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REVIEW

Tube Imp Mini Tester

By Charles Hansen

PHOTO 1: Tube Imp in its carrying case.

The Tube Imp mini tube tester, designed and built in the UK, measures the steady-state current, gain, and transconductance characteristics of any B9A double-triode tube with the standard ECC83/ECC88 footprint.

Operating at 12V AC from the included external power supply, the Tube Imp offers matching and parameter testing of a range of commonly used double-triode tubes to individual tube equipment enthusiasts as well as retail outlets and small OEM concerns.

Specifications:
HT voltage maximum: 200V
HT voltage adjustment: 0-200V
HT setting accuracy: Typically better than ±2%
HT current: 10mA maximum
HT current limit LED: >12mA
HT impedance on gain setting: >1MΩ
Grid voltage range: 0 to -10V
Grid voltage setting accuracy: Typically better than ±2%
Heater voltage: 6.3/12.6V DC, switchable
Heater current 350mA, 500mA for less than 5 minutes
Measurement accuracy:
Cathode current: ±2%
Transconductance: ±4%
Gain: (Anode impedance in kilohms) ±5%
Valves that can be tested:
ECC81/12AT7
ECC82/12AU7
ECC83/12AX7
ECC88/6DJ8WA/6922
ECC189/ECC803

INSIDE THE TUBE IMP

The Tube Imp comes in a nice carrying case that includes the tester, 12V AC power adapter, and the manual **(Photo 1)**. I plugged one of my vintage Mullard ECC83 tubes, err valves, into the Tube Imp **(Photo 2)**.

The tester is quite rugged, constructed of red powder-coated heavy gauge steel. The 2.1mm × 5.5mm AC power jack is located on the rear panel. **Photo 3** shows the Tube Imp with the bottom cover removed. All chassis components are mounted on two PC boards with some hard wiring also involved.

British Audio Products/Moth Group
10 Dane Lane, Wilstead, Bedford, Bedfordshire, UK MK45 3HT
www.britishaudio.co.uk or
www.tube-imp.co.uk
e-mail: info@mothgroup.com
++44(0)123 474 1152
Fax: ++44(0)123 474 2028
Price: £299 UK
Test unit dimensions:
Net weight with carrying case: 4.4 lbs (2kg)
Available online at http://store.securehosting.com/stores/sh204131/shophome.php?itemprcd=tubeimp

The transformer at the left is a 120/120 to 12/12V AC step-down unit that is wired in reverse; the external AC adapter feeds 12V AC to the paralleled transformer secondaries, and this is stepped up to 240V AC via the primaries connected in series. The AC primary voltage is rectified and used to supply the adjustable HT (plate) DC voltage. The smaller heatsink just below the transformer sits on the HT regulator MOSFET. The adjacent 22µF 450V electrolytic filters the HT DC voltage.

The large heatsink in the middle holds the filament DC regulator, which is powered directly from the AC adapter. A switch on the front panel allows you to select either 6.3V or 12.6V DC. The manual advises starting 12.6V tubes in the 6.3V position, then switching to 12.6V after a few seconds to minimize the stress on the filaments.

The 9-pin gold-plated ceramic tube socket pins are just to the right of the transformer. Pin 9 of the tube socket is not connected. Four small trimpots visible through holes in the PC boards allow factory adjustment of the Tube Imp.

PHOTO 2: Tube Imp testing Mullard ECC83.

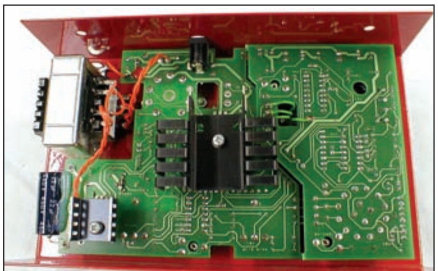

PHOTO 3: Tube Imp interior view.

TOPOLOGY

The HT supply consists of a source follower MOSFET. The Test Selector allows you to switch between a voltage source and a current source in order to provide the optimum loads for transconductance and gain testing. The MOSFET is protected by a 12mA current limit circuit, which also lights a red LED when the HT supply is in current limit. A switch on the front panel allows testing of either the A or B section of the dual triodes. The Section-1/2 switch automatically switches the grid and cathode connections. The tube section not selected is idled with a -15V grid bias.

When the Test Selector is in the gain (µ) position, the HT MOSFET is switched into current source mode with an equivalent impedance of about 2MΩ. An AC signal is fed to the grid, and the anode voltage is rectified and displayed on the front-panel digital meter.

When the Test Selector is in the mA/V (transconductance, or gm) position, the HT is supplied by the MOSFET as a regulated voltage. A small AC signal is fed to the grid, and the resultant AC current is used to calculate transconductance for the front-panel digital meter. With the Test Selector in the mA position, the drop across the low value cathode resistor is used to measure the cathode current.

The Tube Imp does not directly measure plate resistance, but you can easily calculate it by Rp = µ/gm. By plotting a series of cathode current versus plate voltage at a fixed grid voltage, you can produce a plate curve for your own tube.

MEASUREMENTS

I measured the actual heater, grid, and plate voltages at the tube socket as selected by the front-panel control settings. I used a power resistor decade box set for 18Ω (6.3V) and 36Ω (12.6V) to check the heater voltages at 350mA. I didn't use any grid resistor to measure the grid voltage because my Fluke DMM (digital multimeter) has a 1MΩ input impedance. I used a 220k resistor (A to K) to simulate the plate resistance and also checked the current limit point using a 10k 5W 1% load resistor, raising the HT until the LED was lit.

The filament voltages measured 6.44V DC and 12.38V DC at 350mA, or within about 2% of nominal, with pin 4 being positive. I measured the grid and HT voltages with respect to the scale markings silkscreened on the front panel of the chassis. I centered each line on the scale at the center of the notch on the adjustment knob.

The grid voltages were consistently lower than the scale markings, from -20% on the low end to -10% at the high end. The grid voltage at the maximum CW (clockwise) rotation read -9.2V DC. Perhaps this could be easily fixed with an internal trimpot adjustment or a tweak of the knob set screw. The grid voltage of the idled tube section had -11V DC rather than the specified -15V DC.

The HT voltage settings were quite accurate, varying only 1.6% above 20V on the scale. The HT current limit LED just began to glow at 12.6mA and was fully on at 13mA.

Finally, with the correction factors in hand for grid voltage, I checked the gain and transconductance using the Mullard ECC83 for the two Class A amplifier conditions specified in the RCA Receiving Tube Manual RC-30. For the Tube Imp, I set the specified plate voltage and then adjusted the grid voltage to produce the specified cathode current. Note that for the second Class A amplifier condition I

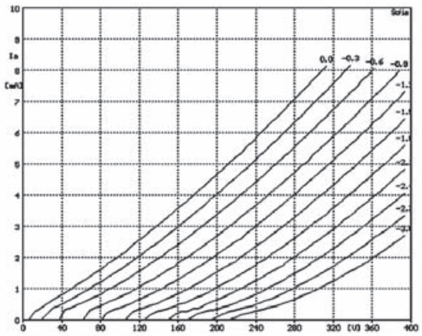

FIGURE 1: Audiomatica Sofia plate curves for Mullard ECC83.

needed to use Va = 200V DC rather than the 250V DC specified in the RCA manual due to the Va limitation of the Tube Imp. I also took these same data points from the plate curve data file I ran on the Audiomatica Sofia **(Fig. 1)**.

The results of these tests on section 1 of my Mullard ECC83 are shown in **Table 1** and **Table 2.** The Sofia displays µ, gm, and Rp directly along with plate current Ia. The Tube Imp measures gain (µ), mA/V (gm), and cathode current (Ik), so I calculated Rp from the formula Rp = µ/gm.

Table 1

Parameter	Data Book	Sofia	Tube Imp
µ	100	95.2	72.4
gm (mA/V)	1.3	1.17	1.3
Rp kΩ	80	81.2	55.7 (calc)

Measurements, Mullard ECC83 section 1
RC-30 Class A: Va = 100V, Vg = -1V Ia = 0.5mA
Note 1: Rp calculated from Rp = µ/gm for Tube Imp

Table 2

Parameter	Data Book	Sofia	Tube Imp
µ	100	98.1	72.1
gm (mA/V)	1.6	1.64	1.2
Rp kΩ	62.5	59.8	58.1 (calc)

Measurements, Mullard ECC83 section 1
RC-30 Class A: Va = 200V, Vg = -2V Ia = 1.2mA
Note 1: Rp calculated from Rp = µ/gm for Tube Imp
Note 2: Va held to 200V due to Va limit of Tube Imp

CONCLUSION

The Tube Imp consistently understated the gain by about 26% in comparison to the Sofia. There is some discussion of this in the Tube Imp manual. The gm was 11% high in the first test and 27% low in the second test. Again, there is a discussion of calculating the theoretical value of true transconductance in the manual.

I repeated the Tube Imp tests by setting the plate and grid voltages at the designated values and accepting whatever cathode current resulted from these settings. The µ and gm results were essentially the same.

I believe the Tube Imp would be quite

valuable in matching tubes where the absolute values of μ are less important than the comparative values.

MANUFACTURER'S RESPONSE:

Thank you for the opportunity to comment on the in-depth review of the mini TT. The reviewer gives a fair assessment of the mini TT and of its target market. There are, however, a couple of points I need to comment upon.

The grid circuit has a source impedance of 1MΩ at DC, so reading the voltage at the grid pin with a DVM (typically of 10MΩ input impedance) would cause a drop of around 10% from the actual set value, as found by the reviewer. The safest place to measure the grid voltage with a meter of less than infinite input impedance is at the wiper of the grid voltage pot, although not accessible without taking the back off!

The gain readings of the ECC83 measured by the reviewer also need to be addressed. If we understand correctly the Sophia calculates gain, from measurements of the transconductance and anode impedances. The mini TT cannot reach these calculated values for gain. It measures gain directly, feeding a signal to the grid and measuring the amplified signal at the anode/plate. This requires a high impedance current source for the anode load. The impedance of the current source will appear in parallel with the anode impedance, giving a slightly lower reading.

For the mini TT we originally specified an IRF730 MOSFET, configured to act as a voltage or current source. The circuit is quite simple and relies completely on the MOSFET's high impedance behavior in current source mode to work effectively. MOSFETs are known to work as an almost perfect current source (theoretically), when the gate to source voltage is held constant. This simple circuit works well; however, we were disappointed by the gain measurement results found during the review of the mini TT.

Checking the production unit, we found that the current source impedance was lower than we were expecting, at about 200kΩ at typical ECC83 cathode currents. This in conjunction with the ≈60kΩ anode impedance of the ECC83 results in the reduced gain reading seen by the reviewer.

On further investigation it transpires that not all "IRF730s" are created equal with respect to their current source behavior. After much measuring of different samples and scouring datasheets, we found that unfortunately the ST IRF730—which we had sourced—is probably one of the worst current source MOSFETs there is, although the specs are all the same! Every other manufacturer's IRF730 does better!

We have now found a good replacement with a (dv/di) drain impedance of 240kΩ at 10mA (rather than 15kΩ of the ST IRF730), and have modified the mini TT test rig and test procedure to test for this parameter.

With the new MOSFET fitted we get the following results for gain, from a random selection of tubes:

Device	Gain	Cathode current	Anode volts
Aged Mullard 12AX7	90.5	2.08mA	180V
Sovtek 12AX7WXT	127.1	1.94mA	180V
Gold Dragon E83CC	94.8	2.88 mA	180V
Telefunken E88CC	34.8	5.00 mA	80V
Mullard 12AT7	64.4	10.00 mA	150V
Brimar 12BH7	19.4	10.00 mA	100V

Best regards,

Hamilton Cleare
Tube IMP aX