Ameritron ALS-600S HF Amplifier with Switching Power Supply

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Is measuring *watts per pound* any way to evaluate amplifiers? If so, the ALS-600S just moved way up in the ranking. With its new switching power supply, the overall weight of the amplifier and power supply has dropped almost in half, from 44.5 to 22.5 pounds. Wary of back strain from moving amplifiers around the shack, my first reaction upon picking up the amplifier from UPS was "where's the other box?" The amplifier and power supply were shipped in one outer box, with a total shipping weight of just 36 pounds.

So What's in this Little Box?

The ALS-600S is an upgrade of the popular ALS-600.[4] The only difference between the two models is the power supply. In fact, the new power supply is perfectly compatible with earlier ALS-600 RF decks and can be purchased separately. If that were all there is to it, this review could end here. However, the ALS-600S is so much lighter than its predecessor that it deserves a fresh look.

The ALS-600S utilizes four MRF-150 MOSFET RF output transistors. This device is used by many manufacturers in both transceivers and solid-state amplifiers (including the ICOM IC-7800 and IC-PW1, Yaesu Quadra and the discontinued Ten-Tec Hercules). It is a tried and true transistor, originally developed by Motorola and now produced by MA/COMM. Each device is rated at about 300 W of power dissipation. At the specified output of 600 W, the ALS-600 would require a minimum of 923 W of dissipation at 65% efficiency into 50 Ω load, so there's some welcome headroom in this design. The ALS-600 RF deck was designed for Ameritron by Tom Rauch, W8JI, who also had a hand in engineering the noise filtering for the new SPS power supply.

Solid-state FET amplifiers have several obvious advantages. Because the output network is broadband, they do not require tuning. Operation is as easy as setting the correct frequency range on the band switch. Moreover, unlike tubes, the output devices do not deteriorate with use. High voltages are not present, so arcing is not a problem, and the MRF-150 is said to have about the same high-order intermodulation distortion and momentary overload tolerance as vacuum tube finals. No-warmup operation provides an instant boost in power at the press of a switch.

With such advantages, one wonders why solid-state amplifiers aren't more popular. One problem has been the power supply. Apparently, it has been easier and less expensive for manufacturers to build a high voltage, low current supply for tubes than to build a high current low voltage switching supply (with low RF noise) for transistors. Ironically, until now, the weight advantage of solid-state designs was lost in the conventional power supplies they employ.

Tunable tube amplifiers have some clear advantages of their own. The adjustable output networks they employ can be tuned to compensate for imperfect SWR and thus buffer the tubes from the "outside world," which in amateur service can be pretty harsh at times. In solid-state amplifiers high SWR can cause current and power dissipation to exceed the rating of the output devices. So, RF power FETs, like those in the ALS-600S, require protection from excessive SWR to prevent heat damage. Of course, an antenna tuner can be used with antennas that do not present a matched load, just as with solid-state transceivers.

Bottom Line

With its new switching power supply, the ALS-600 has become a great choice for those who like to travel with power, or even those who like to be able to move equipment in their stations without hurting their backs!

What Keeps it Going?

The ALS-600S employs several important protection schemes to improve reliability. At 70 W of reflected power, the amplifier will fault and automatically switch to standby. At 600 W output, this will occur when the SWR exceeds 2:1. With power output reduced to 300 W, the amplifier will fault at about a 3:1 SWR. Toggling the STANDBY switch puts the amplifier back into operation. One way to avoid switching into fault mode is to use the ALS-600's automatic level control (ALC) system to reduce exciter power automatically when the SWR rises. This requires the connection of a shielded audio type cable between the exciter and the amplifier. The manual does a good job of explaining how to set up this system. The amplifier will also switch to fault mode if the band selector is set below the operating frequency. A thermal protection circuit will force the amplifier into standby mode when it senses excessive heat. The amplifier will remain in this mode until the operating temperature drops to a nominal range. Overheating can occur while employing extended duty cycle modes that tax the cooling system, or by exceeding the power dissipation rating of the final transistors—through overdriving or high SWR.

Ten and 12 meter operation requires the addition of a filter board (MOD-10MB), available from Ameritron for $29.95 and a copy of an amateur license. We had a bit of a problem with our filter. The capacitors on the edge next to the meters (see Figure 6) were installed in such a way that the filter did not have

[4]R. Lindquist, N1RL, "Product Review—Ameritron ALS-600," *QST*, Aug 2001, pp 73-76.

From March 2005 QST © ARRL

Table 2
Ameritron ALS-600, serial number

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency range (US units): 1.5-22 MHz.[1]	As specified.
Power output: 600 W PEP, 400 W CW.	As specified for SSB and CW.
Driving power required: 100 W maximum.	Typically 100 W.
Input SWR: 1.5:1 maximum.	As specified.
Spurious signal and harmonic suppression: Not specified.	49 dB.
Intermodulation distortion (IMD): 25 dB.	See Figure 5.
RF unit power requirements: 50 V dc at 25 A, ±14 V dc at 1 A.	
Power supply power requirements: Strappable for 90 to 130 or 185 to 260 V ac.	11 A at 120 V ac.
RF unit size (HWD): 7.1"×9.5"×12", weight, 12.5 pounds.	
Power supply size (HWD): 6"×9"×14", weight, 10 pounds.	

[1]As shipped from the factory, operation on 12 and 10 meters is disabled. The ALS-600 can be modified for operation above 15 meters by the purchase of an optional kit. Information on this kit is available from Ameritron by written request, which should include a copy of the owner's valid Amateur Radio license.

enough clearance. ARRL Lab Engineer Michael Tracy, KC1SX, was able to remove, invert and reinstall the capacitors so the unit would fit as intended. Ameritron has identified the manufacturing problem and has corrected it for new shipments. If your filter doesn't fit, they request that you return it for a replacement.

After removing the top cover, the plug-in board was quickly and easily mounted to the main filter board with four screws. Figure 6 shows the board installed in the amplifier. When reinstalling the cover, I was careful to put the vent holes on the same side as the heat sink, as the proper alignment is not otherwise indicated. Full break-in (QSK) operation can be provided with the optional pin-diode switch, model QSK-5. We didn't test this feature.

Taking the ALS-600S on the Road

I like to compete from outside the US in DX contests. DXpeditioners have long put a high value on reducing weight, and amplifiers traditionally present a problem. In late 2001, I acquired a commercial 50 V switching supply and mated it to the ALS-600 RF deck, just for fun. Jim McCobb, W1LLU, and I used this setup in the 2002 ARRL DX Phone Contest, racking up 4500 QSOs as V31DJ. Figure 7 shows the author operating his compact medium-powered travel station.

Switching power supplies are now standard fare for powering 12 V gear, but they haven't been used much for amplifiers. Aside from the 50 V requirement of the MRF-150, a big stumbling block is radiated noise. At V31DJ, interference from the commercial switching supply was a problem on some frequencies, especially with the Yagi directly over the shack, and it cost us some contacts. This experiment made it quite clear that switching power supplies intended for amateur use require significant filtering that is absent in general purpose commercial units.

Operating 160 through 10 meters in the multi-operator, single-transmitter class, we unintentionally abused the ALS-600 in just about every possible manner. Nonetheless, I am happy to report that the amplifier faulted only when it was supposed to. It protected itself from our boneheaded, sleep-deprived band changing maneuvers, and otherwise kept on trucking. One quick toggle of the standby switch was all it ever took to reactivate the amplifier after a fault shutdown. Outside the contest, this amplifier demonstrated its attributes on the non-contest bands, as well. We also gave it a good workout on CW and PSK31, throttling the power back to 500 W, as recommended in the manual. Unlike past trips, after a while I found myself not worrying about damaging this amplifier. It seems quite capable of looking out for itself.

Behind Door Number Two

The ALS-600SPS switch mode power supply provides 50 V at 25 A maximum (1250 W) for the MRF-150s and ±14 V at 2 A for other circuits. There is a separate 12 V supply for the current surge relay, which also supplies +12 V dc at 200 mA maximum to an auxiliary jack on the rear panel of the RF deck. Jumpers allow input voltages from 90 to 135 V ac or 185 to 260 V ac. In the USA, the correct setting will almost always be 120 or 240 V, and all my operation was at 120 V on an ordinary 15 A household circuit. The SPS interconnects with the RF deck using a

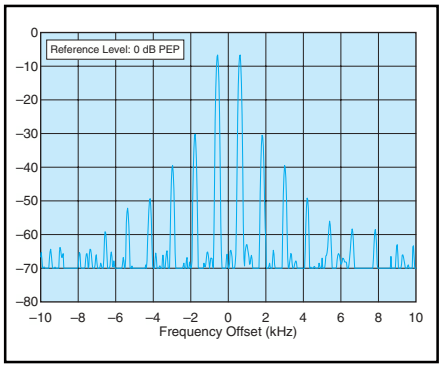

Figure 5—Worst-case spectral display of the Ameritron ALS-600S during two-tone intermodulation distortion (IMD) testing. The worst-case third order product is approximately 30 dB below PEP output, and the worst-case fifth order product is down approximately 40 dB. The transmitter is being operated at 600 W PEP output at 14.02 MHz.

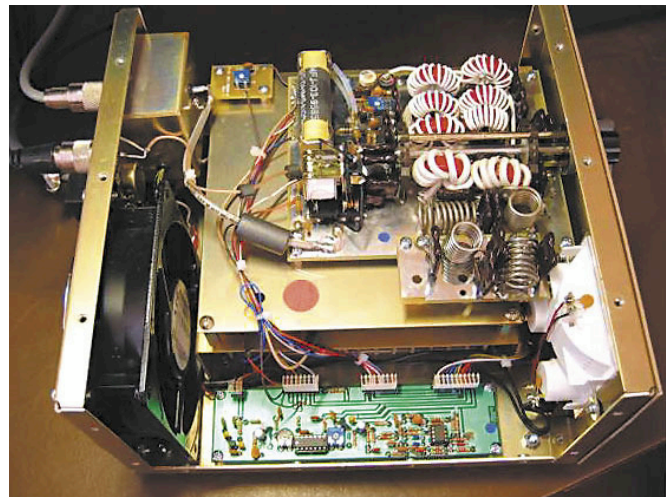

Figure 6—Interior view of the ALS-600S RF deck. The 10 and 12 meter filter board is attached to the lower right corner of the top board, adjacent to the white meter housing.

Figure 7—The author making contacts from his lightweight portable medium power station.

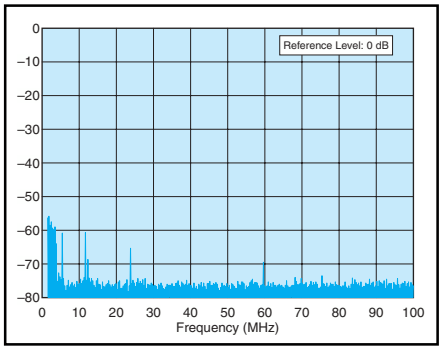

Figure 8—RFI measurements of switching power supply.

6 foot cable with Jones connectors. This power supply uses active regulation, as compared to choke regulation in the conventional unit. As a result, the supply voltage is more stable, which keeps the output transistors happy. The supply has a meter on the front panel and, in operation, no sag was apparent in the voltage at full output. I found that the fan noise from the switching supply was higher than from the conventional supply or the RF deck. Fortunately, the interconnecting cable is long enough to locate the supply on the floor. This arrangement frees up some desk space while reducing annoying fan noise.

The Results are In

I am happy to report that the ALS-600SPS is a big improvement over the commercial unit I used three years ago. The benefits of engaging a talented RF engineer, who is also a ham, to refine the power supply design are readily apparent when comparing the radiated noise level of the SPS to the commercial unit. I couldn't hear any noise at all from the SPS on the vertical or quad located in the yard next to my shack. I then connected a piece of wire to my transceiver's antenna jack and laid the wire on top of the SPS. I could hear every wall wart in my shack loud and clear, but tuning through the bands and switching the '600S on and off it took me a few minutes to find one barely audible signal from this switching supply. The ARRL Lab EMI measurements are shown in Figure 8. Kudos to Ameritron.

On the air contacts reported the expected increase in signal strength when the ALS-600 was switched on line. One S unit is nominally 6 dB, although the actual calibration varies quite a bit among various receiver models. At 600 W output, the calculated increase in strength over a 100 W transceiver will be about 8 dB. Notably, at 1500 W output, legal limit, the amplifier will only provide another 4 dB of signal strength—less than an additional S unit.

On SSB, I obtained 600 W output on SSB voice peaks. The theoretical output limit of the amplifier is about 700 W, but it's a good idea not to push it to the limit to keep the distortion products at a low level. Operators on adjacent frequencies will thank you. Operation on RTTY is possible, but it's advisable to keep the output power below 300 W unless an auxiliary fan rated at 80 CFM is utilized.[5] With the fan, the rating goes up to 500 W (with a duty cycle of 2 minutes on, 1 minute off). The standard power supply has a front panel RTTY switch to reduce the high voltage to 30 V and the maximum output to about 275 W. The SPS lacks this feature, so it's necessary to reduce the drive power or get a fan when using digital modes.

There is Some Room

Over time, I came to greatly appreciate the size, weight, reliability and simplicity of this amplifier. My wife Mary, KØZV, also enjoyed using the amplifier, especially when chasing DX. Still, there are a few improvements I would like to see. Automatic band switching capability would add greatly to the appeal of this amplifier by leveraging the convenience of "no-tuneup." Another plus for CW operators would be a built-in full-QSK arrangement.

I'd definitely like the power supply to be smaller. There appears to be enough room in both the RF deck and SPS to shave another 10 to 20% off the dimensions. This might reduce weight even more. The SPS meter is a nice touch but it seems unnecessary and could be sacrificed in the interest of reducing size and weight.

The lamps in the RF deck and in the power supply meters seem overly bright. The lamps in my original unit burned out after a couple of years. I replaced them with super reliable LEDs. Now that white ones are available, I think LEDs should be standard for meter illumination. The owner's manual, while including comprehensive schematics and operating instructions, lacks a concise specifications page. It includes a brief addendum for the switching power supply, but no schematics. Otherwise, the manual has not been updated for the '600S.

In designing any amplifier there are engineering trade-offs. In the real world there is no *perfect* amplifier. In the past, the desire to achieve high performance and low price has necessitated trade-offs of space and weight. A steady improvement in technology through the ensuing years has permitted size to shrink and weight to drop. For the most part, these advances have not been as evident in amplifiers as they have been in transceivers. For the sake of our backs, it's time for that to change. Hopefully, we'll see more examples in the future. There's nothing fun about lugging around a 60 pound amplifier—or paying excess baggage charges. But now, fellow contesters and DXpeditioners, the ALS-600S makes it possible to pack a transceiver and 600 W amplifier that together weigh less than 30 pounds.

Manufacturer: Ameritron, 116 Willow Rd, Starkville, MS 39759; tel 662-323-8211; **www.ameritron.com**. Price: ALS-600S amplifier with switching power supply, $1428; ALS-600SPS switching power supply upgrade, $629; Filter board for 10 and 12 meter operation, $29.95 (with amateur license); QSK-5, $349.95. QST

[5]Pabst 4530Z, part number 410-3140, $43.

Going Once, Going Twice...

The ARRL-purchased equipment listed below is for sale to the highest bidder.

Details of equipment offered and bidding instructions can be found on the ARRL members' Web page at **www.arrl.org/prauction**. The following items are available for bid in the March auction:

- Yaesu FT-857D mobile HF/VHF/UHF transceiver
- Yaesu MH-59 remote control microphone
- Emtron DX-1d HF linear amplifier
- SGC SG-211 60 W portable auto-tuner
- Palstar AT4K balanced/unbalanced HF antenna tuner
- MFJ-616 speech intelligibility enhancer
- Diamond MX-72D HF to 2 meter and 70 cm diplexer