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Ameritron AL-1200 HF Linear Amplifier

Santec LS-202A 2-Meter SSB/FM Hand-Held Transceiver

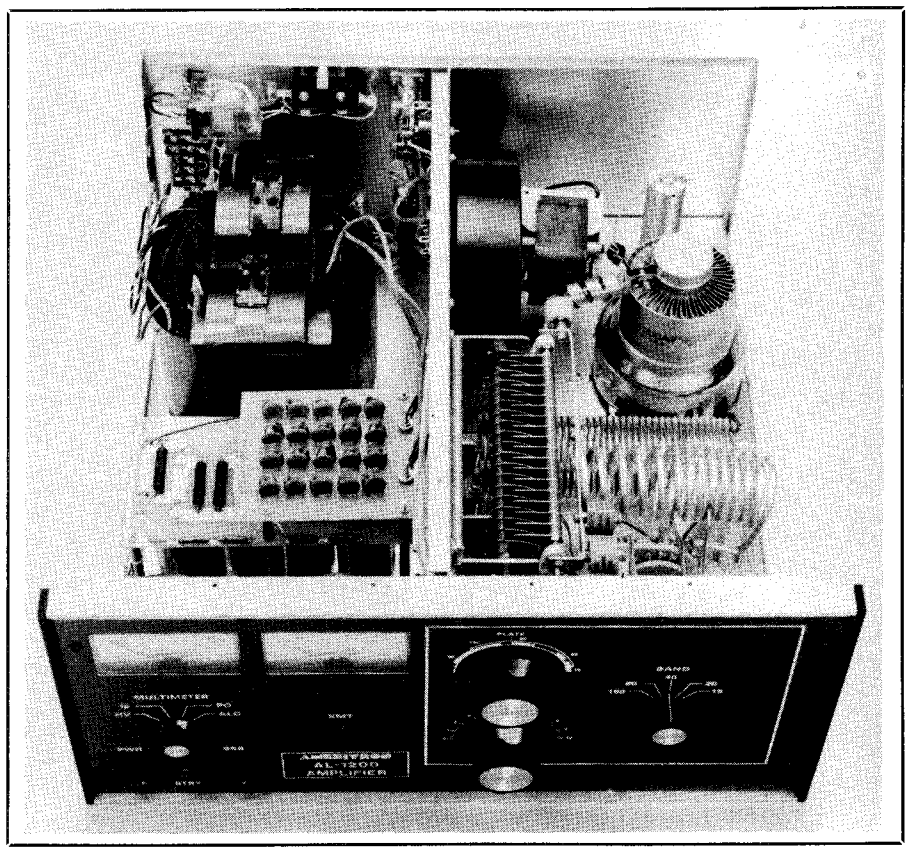
Conducted By Bruce O. Williams, WA6IVC
Assistant Technical Editor

Ameritron AL-1200 HF Linear Amplifier

It's big, and that's good. It's heavy—77 pounds—and that's good, too. In these days of "smaller is better" (for example, hand-held VHF rigs that are barely larger than a pack of cigarettes and all-band transceivers the size of a shoebox), it's refreshing to see some manufacturers building big, heavy boxes and bragging about them. Even with all of the available modern technology, it's still not possible to build a tough, 1500-W-output, multiband HF amplifier with a built-in power supply that fits inside a shoebox and can be lifted with one hand.

The Ameritron AL-1200 allows legal-limit, continuous-duty operation on 160 through 15 meters, including the 10- and 18-MHz WARC bands. It is possible, with a simple modification, to put the amplifier on the 12- and 10-meter bands. The band switch has an extra, unmarked detent position allowing this modification.

All power supplies are built in, and the tube is cooled by a rugged forced-air system. An ALC circuit, hooked up to the transmitter ALC input, prevents amplifier output from exceeding 1500 W in case of excessive drive.



Ameritron AL-1200 Full-Power Linear Amplifier, Serial No. 033

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 1.8-2.0 MHz, 3.3-4.4 MHz, 6.3-8.3 MHz, 9.5-15.5 MHz, 15.5-21.5 MHz, 24-29 MHz (export model).	As specified.
Modes of operation: SSB, CW.	As specified.
Power output: 1500 W, all bands.	See Table 1.
Harmonics and spurious emissions: Not specified.	See Fig. 1.
Color: Gray front panel, black cabinet.	
Dimensions (height, width, depth): 10 × 17 × 18½ in.	
Weight: 77 lb.	

Inside the Box

Ameritron's AL-1200 is the first commercially built, amateur-band amplifier to use the new EIMAC 3CX1200A7 ceramic/metal triode. This tube is designed to meet the requirements for amplifiers operating at the higher amateur power levels now allowed by the FCC. According to EIMAC, the 3CX1200A7 can be thought of as a ceramic version of the popular 3-1000Z. The 3CX1200A7 has drive, power-output, dc-supply and frequency ratings similar to its glass counterpart. It features ceramic and metal construction and a thoriated tungsten filament requiring virtually no warmup time. Grid dissipation is 50 W, so the 3CX1200A7 is more rugged than other ceramic/metal triodes.

But back to the AL-1200. The interior of the amplifier is divided into two sections by a partition between the front and rear panels. The power supplies, metering, ALC circuitry and relays reside on the left side of the partition; the input network, tube, blower and tank components are on the right. When the cover is attached securely with its 30 screws, the RF circuitry is completely enclosed in its RF-tight compartment.

Power Supply

The full-wave bridge rectifier is built on a PC board and includes five 1-kV PIV, 3-A diodes in each leg of the bridge. Ameritron has included 0.01-μF capacitors across each diode for transient suppression, but no equalizing resistors. Filtering is accomplished by eight 210-μF, 450-V electrolytic capacitors connected in series for a total filter rating of about 26 μF at 3600 V. According to the front-panel HV meter, the power supply delivers about 3400 V under no-load conditions and 3000 V under full load when connected to a 240-V line regulated to within 3%.

RF Circuitry

A tuned input circuit is used to provide best linearity and drive characteristics, and the input circuitry is completely shielded in a metal box that attaches to the rear of the front panel. The plate-circuit band switch attaches to the rear of the input-circuit compartment so that the shaft from the front-panel band switch directly drives both the input- and the tank-circuit band switches. This thoughtful arrangement eliminates the need for elaborate chain drives or (heaven forbid!) separate input and output switching. The band switch is the genuine article—a heavy-duty ceramic switch with 6-kV, 20-A contacts and a firm detent at each band position.

The tube, blower and plate RF choke are mounted on a small chassis at the rear of the amplifier. The blower is mounted to the partition so that it draws air through perforations in the side panel, past the transformer and other power-supply components. The air is forced into the chassis supporting the 3CX1200A7, and it must exit through the EIMAC air system socket, past the tube seals and through the tube cooler. The cabinet top is vented directly above the tube.

The tank circuit, a pi-L network on 160 and 80 meters and a pi network on the other bands, features a 190-pF, 4.5-kV air-variable PLATE tuning capacitor and an 800-pF,

Table 1
ARRL Laboratory Power Measurements
Ameritron AL-1200 Linear Amplifier

Band (MHz)	Mode	Plate Current (A)	Plate Voltage (V)	Power Output (W)	Drive Power (W)	Input SWR	Efficiency (%)
1.8	CW	0.700	2950	1150	100	1.24	51
	SSB	0.775	2900	1250*	100	1.29	51
3.5	CW	0.700	2900	1400	100	1.38	64
	SSB	0.775	2900	1500	100	1.30	62
7.0	CW	0.700	2950	1400	100	1.13	63
	SSB	0.775	2900	1500	100	1.21	62
14	CW	0.725	2900	1450	100	1.27	64
	SSB	0.775	2900	1500	100	1.34	62
21	CW	0.750	2900	1200	100	1.44	51
	SSB	0.850	2900	1250*	100	1.32	47
24	CW	0.775	2900	1200	100	2.30	49
	SSB	0.850	2900	1250	100	2.10	47
28	CW	0.700	2950	1000	54	1.70	46
	SSB	0.700	2950	1000	43	2.00	46

*1500-W output could be obtained with 120-W drive.

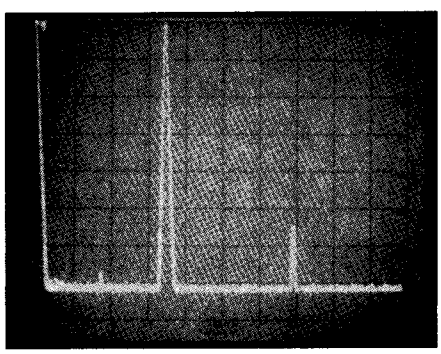


Fig. 1—Worst-case spectral display of the AL-1200 linear amplifier. Power output is 1500 W at 7 MHz. Horizontal divisions are each 2 MHz; vertical divisions are each 10 dB. All spurious and harmonic emissions are at least 54 dB below the fundamental output. The AL-1200 meets current FCC spectral-purity requirements.

1.2-kV air-variable LOAD capacitor. Fixed transmitting-quality ceramic doorknob capacitors are switched in parallel with the tuning capacitor for 160-meter operation, and similar capacitors are switched in parallel with the loading capacitor for 160, 80 and 40 meters.

Control Circuitry

The AL-1200 has a CW/SSB front-panel switch, but not for the traditional reasons. Since the FCC changed the Amateur Service power limitations to 1500-W output for both CW and SSB, different operating voltages for each mode are no longer necessary. In this amplifier, the CW/SSB switch changes the value of the Zener-diode voltage in the bias circuit. For SSB (and indeed SSTV or even AM), the tube operates in class AB_2 for best linearity. In the CW mode (for CW or RTTY), the bias is changed so that the tube operates closer to class B for greater efficiency. This feature really works; the efficiency does increase (see Table 1), and the tube dissipates less power. The result is cooler operation in the high-duty-cycle modes, probably leading to longer tube life.

Metering is another area where Ameritron takes a step forward from traditional amplifier designs to produce an updated scheme for today's power rules. Many more tube failures result from excessive grid current than from excessive plate current, so it is important to monitor grid current at all times. Accordingly, the AL-1200 sports two meters: one constantly monitors grid current; the other, a multimeter, can be switched to monitor plate voltage, plate current, ALC (drive power) or peak RF-output power. During normal operation you would monitor grid current to protect the tube and peak RF-output power to ensure compliance with FCC rules. Dedicated plate-current meters (to monitor input power) are no longer necessary.

Construction

Overall, the AL-1200 is well built, although it is not an "overkill" design. The power transformer is impressive for a commercially built amplifier in this price range, as is the size and quality of the blower. Shielding is excellent, and the chassis and cabinet are up to the job of supporting all the weight. Machine screws, not sheet-metal screws, secure the cabinet cover.

The 3/16-in copper tubing used for the 20, 15 and 10-meter tank coil is silver plated. Tank coils are mounted well away from the chassis. Good design practices allow the use of air-variable capacitors, and fixed capacitors in the tank circuit are RF-type ceramics. Not once did I hear the telltale crackling indicative of arc-overs, even when I ran the amplifier at full output into an antenna with a 3:1 SWR.

Hookup and Operation

The AL-1200 is shipped in three packages: The 3CX1200A7 is shipped in the manufacturer's original shipping carton; another carton contains the power transformer; and the rest of the unit is in a third box. Ameritron supplies instructions, complete with drawings, for installing the tube and transformer. As shipped, only a few screws are used to secure the cabinet top. The rest come in a small bag to save you the trouble of removing 30 screws before installing the other parts.

Transformer installation takes about 10 minutes—just bolt it in place and connect six clearly marked wires. Tube installation is just as easy. Firmly seat the tube in the socket, place the chimney in its spring clips, make the anode connection to the tube and you're ready to go (after replacing the 30 screws to secure the cover).

While the cover is off, you may wish to modify the amplifier for use on 12 and 10 meters. This is simple: Just clip the green wire that protrudes from the input compartment, and you're all set. These bands will then be operative in the unmarked position on the band switch. Consult the manufacturer if you have any questions about this modification.

We experienced some problems with our AL-1200. According to the manufacturer, these problems existed with only a few of the earlier serial numbers (ours is no. 33), and they have been taken care of on later units. The first problem, low high voltage, was caused by an improperly wound plate transformer. The second, low power output, was caused by a defective tube. Tom Rauch, W8JI, of Ameritron was exceptionally responsive in helping us track down the problems. He promptly replaced both defective parts, and the AL-1200 worked as specified.

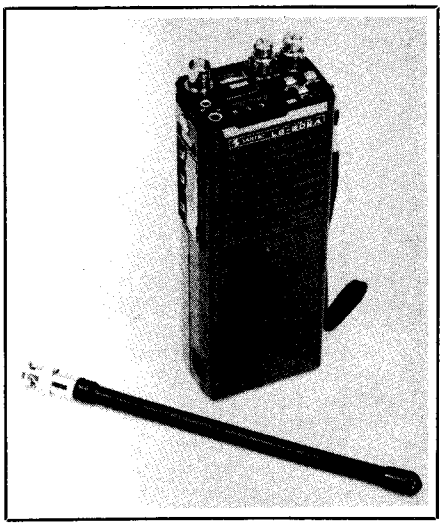
The amplifier is indeed capable of continuous operation at full output power for at least half an hour, as claimed in the promotional literature. In fact, the amplifier case was cooler than our 2-kW dummy load at the end of a half-hour key-down test in the ARRL lab. Thanks to the pi-L output circuit and proper component choice, tuning on 160 and 80 meters is exceptionally smooth. The loading control actually has an effect! The AL-1200 works better on the low bands than on 10 meters, as shown in Table 1. The manufacturer says that the amplifier was designed with low-band operation in mind, and that's probably a good thing during this part of the solar cycle. The extra power really helps on 160 and 80 meters.

The AL-1200 is worth considering if you're in the market for a companion for your 100-W transceiver. It offers good performance and reliability. Given the cost of the components used in a power amplifier, this amplifier is reasonably priced at $1695. Manufacturer: Ameritron, Division of Prime Instruments, 9805 Walford Ave., Cleveland, OH 44102, tel. 216-651-1740.—*Mark Wilson, AA2Z*

SANTEC LS-202A 2-METER SSB/FM HAND-HELD TRANSCEIVER

A 2-meter hand-held rig that includes SSB operation? Yes! Imagine having the option of calling through the local repeater or keeping in touch with your friends on sideband while walking (or driving) around town. If a lot of your 2-meter operation is on SSB, and you have resisted the temptation to buy a hand-held transceiver because you don't use the FM repeaters very much, Santec may have just the rig for you.

This versatile radio uses thumbwheel switches for frequency selection, with a slide switch to set +5 kHz offsets. The top panel also includes a MODE switch to select FM, USB or LSB. The on/OFF/VOLume control and SQuelch control are mounted as a single concentric unit. RIT and VXO controls make up another concentric pair. (This pair operates only when the MODE switch is set for sideband operation.) There is a slide switch



Santec LS-202A Hand-Held 2-Meter FM and SSB Transceiver, Serial No. 1197

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 144.000-147.995 MHz in 5-kHz steps.	As specified.
VXO range: ±5 kHz.	±5.8 kHz.
RIT range: ±1 kHz.	±2.8 kHz.
Modes of operation: FM, LSB, USB.	As specified.
S-meter sensitivity (μV for S9 reading): Not specified.	50.
Transmitter	*Transmitter Dynamic Testing*
Transmitter power (output):	
High: 1.5 W at 7.2 V.	1.8 W.
3.5 W at 10.8 V.	3.8 W.
Low: 0.5 W at 9.0 V.	0.5 W at 10.8 V.
Not specified at 7.2 V.	0.2 W.
Carrier Suppression: Not specified.	See Fig. 2.
Third-order intermodulation distortion dynamic range: Not specified.	See Fig. 3.
Harmonic and spurious suppression: 60 dB.	See Fig. 4.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity: Less than 0.25 μV for 10-dB signal-to-noise ratio.	Noise floor (Minimum discernible signal) (dBm): −138.
	Blocking dynamic range (dB): 112.
	Two-tone, third-order intermodulation distortion dynamic range (dB): 81.
	Third-order input intercept (dBm): −16.5.
Receiver audio output at 10% total harmonic distortion: More than 400 mW.	400 mW.
Squelch sensitivity: Not specified.	0.07 μV min, 0.3 μV max.
Color: Dark green.	
Size (height, width, depth): 7 × 2.5 × 2 inches including projections (except antenna).	
Weight: Approximately 1 lb with battery and antenna.	

to turn on a noise blanker, also only operational in the sideband mode. A small D'Arsonval-movement S meter doubles as a battery indicator when the radio is transmitting. A red LED should also light during transmit to indicate good batteries. If the LED does not light, or flashes, the batteries should be replaced. This indicator is handy for nighttime operation. It is also easier to take a quick look at the LED than the meter during mobile operation. A BNC antenna connector and a pair of jacks for an external speaker/microphone (2.5-mm jack for the mic and a 1/8-inch jack for the speaker) round out the top-panel complement.

A number of controls are located along the left side of the radio. The PTT switch is operated by a bar conveniently located toward the front of the radio on this side. Three slide switches are found behind the PTT bar. One slide switch selects +600 kHz offset, −600 kHz offset or simplex operation. Another selects either of two power levels. Slide the TONE switch on, and the radio transmits a short 1750-Hz signal when the push-to-talk bar is pressed. Some repeaters require such a signal for access. On the left side, near the top, is a yellow button labeled LAMP. Press this button and a pair of green LEDs light on the top panel. The idea is to illuminate the S meter and the frequency-set thumbwheel switches, although I never found the lamps helpful when trying to set a frequency in the dark. A jack for the wall-transformer battery charger is located on the left side, near the bottom.

There is a wrist strap attached to the top right side of the radio. It is easy to hold the radio securely with this strap slipped around a wrist. A metal belt clip slides into a slot on the back of the radio. I found that the radio has a tendency to slide off a belt if carried in this manner. The top portion of the front panel sports a grille with raised horizontal bars. The openings for the built-in speaker and microphone are in the bottoms of these bars. This protects the speaker, mic and other internal components from dust or even water that might tend to enter through a flat grille. The case is made of a very heavy, dark-green plastic.

The slide-on battery pack takes up the bottom rear quarter of the radio. The battery pack locks securely in place by means of a notch in the battery right side panel and a sliding catch on the case. Connections for the optional mobile console appear to be included on the radio bottom, although the operator's manual makes no mention of them. Markings indicate + and − terminals, along with a pair of connections marked LAMP and TXB. These connections are recessed 7/32 of an inch into the bottom. The schematic diagram leads me to believe that the + and − terminals may serve to power the radio or be used with a drop-in quick-charge unit, although no quick charger is listed as an accessory.

Circuit Description

Receiver Section

The receiver uses single conversion on SSB and double conversion on FM. Signals are routed from the antenna through a low-pass filter and then to the RF amplifier stage. From there the signals go through a band-pass filter and are mixed with an oscillator output to produce a signal at the first IF, 10.695 MHz. Depending on the MODE switch setting, the signal is then sent either to the FM or the SSB IF section.

In the SSB IF section, the signal goes through a crystal filter, is amplified and detected by a diode-ring product detector. The FM IF section uses a different crystal filter and amplifier. A 10.24-MHz PLL-oscillator signal is mixed with the 10.695-MHz first-IF FM signals to produce a signal at the second IF, 455 kHz. A single IC provides a limiter amplifier, quadrature detector, active filter and squelch circuit.

The detected FM or SSB signal is finally routed to an audio amplifier that drives the speaker. An AGC signal is derived from the product-detector output during SSB operation. The S meter is driven by the product-detector output in the SSB mode and by the second-IF output in the FM mode.

Transmitter Section

In the FM mode, a voltage-controlled-oscillator (VCO) generates a carrier signal at 10.695 MHz. This is mixed with the PLL heterodyne oscillator and doubled in frequency to attain the final output signal. An IC amplifier limits the microphone audio frequency to less than 3 kHz and amplifies this signal.

For SSB operation, a VCO generates a 10.6935-MHz carrier signal for USB and a 10.6965-MHz signal for LSB operation. This carrier is mixed with the microphone audio in an IC balanced modulator to produce a double-sideband, suppressed-carrier signal. This signal then passes through a filter to remove the unwanted sideband before being mixed with the output from a PLL oscillator to generate the final signal. Four stages of amplification increase the signal to the 2.5-W level.

The PLL unit uses crystal oscillators to generate the various signals, such as the 10.24-MHz master oscillator signal, which is divided by 2048 to produce a 5-kHz reference signal. The +5 kHz output switch also selects the proper crystal oscillator for the desired output. The RIT and VXO circuits for varying the SSB operating frequencies are included in the PLL section. An out-of-lock signal prevents the LS-202A from transmitting if the PLL circuitry is not locked.

Operating the Radio

The LS-202A operating manual is nicely illustrated and clearly written—even if some of the English seems a bit broken. It is much better than some of the manuals that I have seen for imported equipment. But even without quickly going through the manual to become familiar with the operating details, you should have no trouble figuring out how to turn this rig on and "make it play." All controls are clearly marked, or their function is obvious to anyone who is even remotely familiar with radio equipment.

Battery packs available for the LS-202A range from 7.2 V to 10.8 V. The radio includes an IC voltage regulator, so it can be

operated from a supply in the range of 7 to 12 V. You are cautioned against connecting the rig directly to an automobile battery; the voltage-regulator output on most vehicles is in the range of 13.8 V, and that could easily damage the radio.

The standard battery pack holds six AA cells. One set of batteries comes with the radio. These are alkaline cells, recommended over carbon-zinc ones. There is no recharger included, since you should not recharge alkaline cells. After a short time I replaced the original batteries with NiCd AA cells, and was able to have a fresh set charged up and ready to go into the holder throughout the review period.

About a month after the radio for review was received, a package of accessories arrived. Included was the high-power NiCd battery pack, model NP-9. This is a 10.8-V, 450-mAh battery. With it, the radio produces about 3.5 W of output power. The wall-transformer unit that comes with this battery pack will recharge the battery in about six hours. You can also operate the radio with the charger plugged in, although I did notice a slight amount of ac hum on the transmitted signal if the battery was very low.

Another accessory item was a speaker/microphone. This is a most welcome addition if you plan to use the radio for any mobile operating. It is also very convenient to clip the radio to your belt and the speaker/mic to a shirt pocket while walking. The audio from the external speaker is not quite as clear as that from the internal one, but there seemed to be little if any difference in transmitted audio using the built-in or external microphones.

I was able to work into quite a few repeaters throughout the central Connecticut area. I had to keep the power switch in the HI position almost all of the time for reliable access to the repeaters. Of course, that is more because of terrain and distance to the repeater than any other factor. Using an eight-element log-periodic array suspended from the rafters in my attic I was able to work Chuck Hutchinson, K8CH, on SSB. His station is located about 20 air miles from mine. I was also able to work Mark Wilson, AA2Z, with no trouble, but Mark's station is only about 12 air miles away.

Later on, I mounted a Cushcraft A144-20T VHF Twist antenna on my roof. This antenna provides 10 elements with vertical polarization and 10 with horizontal polarization. Instead of phasing the two sets of elements to obtain circular polarization, I used one feed line to the vertical elements and one to the horizontal ones. That way I can choose the best antenna for FM repeater use or for SSB operation. With this rotatable array I am able to work through many more repeaters, and I have logged a number of other stations on SSB. With only 3.5 W of output power, I can definitely hear more stations on SSB than I can work, however!

A single battery charge can last a week or more if you are using it mostly to monitor a frequency for an hour or so a day and seldom transmitting, even on low power. If you are doing much transmitting, especially on high power, the battery may last less than an hour. If you are using the unit on SSB, the battery life seems to be extended by quite a bit. The manual claims that SSB operation extends the battery life three to four times over FM operation. I made no attempt to measure this, but with the reduced duty cycle of an SSB transmission as compared to an FM transmission, it certainly seems possible.

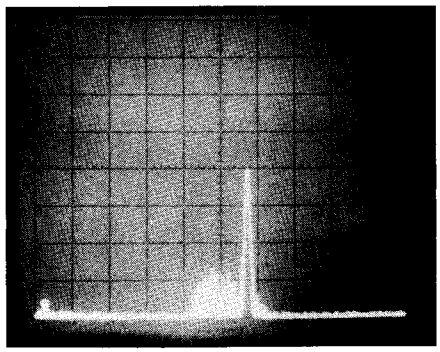


Fig. 2—Spectral display of the LS-202A operating on LSB with no modulation. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz.

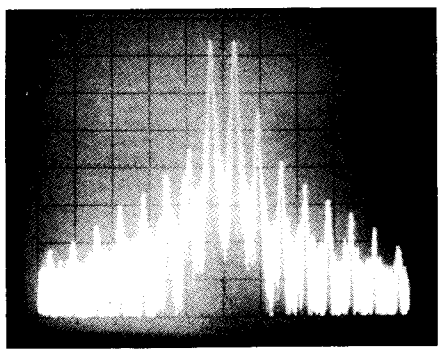


Fig. 3—Spectral display of the LS-202A undergoing two-tone, third-order intermodulation distortion test. Transmitter output is 1.4 W. Vertical divisions are each 10 dB; horizontal divisions are each 2 kHz.

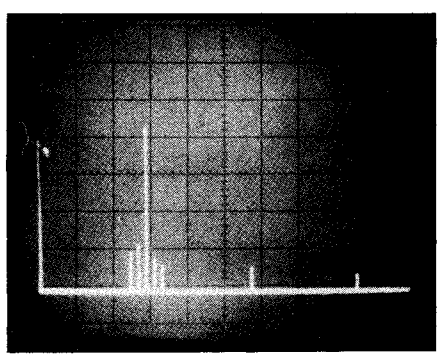


Fig. 4—Spectral display of the LS-202A operating on FM at 1.8-W output. Vertical divisions are each 10 dB; horizontal divisions are each 50 MHz. The LS-202A complies with current FCC requirements for spectral purity.

On-The-Air Impressions

Received audio reports were usually of excellent quality signals on FM (as long as I was able to work the repeater reliably). I did not receive any complaints of distorted audio or other problems. The quality is generally good on SSB, with one exception. There is a noticeable amount of carrier transmitted with the SSB signal. I did receive a couple of reports about this, and a lab check with the spectrum analyzer confirmed it. Fig. 2 shows the LSB spectral output, with no modulation present. The large pip to the right of center represents the carrier, while the small, wider "hump" to the left represents noise generated in the radio that is being passed by the sideband filter. If the receiving station tunes properly, this carrier should not be objectionable, and the radio does meet the manufacturer's specifications for carrier suppression.

Fig. 3 shows the spectral display for the transmitter two-tone IMD test. The upper sideband distortion products are a little greater than the corresponding lower sideband products, and by comparison to other "standard" SSB rigs we might expect them to be reduced a bit more. But when you consider the size of this radio and the type of use that it can expect, the output is acceptable.

Fig. 4 is the spectral output of the radio operating in the FM mode. The tallest line represents the carrier frequency. This is a fairly typical FM spectral display.

Conclusion

I really can't find much fault with the LS-202A. It is simple to operate and does a fine job for its intended purpose. It lacks a lot of the bells and whistles found on many hand-held rigs today such as frequency memories, scanning features, DTMF (dual-tone multi-frequency) pad for autopatch calls, and so on, but it doesn't have the high price tag either! The SSB feature is a definite plus if there is much activity on this mode in your area. All in all, it is a fine radio.

One area that I might complain about is the tight spacing on the on/OFF/VOLume, SQuelch, RIT and VXO controls. My big fingers had a hard time finding the bottom, or outer knob on the concentric controls. Even though these knobs are a bit larger than the top or center controls, I still tend to turn both when I only want to adjust the bottom one. I also have a tendency to turn the adjacent set while turning the one I want. In other words, when I am adjusting the RIT control during SSB operation, I am likely to change the volume and squelch settings. The layout is very tight to fit even these few controls on the top panel. I don't see any way that the situation could be improved, but prospective buyers should decide how difficult it will be for them to operate the controls properly.

The frequency-setting thumbwheel switches are recessed a bit into the top panel, and the megahertz and 10-kilohertz switches are very close to the edge of the recessed area. I find them somewhat difficult to turn, but then my fingers don't always do what I expect them to. I also found that I am likely to turn two of the switches at once. It sometimes takes a bit longer than expected to dial in a specific frequency. I have found these same problems with other radios using thumbwheel switches, so it is not a problem specific to this radio.

The LS-202A is available from ENCOMM, Inc., 2000 Avenue G, Suite 800, Plano, TX 75074, tel. 214-423-0024, or from any authorized dealer. Price class: LS-202A, $280; NP-9 quick-rechargeable NiCd 10.8-V battery pack, $43; CA-110E ac charger for NP-9, $18; SH-1 speaker/microphone, $25; LA-207 speaker/30-W amplifier, $160.—*Larry D. Wolfgang, WA3VIL*