In this month's column, Peter Hart reports on two HF linear amplifiers – the SGC SG-500 and Ameritron ALS-500M – that can help mobile operators boost their power.

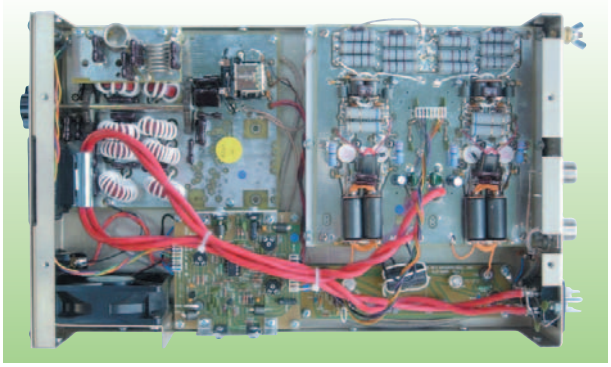
Empowering mobile operators

The enthusiastic mobile operator keen to improve his HF DX performance might very well think of adding a linear amplifier to his equipment line-up. Such a decision needs to be properly planned and engineered. High power doesn't lend itself well to 12V power supplies where current drains can reach 100A or more. A heavy-duty battery or a second battery needs to be safely installed with thick, short and fully fused cable runs from the battery to the amplifier to prevent voltage drop. The power output from low voltage amplifiers will drop heavily if the supply voltage sags. Another consideration is the antenna. Very high RF voltages are generated on short high-Q resonant mobile antennas and even corona discharge or flashover is possible. At high power levels safety is of course of paramount importance.

There is a select but limited choice of suitable amplifiers available, and mainly from manufacturers in the USA. This review looks at two such offerings in the 500W power class, the SGC SG-500 SmartPowerCube and the Ameritron ALS-500M. Both have been available for some years now and as a consequence are well established designs. Both are fully semiconductor broadband amplifiers with no tuning required and no warm-up time needed.

AMERITRON ALS-500M

The ALS-500M is rated at 500W PEP output on SSB or 400W output on CW and covers all bands from 1.8 to 30MHz. The standard version sold off the shelf in the USA requires an internal modification to cover 24 and 28MHz. This is a legal requirement for all amplifier sales in that country. Early versions of the amplifier need to be mounted where the operator has access to the front panel controls. Later versions can also be remotely mounted with all front panel controls and indicators replicated on an optional remote control head unit. An upgrade kit is available to allow earlier units also to be used in conjunction with remote control.



ALS-500M linear amplifier

ALS-500M front panel

Inside the ALS-500M showing amplifier, filters and control boards

The amplifier uses a total of four Toshiba 2SC2879 bipolar power transistors arranged as two separate 250W push-pull amplifiers coupled together using hybrid splitters and combiners. A separate PCB contains the temperature compensated biasing circuitry and control for the fan and trips. The output from the amplifier assembly is followed by a low pass filter to reduce harmonics to an acceptable level, and a bandswitch on the front panel or on the remote unit selects one of six filters to cover the entire frequency range.

The whole assembly is constructed on an aluminium chassis with a wrap-around case 23.7cm wide, 9.7cm high and 37cm in depth. It weighs about 3.4kg. Internally, the RF power amplifier is mounted on a finned aluminium heatsink and is cooled by a fan. This is fairly quiet in operation and also only operates when the heatsink temperature rises so there is no fan noise during lengthy periods on receive. The amplifier is switched from the transceiver via a 'ground to transmit' line (12V open, 100mA closed). The main DC power feed is via a plug and socket on the rear panel. The high current lines remain permanently connected but a separate lower current line is used to switch the amplifier on and off. Although the power connector is quite substantial, the current passing through the pins is as much as 80A peak. This is a 10-way connector but only two pins are used to carry the positive feed and two for the ground return. If this were my amplifier, I would parallel up the remaining vacant pins to share the high current load. A power cable is provided but it is quite long and should be shortened to be no longer than necessary. The current drawn by the amplifier is indicated on the front-panel meter.

Protection circuitry is built-in to guard against damage to the power

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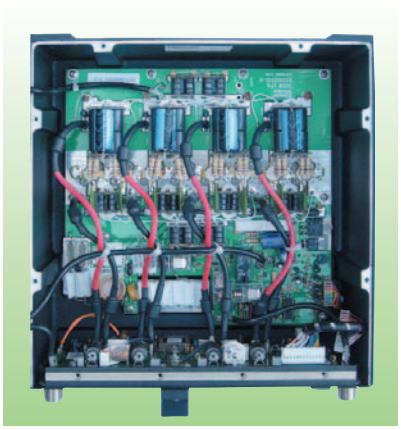
transistors. If the heatsink temperature rises excessively, the amplifier is placed in a standby (receive only) condition until the temperature drops to safe limits. If the reflected power on either amplifier output is excessive, due either to a high antenna VSWR or having the wrong output filter selected, a load fault condition is triggered. This can only be reset by turning the power off and on again. Front panel LEDs indicate if either of these conditions has occurred.

The 18 page instruction manual covers the installation and operation of the amplifier and a full set of circuit schematics and parts lists is also included.

The amplifier is rated for full output when operating from a 14V supply. Below this level, Ameritron claims that the power decreases by approximately 85W per volt. It is also safe up to a supply voltage of 16V. I carried out measurements in my garage with the amplifier powered directly from my car battery and with the engine running, resulting in 13.9V measured at the amplifier power plug at full power output. The results are shown in **Tables 1 and 2** (see page 20). Limiting to 100W drive, the maximum power that could be achieved was 435W on 14MHz, 420W on 18MHz, 330W on 21MHz and 480W on 24MHz. Slightly lower powers were achieved using the SGC PS-50 mains power supply which yielded an average supply voltage of 13.3V under full load and 10% pk-pk mains ripple. The amplifier showed significant flat-topping of the two-tone waveform at full output and as a consequence the distortion levels are rather poor at 500W output. I would rate this unit more as a 400W amplifier.

SG-500 linear amplifier



SG-500 hybrid coupled amplifier board

SG-500 filter board

SGC SG-500

The SG-500 SmartPowerCube is rated at 500W PEP output power on all modes and covers all bands from 1.8 to 30MHz. Units sold within the US need a small internal adjustment (jumper change) to enable 28MHz coverage. The amplifier is designed for remote mounting and unattended operation and operates over the supply voltage range of 10 to 18V although 14V is the rated figure. At full power the current consumption is quoted as 90A or 40A average on SSB voice. A separate power supply is available if required for mains power operation, the PS-50, which is an unregulated unit rated at 50A output. This compact but very heavy PSU is rather under-powered for full carrier operation but is suitable for voice modes. Rated at 500W output 50% duty cycle CW for 10 minutes maximum, the SG-500 does not contain a fan but relies on a substantial heatsink. An optional cooling fan is available from SGC which removes the 10 minute time limit. Other fans (cheaper fans) can also be fitted and there is a fan control connector.

The amplifier uses a total of eight Toshiba 2SC2290 bipolar power transistors arranged as four separate 125W push-pull amplifiers. These are coupled together using hybrid splitters and combiners. The 2SC2290 is rated at about two-thirds the power output of the 2SC2879 used in the Ameritron amplifier. The SGC-500 is a more conservatively rated design. The output from the amplifier combiner assembly is followed by relay switched low pass filters to reduce harmonics to an acceptable level. Six filters cover the frequency range and these can be selected either manually or automatically by measuring the frequency of the incoming drive sig-

nal. SGC claims that this takes just 15ms but of course this does involve an element of 'hot switching' and possible wear of the relay contacts. The selected band is indicated on status LEDs.

The whole assembly is contained within a substantial and rugged diecast box with an integral heatsink and measures 27.4cm in width, 12.4cm in height and 30.5cm in depth. Rubber feet add an extra 3cm to the width or height dimensions depending whether the amplifier is horizontally or vertically mounted. The weight is about 9.5kg. The amplifier is switched from the transceiver either manually via a 'ground to transmit' line (PTT) or automatically in RF sensed mode. In RF sensed mode, it requires about 6W of power to switch the amplifier and there is a one second hang time before switching back to the receive state. The DC power is connected via screw terminals but no power lead is provided. The amplifier can be switched on or off either by a switch on the front panel or remotely.

Extensive microprocessor controlled protection circuitry is built-in to guard against damage to the amplifier. This includes excessive current consumption, current imbalance between the amplifiers, excessive heatsink temperature, high antenna VSWR, PTT switching with the RF present or low voltage power supply. If a fault condition occurs, the amplifier trips off-line and needs to be powered down to reset. Status LEDs indicate the fault condition. The normal drive power required for full output is up to 60W and at higher drive levels an input attenuator is automatically switched in circuit to prevent overdrive. An ALC output is available for feeding back to transceivers but the positive-going voltage is incompatible with most radios.

The 32-page instruction manual is well written and includes a full set of circuit schematics.

Tables 3 and 4 show the performance of the amplifier when it is powered from the PS-50 mains PSU, which delivered 13.3V under full load. A good overall performance is achieved at 500W output power.

CONCLUSION

Both amplifiers are well made units and will give a useful increase in output power with the usual 100W transceiver. The ALS-500MXCE is priced in the UK at £819.95 and the SG-500 at £1,399.95 inc VAT. The SGC amplifier is a more conservatively rated design, yielding lower distortion and is a very professional rugged unit but it is significantly more expensive than the Ameritron. The Ameritron delivers 400W (except 21MHz) but is straining to reach 500W. Both amplifiers are available from Waters and Stanton who kindly loaned the units for review. ♦

ALS-500M and SG-500 amplifiers side by side

Table 1 Ameritron ALS-500M measured performance

		DRIVE POWER		HARMONIC OUTPUT	
FREQUENCY	INPUT VSWR	400W O/P	500W O/P	2nd	3rd
1.8 MHz	1.2	31W	45W	-52dB	-56dB
3.5 MHz	1.25	32W	46W	-51dB	-57dB
7 MHz	1.4	29W	65W	-65dB	-55dB
10 MHz	1.6	41W	70W	<-70dB	-62dB
14 MHz	1.6	79W	-	<-70dB	<-70dB
18 MHz	1.7	90W	-	<-70dB	-66dB
21 MHz	1.7	-	-	<-70dB	-68dB
24 MHz	1.7	48W	-	<-70dB	<-70dB
28 MHz	1.5	36W	81W	<-70dB	<-70dB

Table 2 Ameritron ALS-500M two-tone SSB performance

	INTERMODULATION PRODUCTS ref to PEP 400W PEP OUTPUT		INTERMODULATION PRODUCTS ref to PEP 500W PEP OUTPUT	
FREQUENCY	3rd order	5th order	3rd order	5th order
1.8 MHz	-30dB	-50dB	-26dB	-50dB
3.5 MHz	-30dB	-47dB	-25dB	-50dB
7 MHz	-28dB	-48dB	-24dB	-50dB
10 MHz	-28dB	-42dB	-25dB	-40dB
14 MHz	-24dB	-42dB	-	-
18 MHz	-24dB	-42dB	-	-
21 MHz	-	-	-	-
24 MHz	-25dB	-40dB	-22dB	-32dB
28 MHz	-24dB	-42dB	-22dB	-34dB

Table 3 SGC SG-500 measured performance

		DRIVE POWER		HARMONIC OUTPUT	
FREQUENCY	INPUT VSWR	400W O/P	500W O/P	2nd	3rd
1.8 MHz	1.7	19W	26W	<-70dB	-55dB
3.5 MHz	1.8	17W	23W	-61dB	-55dB
7 MHz	2	18W	28W	<-70dB	-56dB
10 MHz	2.4	19W	31W	<-70dB	-42dB
14 MHz	2	24W	39W	<-70dB	-65dB
18 MHz	1.45	32W	53W	<-70dB	-60dB
21 MHz	1.7	29W	70W	<-70dB	-62dB
24 MHz	1.2	21W	31W	-69dB	-63dB
28 MHz	1.9	24W	45W	<-70dB	<-70dB

Table 4 SGC SG-500 two-tone SSB performance

	INTERMODULATION PRODUCTS ref to PEP 400W PEP OUTPUT		INTERMODULATION PRODUCTS ref to PEP 500W PEP OUTPUT	
FREQUENCY	3rd order	5th order	3rd order	5th order
1.8 MHz	-37dB	-46dB	-32dB	-40dB
3.5 MHz	-37dB	-46dB	-32dB	-43dB
7 MHz	-35dB	-45dB	-32dB	-45dB
10 MHz	-34dB	-45dB	-32dB	-45dB
14 MHz	-32dB	-44dB	-30dB	-43dB
18 MHz	-31dB	-44dB	-29dB	-44dB
21 MHz	-29dB	-48dB	-25dB	-44dB
24 MHz	-32dB	-43dB	-28dB	-45dB
28 MHz	-31dB	-40dB	-26dB	-40dB