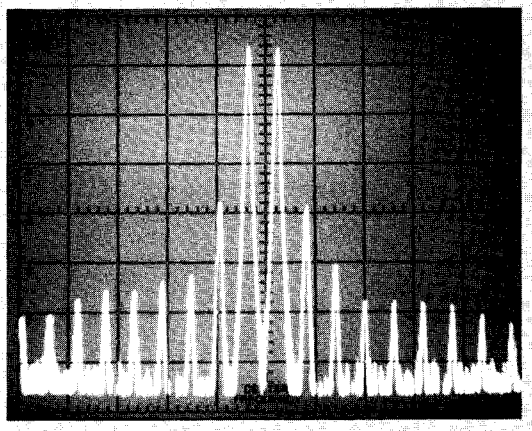
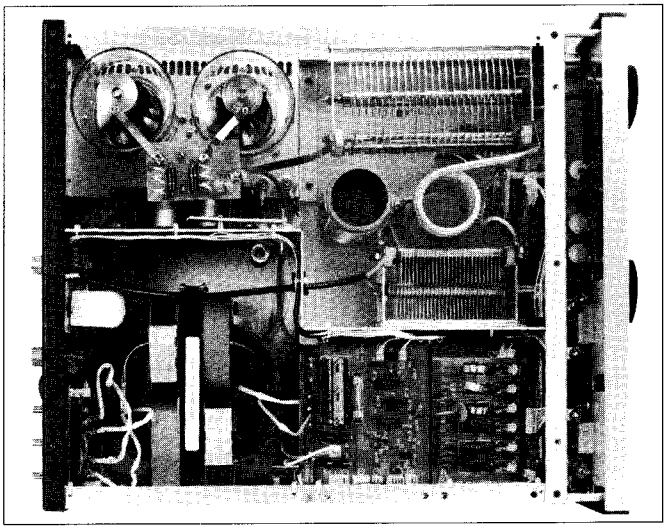


Fig 4—Worst-case spectral display of the Ten-Tec Centurion amplifier during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 38 dB below PEP output, and fifth-order products are approximately 50 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The amplifier was being operated at 1330 W PEP output at 14 MHz.

Table 8

Ten-Tec Centurion Test Results

Frequency (MHz)	*Drive Power (W)*	*Anode Voltage (kV)*	*Anode Current (mA)*	*Grid Current (mA)*	*Power Output (W)*	*Harmonics/ Spurious (dBc)*
1.9	81	2.6	590	220	1000	−45
3.75	68	2.6	530	180	1000	−52
7.1	73	2.6	530	170	1000	−58
14.2	63	2.6	520	160	1000	−55
18.07	93	2.5	700	200	1000	−46
21.2	90	2.6	550	180	1000	−50
24.89	92	2.5	630	210	1000	−50
29.0	95	2.6	610	200	1000	−50



Inside the Ten-Tec Centurion.

When we received our Centurion, it operated in a way we had never seen before: The tubes were biased into conduction whenever the **STANDBY/OPERATE** switch was in the **OPERATE** position. Even when the amplifier was unkeyed, it drew over 100 mA of idling anode current, heating the room more than we'd have liked. During the review period, Ten-Tec changed the amplifier's bias circuit to cut off the tubes when the amplifier is unkeyed. Ten-Tec doesn't consider this a performance-related change, so they're not updating Centurions free of charge (but they will supply Centurion owners with the components to make the modification at no charge). Owners of Centurions with the older bias circuit can return the amplifier to Ten-Tec for a replacement bias board. The cost is $30 plus shipping (both directions).

The Centurion's manual wins hands-down in this competition. It's an operation *and* service manual, whereas the others describe operation and theory of operation only. Pages of photos, schematics and an excellent section on troubleshooting and maintenance make this manual among the best we've seen.

Manufacturer's price: $1695. Warranty: 1 year, except for the 3-500Z tubes, which are warranted by their manufacturer through Ten-Tec. Manufacturer: Ten-Tec, 1185 Dolly Parton Pkwy, Sevierville, TN 37862, tel 615-453-7172.

The Bottom Line

Ten-Tec Centurion: Attractive and built to last, this amplifier's good metering, solid feel and standard QSK make it a tough competitor in this class; arc-free tuning would make it even stronger.

Conclusions and Some Words About Warranty Coverage

Our favorites are the Commander HF-1250, Centurion and AL-82, all for different reasons. It's difficult to pick a clear winner from these three units; we'd not hesitate to recommend any of them.

With its hefty power supply and forced-air cooling, Ameritron's AL-82 takes 3-500Z technology to the limit. The AL-82 is the only amplifier in this group that makes 1500 W output, but its heat, noisy blower and high drive requirements make it feel like it's stretching a bit to do so.

The Commander HF-1250's low drive requirements, clean IMD and solid RF performance create a feeling that this amplifier is never strained, and its rated output is in the same class as the Centurion. But to match the Centurion's features, you'd need to buy the QSK option and add an external wattmeter.

The Centurion's good construction, standard QSK, easy tun-

occasional arcing during tune-up on the low bands, it's as good an RF performer as any in this group and offers a great dollar value.

It's difficult to recommend the TL-922A. Although we like its quiet, no-fuss manner and rock-solid construction, this amplifier is a bit long in the tooth. It's about time that Kenwood considered addressing the TL-922A's low power output and lack of 17- and 12-meter coverage. For the same dollar, the other amplifiers in this test offer better value.

All the amplifiers in this comparison use tubes manufactured by Eimac. Amplifier manufacturers customarily warrant everything in the amplifiers except for the tubes, which Eimac warrants through each amplifier manufacturer. This means that if you experience a tube failure, you return the tube to the amplifier manufacturer, not to Eimac, and the amplifier maker works with Eimac and replaces your tube, if it's a failure covered under the tube warranty.

Thanks to Jim Parise, KC1SJ; Tom Russell, N4KG; Jerry Cross, N4NO; and Buzz Miklos, WA4GPM, for their help with this review.

Further Reading

R. Measures, "Improved Anode Parasitic Suppression for Modern Amplifier Tubes," *QST*, Oct 1988, pp 36-38, 66, 89.

R. Measures, "Parasitics Revisited," Part 1, *QST*, Sep 1990, pp 15-18.

R. Measures, "Parasitics Revisited," Part 2, *QST*, Oct 1990, pp 32-35.

R. Measures, "Circuit Improvements for the Heath SB-220 Amplifier," Part 1, *QST*, Nov 1990, pp 25-29.

R. Measures, "Improvements for the Heath SB-220 Amplifier," Part 2, *QST*, Dec 1990, pp 41-43.

Table 9
Feature and Option Comparison

	Tube Complement	*Power Metering*	*Line Voltages*	*ALC Output*	*QSK*	*Variable Blower Speed*	*Size (HWD, inches)*	*Weight (pounds)*	*MSRP*
AL-82	2 × 3-500Z	Peak	217-240	Yes	NA	Yes (4)	10 × 17 × 18.5	77	$1995
HF-1250	3CX800A7	No	110/220	Yes	Opt*	No	7.75 × 18 × 16	65	$1695
TL-922A	2 × 3-500Z	Relative	120/240	Yes	NA	No	7.5 × 15.4 × 16	68	$1983
Centurion	2 × 3-500Z	Peak and Average†	110-125/ 220-250	Yes	Std	No	7.75 × 15.5 × 20	52	$1695

Notes
Std = standard; Opt = optional; NA = not available.
*Available only as a factory-installed option. Price: $200.
†Forward and reflected.