Telecom 23CM150

A new 150W 1.3GHz linear amplifier

PHOTO 1: Front view of the 23CM150.

INTRODUCTION. Solid state power amplifiers (SSPA) are steadily replacing traditional valve based power amplifiers for the 1.3 and 2.3GHz bands. The change is being driven by the ready availability of Laterally Diffused Metal Oxide Silicon (LDMOS) field effect transistors (FET). These devices are now almost universally used in high linearity commercial amplifier applications from HF through to about 3GHz. Individual devices are capable of outputs of up to about 200W at present and a new generation of devices will push this limit even higher. It is already possible to buy amateur band power amplifiers with outputs in excess of 500W in the 1.3GHz band by the use of paralleled LDMOS device techniques.

The Telecom 23CM150 is a self contained, mains powered, 1.3GHz band power amplifier. It uses a single LDMOS device and is rated at 150W output. It is designed to work with the present generation of 10W-output transverters and transceivers and delivers well over 100W of RF output (see later).

As supplied, the 23CM150 connects in line between the transceiver and the antenna. It contains two Tohtsu relays to bypass the amplifier in receive mode. No provision is made for connecting a pre-amplifier. N type RF connectors are used for the antenna and transceiver connections.

APPEARANCE. The Telecom 23CM150 amplifier housing uses two 'U' shaped folded metal covers screwed to an aluminium frame. The top and bottom covers are green; the front and back panels are coated aluminium. A hefty 80mm diameter fan, located behind the rear panel, draws cooling air through horizontal slots in the front panel, over the large internal heatsink before exhausting the warm air through the rear grille. **Photo 1** shows the front of the amplifier.

The front panel contains a moving coil meter that indicates either output power or reverse power according to the position of a rotary switch. Next to the meter are four LEDS for various alarm and status indications. These are input overdrive, high SWR, temperature alarm and transmit/receive status.

The N type RF connectors used for input and output are located on the rear panel together with an RCA phono socket for press to talk (PTT) input. Finally, the IEC mains connector is also located on the rear panel. **Photo 2** shows the rear panel of the amplifier.

INTERNAL INSPECTION. Removing the top screws revealed an aluminium frame containing a screened box that contains the power amplifier (PA) on one side and two other PCBs on the other side. The PCBs are mounted above the 28V switch mode power supply (SMPSU). The larger of the two PCBs contains the microprocessor control circuitry whilst the smaller board contains two further SMPSU voltage supplies.

At the back the two Tohtsu relays are attached to the rear panel, with semi rigid coaxial cable between the input relay and the PA input. An SMA connector is used on the screened RF box input. The PA output from the screened box uses an N type connector with a flexible cable to the output relay. These can bee seen in **Photo 3**, along with the PCBs mentioned above.

I was given permission to remove the many screws that attach the lid to the internal RF screened box. Inside the construction is generally of high quality although I did find two loose solder 'bubbles'. The main PA board uses a gold flashed Teflon board. This connects to a second printed board with a short length of semi rigid coaxial cable. This board contains the forward and reverse power diode samplers for metering and alarm indication. From here, a further length of coaxial cable connects to the internal N socket.

A short internet search revealed that the PCB used to mount the single LDMOS power device was very similar to the Infineon reference board PCB for the PTF141501E GOLDMOS® 1450 – 1500MHz Digital Audio Broadcast (DAB) band power amplifier [1]. The PTF141501E LDMOS FET is rated at 150W CW output at 1500MHz, using 28V, and when used in the DAB band it is operated in a highly linear mode with around 40W average output.

The PTF141501E is a good choice for 1.3GHz as it is internally broadband matched at 'L' band and can provide a power gain of around 15dB at 1.3GHz. The PTF141501E is housed in a flanged ceramic package. Two screws hold the flange to a solid copper heat spreader block, which is in turn bolted to the main finned heatsink.

Matching at 1.3GHz has been achieved by changing the original DAB band input ceramic matching capacitors for alternative values. The PCB showed evidence of resoldering around the input so I assume the original units are bought in ready built as DAB amplifiers. The rematching certainly works, with an input return loss at 1.3GHz measured at a very respectable 14dB.

I was less impressed by the connection between the PA board and the sampler board. The short length of semi rigid coaxial cable was not 'professionally' terminated, although there is no suggestion that this caused any problems. However, with 150W output present the circulating RF currents would be quite large and any mismatch here could lead to heating problems.

It is hard to 'identify' with semiconductor power devices in the way we have previously done with power valves. Transistors seem much more impersonal. However, we are

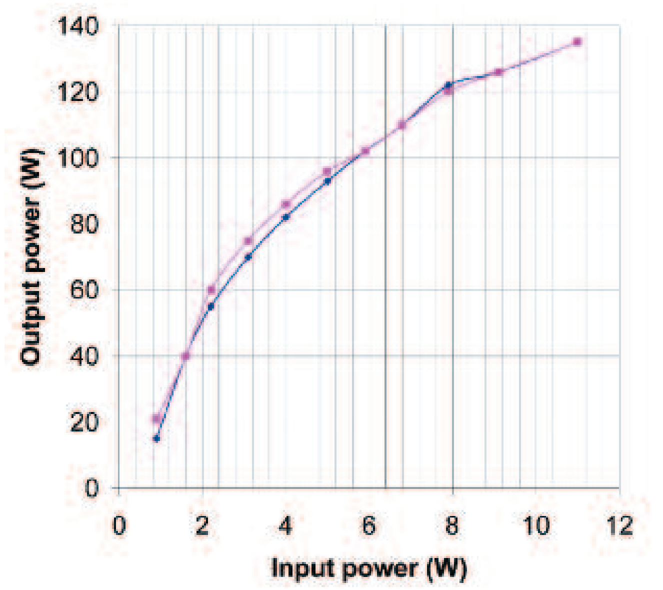

FIGURE 1: 23CM150 amplifier output characteristic. Pink = actual output power, blue = 23CM150 power meter reading.

becoming more familiar with these devices and particularly with the more popular ones used in 23 and 13cm power amplifiers. The MRF286 and MRF9060 are possibly the best known devices for 23cm. The PTF141501E may yet be set to become just as familiar and loved!

MEASUREMENTS. Great care was taken to ensure the accuracy of the measurements and three different Hewlett Packard HP435A power meters with three different power sensors were used to confirm readings. All attenuators and couplers were carefully measured on the network analyser, at 1.3GHz, prior to the measurement session in order to ascertain their actual attenuation or coupling values.

Two different output termination arrangements were used in order to check the measurement results. The accuracy of the results are believed to be within ±0.5dB.

Output power measurements were made with different input powers across the 1.3GHz amateur band between 1240MHz and 1300MHz. The drive source does not cover the section of the UK amateur band above 1300MHz so no measurements were made in this range.

The amplifier through loss, when in receive mode, and power amplifier input return loss was measured at 1296MHz.

Finally, the 2nd and 3rd harmonic output levels of the amplifier were measured.

My Kenwood TS2000X was used as the drive source. The output power from the TS2000X was measured at the end of the 2m length of RG214 used to connect the radio to the 23CM150 in order to eliminate errors due to input cable losses. The results of these measurements are given in **Table 1** for reference purposes. The measured loss of this cable at 1300MHz was 0.5dB.

These input power measurements were made by connecting the input cable to a Weinschel power attenuator and HP8481 power sensor into the HP435A power meter. The input cable was then transferred to the amplifier input. The good input return loss of the amplifier minimises any errors that might have occurred due to the TS2000X reducing power output when connected to a poor load match.

Table 2 shows the results of the power amplifier output power measurements at three different input powers at frequencies of 1240MHz, 1260MHz and 1290MHz, respectively, in addition to a full set of input powers at 1296MHz.

For output power measurements a 150W rated Narda 30dB attenuator followed by a 10dB HP 8491A attenuator into the HP8741A power sensor and HP435A power meter. This was also checked against measurements using a Narda 20dB coupler, 20dB attenuator and a second HP sensor and power meter.

A 50dB broadband coupler, covering 1 - 4GHz, was used in conjunction with an HP8592L spectrum analyser to measure the harmonic output when the amplifier was terminated by a 50Ω load.

RESULTS. **Figure 1** shows the input/output power characteristic of the amplifier, and Table 1 shows the TS2000X drive power levels at each power setting. Table 2 shows the power measurement results. **Table 3** shows the measured amplifier input return loss, through loss on receive, gain, output 1dB compression power and harmonic output levels relative to the carrier at 100W output.

IMPRESSIONS OF THE 23CM150. I was able to briefly test drive the amplifier during the July VHF NFD contest. This was not straightforward as the manual states that the amplifier requires a ground on the PTT input to switch to transmit. There are no details in the documentation to indicate what current this connection might take from the ground connection. Fearing for the safety of my TS2000X PTT output (very low current capability and just 20V on the collector of the switching transistor), I made up a suitable transistor and relay switch interface to isolate the rig from the amplifier. With this interface the amplifier switched perfectly.

I worked 10 stations on 23cm including several PA0, a DL and a GW station. Conditions were not too good on the Sunday on 23cm and so I thought this a good showing for about 1 hour of operation. No adverse comments were received. The amplifier ran cool throughout.

CONCLUSIONS. I expected the amplifier to produce 150W RF output. Indeed the name and the 150W marking on the front power meter reinforce this impression. The maximum output I could measure was 135W and at this level the amplifier output was fully saturated. You could argue that this is only 0.5dB down on 150W and this is within the claimed range of accuracy. At 135W, on CW, it is unlikely that the small difference in power would make any difference to a receiving station's ability to copy the signal. However, I think that the manufacturer could sensibly call this a 125W amplifier.

During my inspection of the inside of the RF screened box I noticed a label that suggested the PA module had been tested and produced 155W output for 7.5W drive. It is possible that the cables, relays and the RF sampler PCB between the PA module and

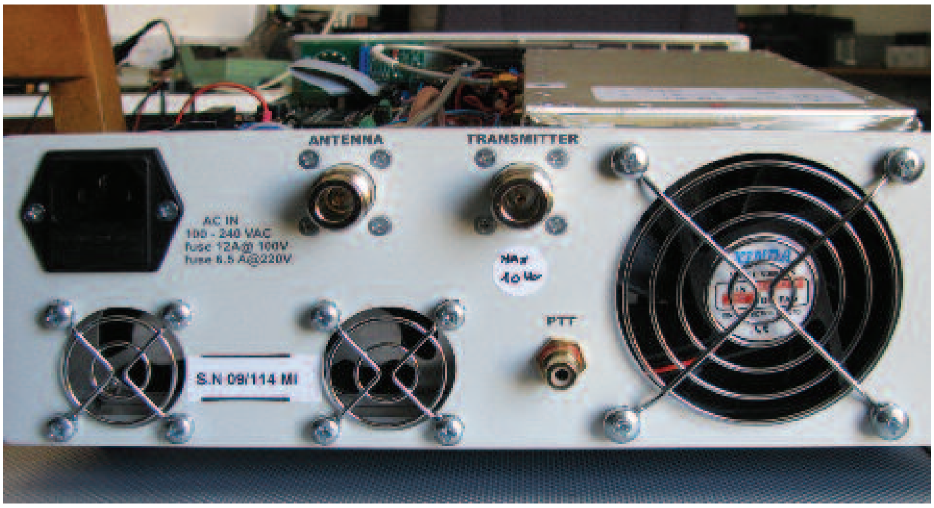

PHOTO 2: Rear view of the 23CM150.

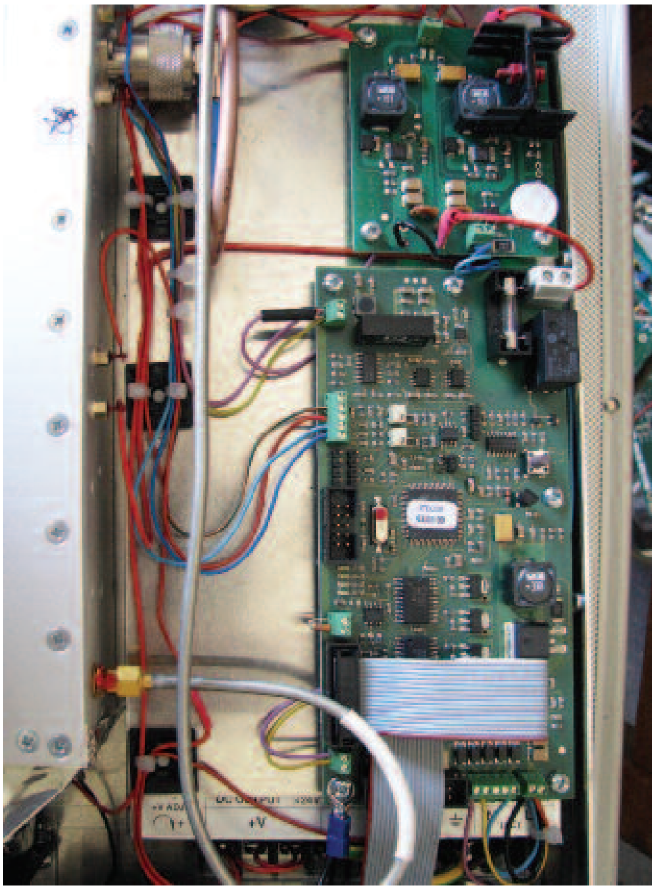

PHOTO 3: Inside view of the 23CM150. The larger PCB is the microprocessor controlled control board. The smaller board is an auxiliary power supply.

the output connector could account for the 'missing' 20W.

The rear of the amplifier carries a warning not to exceed 10W input (the handbook says 4W). At this drive level the RF output was measured at about 128W. With permission I increased the drive to 11W and measured the 135W output mentioned earlier. The amplifier output was clearly saturating and I did not want to damage it. The input overdrive warning LED did not illuminate. *[At the Friedrichshafen show this year I saw one of these amplifiers apparently producing something over 150W, measured using a power meter supplied – and calibrated – by the amplifier manufacturer. The overdrive warning LED was on the verge of operating - G1MFG].*

At 1240MHz the output power meter was apparently not calibrated at the higher end of the power range. Optimistically, the meter showed up to 145W output at an actual measured power level of 110W. I found this rather strange since I don't believe the microprocessor controller would have any way of knowing the frequency range in use.

The measurements indicated a small degree of gain peaking at about 50W output. In use this should not cause any concern.

No two-tone intermodulation tests were performed because of the lack of a second suitable drive source. On-air tests with a station local to me suggested that the amplifier output was clean with no obvious signs of 'splatter' (more correctly called spectral re-growth). In general, LDMOS-based amplifiers, when operated below saturated output, tend to produce less intermodulation distortion than older bipolar based power amplifiers.

I have already mentioned some discrepancies in the accompanying amplifier handbook. This really is quite unacceptable for an amplifier of this price. It contains several errors regarding power input and output etc. The photographs were clearly not of the 23cm version of the amplifier. It appears that the handbook has been copied from the 144MHz version, but only a few of the details have been updated for 23cm. *[Waters & Stanton inform us that the manufacturer apologises for this and is revising the handbook – G1MFG].*

This is an expensive amplifier and there are alternatives available if you don't mind buying a module (ready built or kit) and boxing it together with an adequate heatsink, power supply and relays. Some amateurs may not wish to do this and therefore this ready-to-go amplifier may prove appealing.

From a personal point of view I rather liked this amplifier. It appears sturdy and durable and with the various alarm facilities, should prove reliable in use.

The 23CM150 is one from a range of amplifiers in this same series and it is available for £1995.95 from Waters and Stanton, Hockley, UK. I wish to thank Jeff Stanton of Waters and Stanton for the loan of the review amplifier.

WEBSEARCH

[1] PTF141501E data sheet www.infineon.com/dgdl/ds_ptf141501ef-02p.pdf
[2] Waters and Stanton www.wsplc.com/

TABLE 1: TS2000X output power (W) at each power setting across the range 1.24 to 1.29GHz. These powers were measured at the end of a 0.5dB loss coaxial cable, as discussed in the text.

TS2000X power setting	1	2	3	4	5	6	7	8	9	10
1296MHz	0.9	1.6	2.2	3.1	4.0	5.0	5.9	6.8	7.9	9.1
1290MHz	0.9	1.2	1.9	2.6	3.3	4.8	5.9	6.8	7.9	9.3
1260MHz	1.0	1.8	2.7	3.4	4.3	5.2	6.1	7.1	8.2	9.3
1240MHz	1.0	1.9	2.8	3.5	4.4	5.2	6.2	7.2	8.2	9.9

TABLE 2: Measured output power and 23CM150 output meter indication when driven by the TS2000X at the input powers shown.

Input power (W)	0.9	1.6	2.2	3.1	4.0	5.0	5.9	6.8	7.9	9.1
Output power at 1296MHz	21.0	40.0	60.0	75	86	96	102	110	120	126
23CM150 output meter indication at 1296MHz	15	40	55	70	82	93	102	110	122	127
Output power at 1290MHz	22	-	-	-	94	-	-	-	-	115
23CM150 output meter indication at 1290MHz	17	-	-	-	90	-	-	-	-	120
Output power at 1260MHz	20	-	-	-	100	-	-	-	-	122
23CM150 output meter indication at 1260MHz	24	-	-	-	105	-	-	-	-	130
Output power at 1240MHz	18	-	-	-	84	-	-	-	-	110
23CM150 output meter indication at 1240MHz	20		-	-	130	-	-	-	-	145

TABLE 3: 23CM150 measured parameters of the amplifier.

Insertion (through) loss on receive at 1296MHz	0.25dB
Amplifier input return loss at 1296MHz	14dB
Amplifier gain at 1296MHz	13.8dB
Output 1dB compression power at 1296MHz	~95W
2nd harmonic level (2.6GHz)	-60.2dBc
3rd harmonic level (3.9GHz)	-51.3dBc