An inexpensive, easy to build diy valve/tube tester

For quite some time I have been looking at developing a design for a diy valve/tube tester that is easy to build and uses readily available, low cost parts.

For years I have been using a valve tester that I had developed in the past. This tester was quite simple and usable, but only tested valves at one operating point. In addition, it only had one octal socket and needed outboard extender cables to test 9 and 7 pin valves. It operated by "triode strapping" pentode valves which provided useful emission readings but lacked the capacity to truly test valves at databook operating points.

So in looking at a new valve tester design, I wanted it to provide these functions:

1. Provide emission readings at the recommended databook operating conditions (Plate, Screen and Grid voltages)
2. Provide Gm or mutual conductance readings, directly or indirectly
3. Test valves for internal shorts
4. Test for "gassy" valves - valves whose internal vacuum has been compromised
5. Test a wide range of valves, from 12AX7s to KT88s and any other "receiving" class of valve
6. Be expandable with options to include heater/cathode leakage testing, other valve bases, different heater voltages, "life test" etc

Attempting a valve tester design is quite a challenge - it is very easy for a design to become very complex - more difficult to build, and difficult to use. In short, it is a balancing act between the need to have a useful, comprehensive tester, and for a design that is straightforward and easy to build. I have come up with the following tester design that allows for the above tests in an easy to build format and uses low cost readily available parts .

First, some background on what is required to test a valve. Valve data books provide suitable operating conditions for a particular valve type - specified plate, screen and grid voltages which result in a certain plate current. This is an emission test and will indicate the condition of the valve under test. In addition, several other tests need to be conducted - tests for inter-electrode shorts, measurement of Gm (transconductance), integrity of the valve's vacuum (gas test) and several other tests.

So to be able to test valves at specified operating points, a valve tester needs to generate a range of test voltages for the plate and screen of the valve under test. A source of variable grid bias is fairly straightforward to design, however to generate a range of different plate and screen voltages at up to 150ma of current can be a little involved. While a conventional power supply with a Mosfet VVR variable voltage supply can be used (and was successfully in the "Sussex" valve tester design), I was looking for a simpler solution. While thinking about this a while ago, it occurred to me that the voltage multipliers that are used in my Lamington amp designs already generate several voltages along each stage of voltage multiplication. In addition if a multi-tapped transformer is used to drive the multiplier, numbers of other voltages could be generated .

It was time to test this idea, and here is a photo of the tester design being breadboarded and tested:

The above photo shows a suitable supply lashed up on the bench. As expected, a wide range of voltages could be generated with good voltage regulation (important for accurate test results). With a number of octal valves connected to this variable voltage supply, I was able to replicate the valve databook operating conditions with good results. Also, with attached digital meters, it was possible to measure the Gm of a test valve indirectly by varying the grid voltage by 1 volt and read the change in plate current to measure Gm.

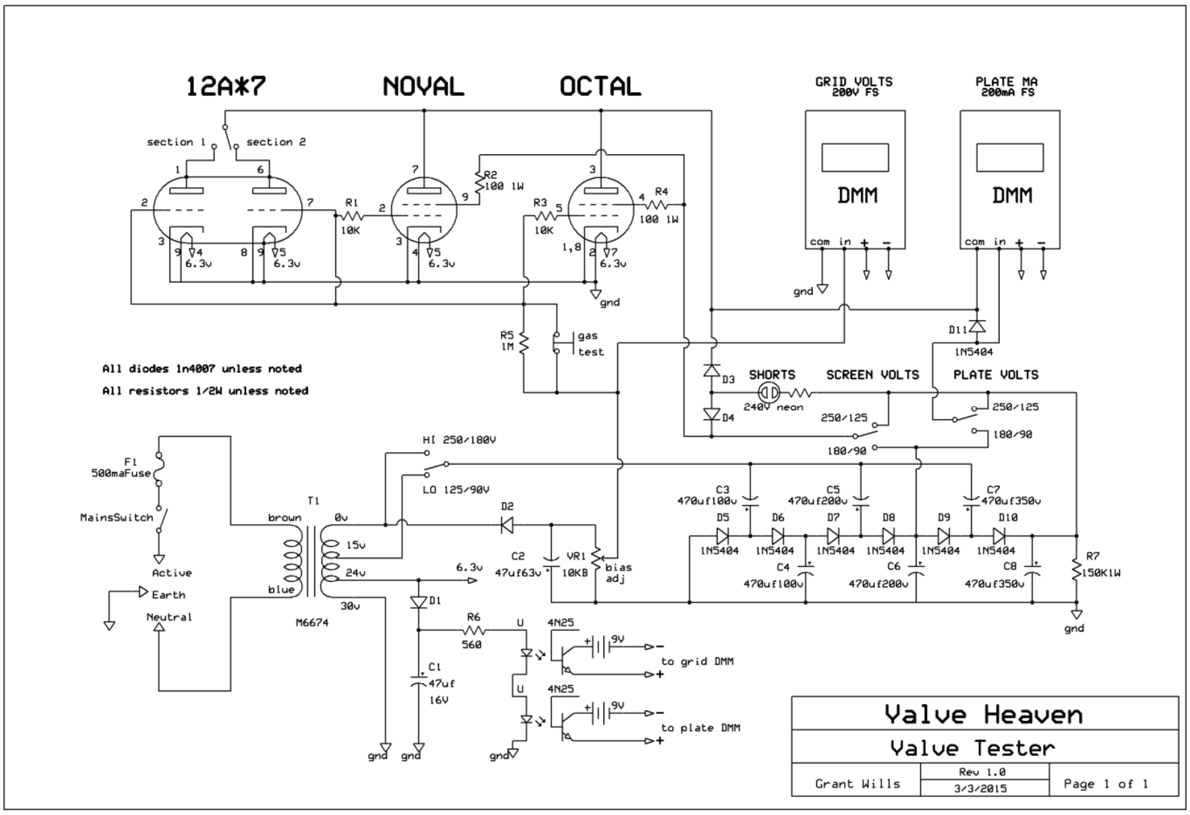
Encouraged by these results, I needed to fine tune the final tester design. Looking at a wide range of valve data, it is evident that it is not necessary to provide unlimited test voltages in a tester. The majority of "receiving" type valves can be tested with operating points of 90V, 120V, 180V and 250V. These test voltages can be generated easily with a 4X and 6X voltage multiplier driven from a readily available 30V AC multitapped transformer. The 30V transformer can also supply the heater voltages for the valves and a source of variable negative bias for the valve grids. This arrangement greatly simplifies the design of the tester and uses low cost readily available parts.

Here are some photos of the prototype under construction:

In presenting the valve tester, I thought I'd make available a few versions of the design.

This first version is about as simple as the tester can be. Rather than providing the necessary switching to cover all valve types, this simplified version will test most octal power valves (6V6, 6L6, KT66, KT88, 6550, EL34, 6W6 etc), numbers of noval power valves (6BQ5, EL82, EL84, EL86, 6P18P, 6P43P etc) and the usual suspect preamp valves (12AX7, 12AT7, 12AU7, ECC81 etc). This tester can be built using the simplified schematic if it is only going to be used for testing typical audio valves like 6V6, 6L6, EL34, EL84, 12AX7 etc. Later is a version which allows for testing any 7 pin, 9 pin and octal valves in the "receiving" class of valves.

Here is the schematic diagram for the first version:



As you can see, the tester is quite straightforward with a 30V 2A transformer doing most of the work. It drives a 4X or 6X voltage multiplier via a "HI/LO" switch to generate 90, 125, 180 and 250 volts for supplying the test voltages for the valve under test. The HI/LO switch feeds the voltage multiplier from either the full 30V from the transformer or from the 15V tap to halve the output voltages.

The multiplier deliberately uses a "shunt" arrangement with the filter capacitors rather than the series arrangement I have used in the past. This provides much better regulation than the series arrangement, and together with the 3A diodes, 2A rated transformer and large 470uf capacitors produces a high current "stiff" supply which is essential for power valve testing. Under test, the supply was easily able to supply 150mA+ into a KT88 under test.

The 30V tapped transformer also provides a variable grid bias supply via D2, C2 and VR1 and a source of 6.3V at 2A+ to feed the valve heater.

The two "plate" and "screen" switches have a centre "off" function. This allows for testing for shorts in the valve under test before applying the test voltages.

The three valve sockets are wired together with the common pinouts for anode, screen, grid cathode and heaters. Grid and screen "stoppers" are used to eliminate the possibility of the test valve oscillating and upsetting tests measurements.

Also note the section 1/2 switch which allows for the testing of twin triode preamp valves.

The question with any valve tester design is how to provide metering - specifically for measuring grid voltage and plate current. I considered analog moving coil meters, but reading accuracy is limited and range switching is required to cover a wider range of voltage and current. The ideal display is a digital panel meter. A suitable range selected eliminates switching and measurements can be made with better accuracy.

Digital panel meters are available on ebay, but I was keen to use a more readily available option. As I looked at the options available from Jaycar and Altronics, I saw a mini multimeter from Jaycar for $4.95! Two of these meters were used in the tester with one set to 200V DC to measure the grid voltage, and the other set to 200mA DC to measure plate current. The 200mA plate current meter has a 1N5404 power diode wired across it to protect the meter from accidental shorts or overload.

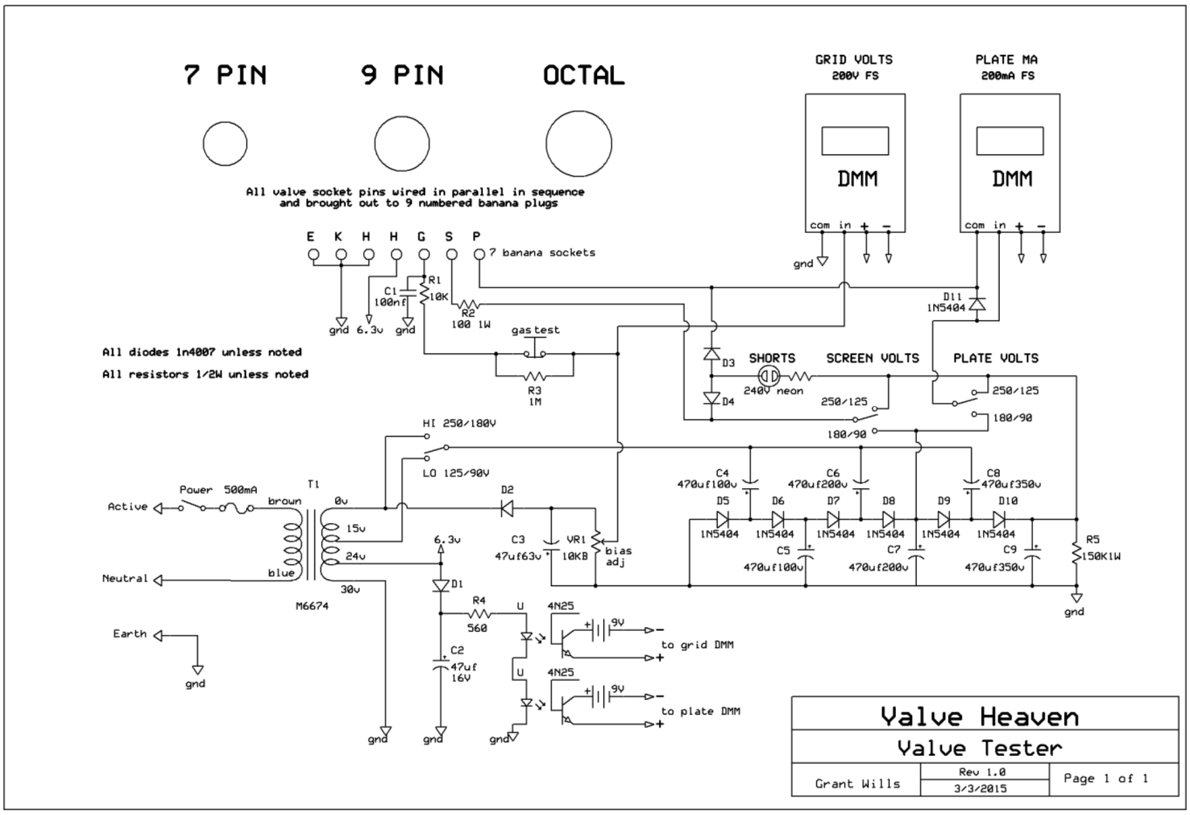
The only issue with digital meters is that unlike analog meters, they need a source of power to work. In addition, in this tester, they are referenced to different ground potentials, so a separate supply is required for each meter. I decided in the end to supply them with battery power as they only draw 250uA of supply current meaning that a battery will last a long, long time.

To switch the meter batteries on and off when the tester is powered up, I used two 4N28 optocouplers. When the tester is powered on, the optocoupler LEDs are turned on by the supply generated from the heater voltage via D1 and C1. These LEDs turn on each phototransistor in the optocouplers to power on the meters.

The tester uses a push to break switch to insert a 1M resistor in series with the valve grid. A "gassy" valve will draw grid current, and this current will cause a voltage drop across this 1M to effectively reduce the applied grid voltage. This in turn causes the plate current to increase. A good valve will see little change in plate current when the "gas" switch is pushed.

The panel neon lamp assembly serves two functions. The plate and screen voltage set switches are put in a "centre off" position before test. When the tester is first turned on and the valve has not warmed up, any plate or screen short will illuminate the neon lamp. If no shorts, the lamp will be off until the valve warms up and normal electron flow will illuminate the lamp providing the second function as a "power" indicator.

Here is the schematic diagram of the full version of the tester:



This is the final version of the tester which uses banana plugs to apply the various test voltages to any pin configuration of 7pin, 9pin or octal valve.

The socket pins are wired sequentially with all pins 1 joined together, all pins 2 joined together and so on. 9 leads from a total of 9 pins are then brought out through the rear of the tester and numbered 1-9 to make appropriate connections to the test voltages. While this version takes a little more time to set up to test different valve types as you need to change banana plug connections to suit each valve, it makes the tester very versatile. Any additional valve bases could be added to the tester if desired. There is also an option to provide different heater voltages if you wish by taking advantage of the different taps on the power transformer.

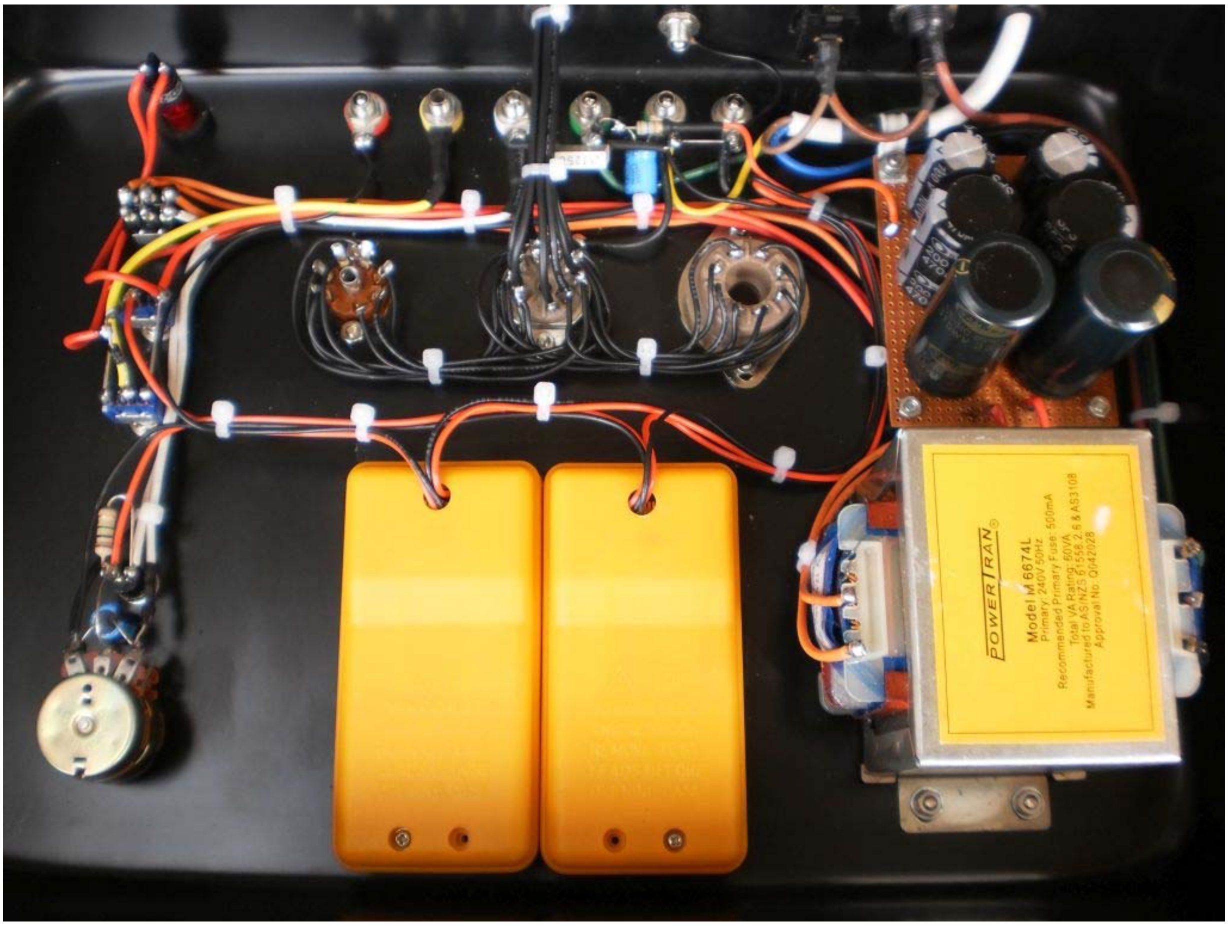
To use the tester, look up the "characteristics" section of the valve datasheet for your valve.

Plug the valve to be tested into the appropriate socket and also the correct banana plugs for the pinout of your valve if you are using the Mk II tester. Set the plate and screen switches in the centre off position. Turn the tester on and make sure the "shorts" neon does not light up. Turn off the tester and set the HI/LO and the plate and screen switches according to the recommended settings in the data. Then turn on the tester and set the grid voltage on the DMM to the datasheet setting. You can now read the plate current on the DMM.

To test for a poor vacuum (gassy) valve, press the gas button. A good valve will not noticeably read an increase in plate current. A gassy valve will increase in plate current.

The prototype was constructed in a medium size "baking" tray which allows for an easy to use tester. A cutout for the meter panels was cut with a jigsaw after covering the top of the chassis with masking tape. The power transformer was mounted under the chassis with a power board mounted next to it. The power board with its supply capacitors and diodes were mounted on a small piece of perforated board. Here is the underside of the completed board wiring:

And here is a photo of the underside of the completed tester:



You can see all of the relevant wiring made mostly "point to point" as there is not much to it. The optocouplers were glued to the inside of the DMM cases and wired to the battery leads. The grid bias control can be seen on the lower left with D1 and C2 and the "gas" switch wired directly to it. The 3 HT switches can also be seen on the left side with the 2 diodes for the "shorts" neon. You can also see the 3 valve sockets with all the pins wired sequentially and brought out to the flying banana plugs.

Finally, here are some images of the tester in operation testing a 6V6, KT88 and a 12AX7. The grid voltage is read on the DMM to the left and plate current on the right:


-13.5
85.4


-02.0
01.5

Here is a parts list for the tester:

Power switch and 500mA fuse holder	1 X DPDT mini switch
240V neon	R1 10K
2 X QM1502 Jaycar DMM	R2 100 1W
C1 100nf 100V	R3 1M
C2 47uf 25V	R4 560
C3 47uf63v	R5 150K1W
C4 470uf100v	T1 M6674 30v 2a multitapped transformer
C5 470uf100v	U1-U2 4N25 optocoupler
C6 470uf200v	VR1 10KB linear pot
C7 470uf200v	Medium size baking tray
C8 470uf350v	Various valve sockets
C9 470uf350v	Banana plugs and sockets
D1-D4, D11 1N4007	Hookup wire
D5-D10 1N5404	Mains power lead
Momentary press to break pushbutton switch	
2 X SPDT centre off mini switches	