THE SUSSEX VALVE TESTER

Construction and User Manual

Compiled and edited by Keith Wevill

A design by Mike Rowe

Ist edition May 2014

Warnings

Valves operate at high voltages which are present inside the tester. Take care when building, commissioning and using the tester. If in doubt consult a suitably qualified person.

This valve tester is not suitable for burning in valves.

SUSSEX VALVE TESTER MANUAL INDEX

THE SUSSEX VALVE TESTER

The subject of valve testing is an emotive issue which often appears on vintage and other forums. Often the question is “Is the valve OK?” Quite often the answer is yes the valve is OK. Valves are often more reliable than people think.

Back in the heyday of valves most TV and radio shops would have a valve tester which, for a small fee, could be used to check customer’s valves and give a quick Go/No-Go indication. The customer could then buy new valves or go home in the knowledge that his valves were OK. Many manufacturers, such as AVO and Taylor, supplied testers to cater for the radio and TV market such as those shown on the next page. As the use of valves declined and these shops closed down their testers made their way into private hands. Like many contemporary items of test equipment spares are no longer available so items such as meters for AVO testers can command very high prices. These testers will generally require significant repair and restoration before they can be put back into service and owners will normally hang on to them. When they do come up for sale they can command quite significant sums even in poor condition and needing repair.

Many people have published designs for valve testers and in 2009 Mike Rowe posted details of a tester he had designed on the UK Vintage Radio Repair and Restoration Forum[1] and was subsequently published in the Spring 2010 issue of the BVWS Bulletin. This was an immediate hit and many people started building copies of his design which became known as the Sussex Valve Tester. At the time of writing the thread on the forum has over 1100 posts and over 200,000 views making it one of the most popular topics.

Sadly Mike died in 2012 but the Sussex Valve Tester is his lasting legacy.

Over the years there have been several modifications and improvements to the original design and Les Carpenter produced a manual based on his Sussex in 2010. This incorporated a circuit description and commissioning details.

This manual, based on the modified design, incorporates much of Les’s manual and is intended to bring together all the information on the design, construction and use of the tester into one document and to incorporate any changes and improvements to the original design. I’ve also taken the liberty to add some background information on valve theory and other information which should be useful to users of this and other valve testers.

Keith Wevill 2014

AVO VCM163

AVO Mk1 VCM

Taylor Valve Tester 45D

Simplified Valve Theory

Before describing the valve tester it's worth reviewing the basics of the operation of valves. If you are familiar with this you can go straight to the next section.

A basic triode valve comprises a source of electrons, either a directly heated filament or cathode with a separate heater, a control grid and an anode. The anode is usually operated at a high positive voltage to attract the electrons emitted from the filament or cathode. These pass through the grid and a negative voltage on the grid controls the flow of electrons from the cathode to the anode, the anode current.

Extra grids can be added and we'll look at these briefly later.

If you look at the data for any amplifying valve, apart from the heater rating, the pin out and maximum ratings for anode voltage and current, you'll see three parameters, **µ, gm** and **ra**. What are these parameters, what do they mean and how are they derived?

Let's take an example, the ECC82 (12AU7) double triode with a centre tapped heater allowing it to be used on either a 12.6V (150mA) or 6.3V (300mA) heater supply.

The Mullard quick reference data book and the Mazda data book show the following data on the ECC82. The data sheet[2] shows full details of the valve including plots of the characteristics.

Mullard Databook (1968)			
Double Triode (separate cathodes)			
	Series	**Parallel**	
Vh	12.6	6.3	**V**
Ih	150	300	**mA**
Characteristics (each section)			
Va	100	250	**V**
Vg	0	-8.5	**V**
Ia	11.8	10.5	**mA**
gm	3.1	2.2	**mA/V**
µ	19.5	17	

Mazda Data Booklet (1972)		
AF Double Triode Audio Amplifier 6.3V, 0.3A or 12.6V, 0.15A heater		
Rating (each section)		
Pa (max)	2.25	**W**
Characteristics (each section)		
Va	250	**V**
Vg	-8.5	**V**
Ia	10.5	**mA**
gm	2.2	**mA/V**
µ	17	
ra	7.7	**kΩ**

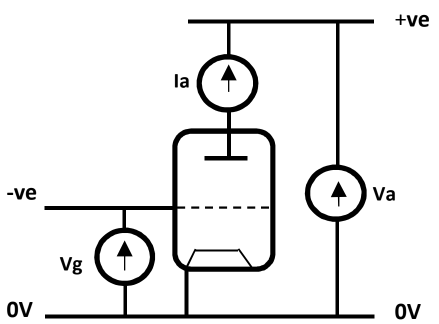


Figure 1 - Test circuit for measuring triode characteristics

If we measure the characteristics, using the test circuit shown in figure 1, we will find that the anode current (**Ia**) is a function of both the control grid voltage (**Vg**) and the anode voltage (**Va**).

Plotting the anode current against the anode voltage at different grid voltages we get the set of plots shown in figure 2 and plotting the anode current against control grid voltage at different anode voltages we get the set of plots shown in figure 3.

Both these plots were taken from actual measurements on one half of an ECC82.

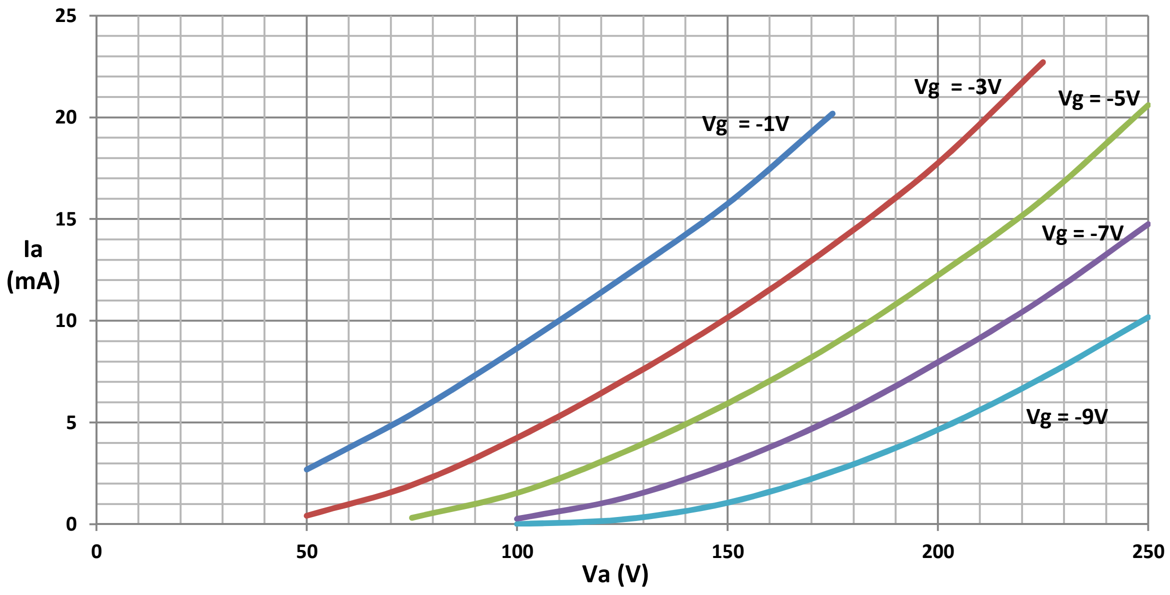


Figure 2 - Anode Current vs Anode Voltage

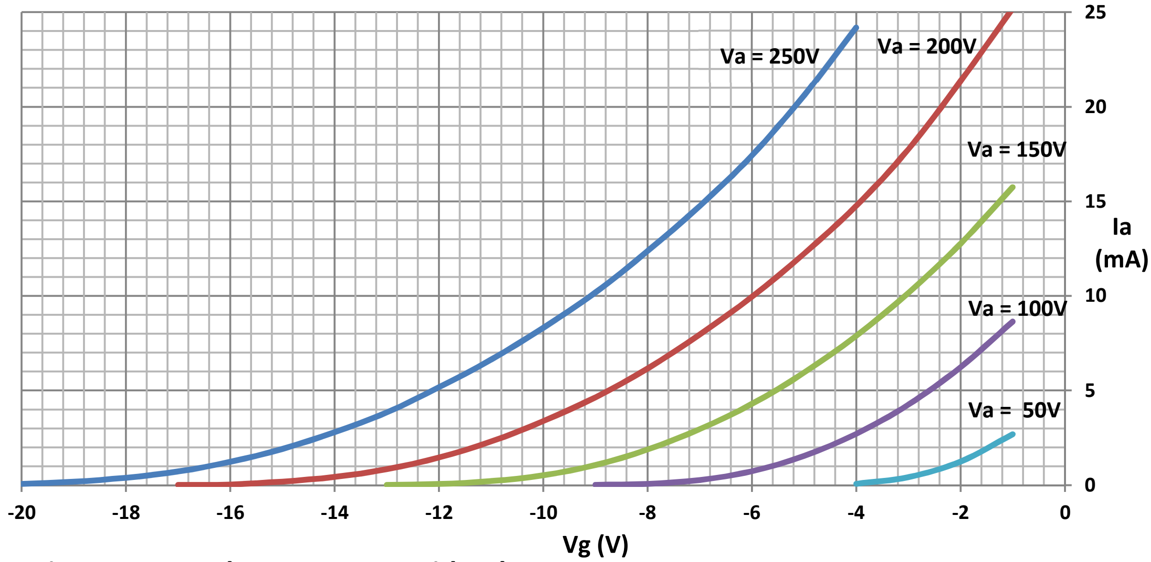


Figure 3 - Anode Current vs Grid Voltage

The first thing to note is that the characteristics are not linear meaning that the test conditions, Anode voltage and Control Grid voltage, must be specified whenever **μ, ra** and **gm** are quoted.

Let's take each of these parameters **μ, ra** and **gm** in turn and see how they are derived and how they are related to each other.

<u>Amplification Factor - μ</u>

Consider point A on the Va/Ia plot in figure 4. The anode current is 10.2mA at an anode voltage of 250V and grid voltage of -9V. If we now change the grid voltage by 2V to -7V the anode current will increase to 14.8mA, point B. To get the anode current back to 10.2mA we have to decrease the anode voltage to 215V, point C.

Therefore for the same anode current, the anode voltage has to change by 35V for a change in grid voltage of 2V. The ratio of these two voltages is the Amplification Factor **μ**.

$$\mu = \frac{\text{Change in Va } (\Delta Va)}{\text{Change in Vg } (\Delta Vg)}$$

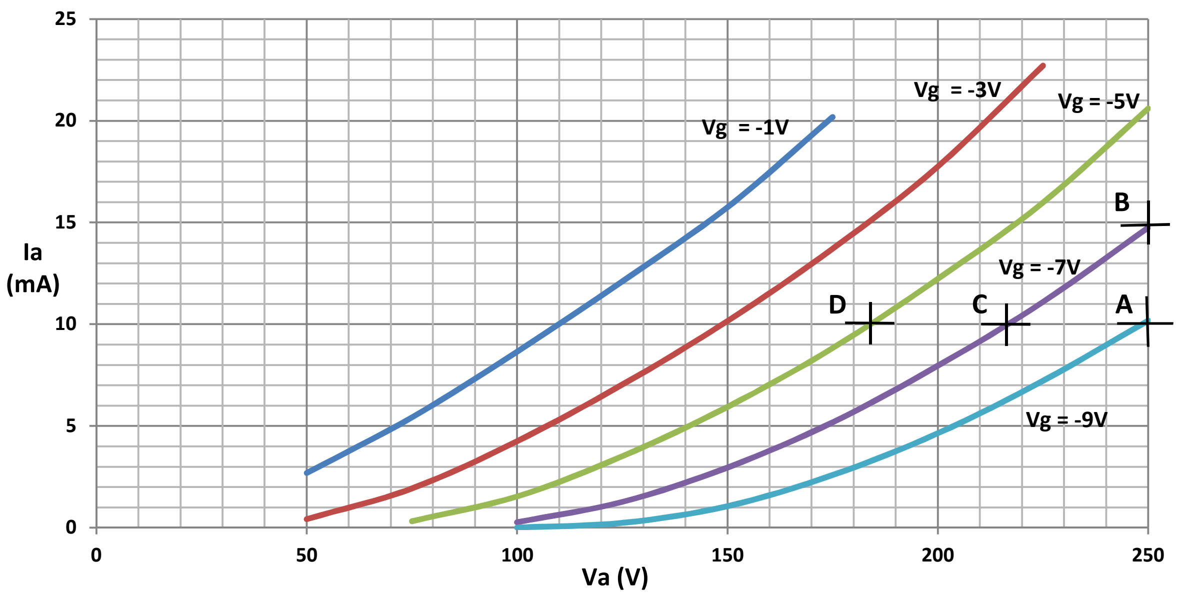


Figure 4 - Derivation of μ

In this case **μ** is 35V/2V or **17.5**.

If we repeat this, changing the grid voltage from -3V to -5V, point C to D, we find **μ** is 15.5 (31V/2V), showing it is important to specify the test conditions when quoting **μ**.

Anode Resistance - ra

As we have seen, if the anode voltage changes, keeping the grid voltage fixed, the anode current will change. This is equivalent to a resistance. In this case from point B to C the current changes by 4.6mA for a change in anode voltage of 35V.

The equivalent resistance is defined as the Anode Resistance **ra**

$$ra = \frac{\text{Change in Va } (\Delta Va)}{\text{Change in Ia } (\Delta Ia)}$$

In this case it is 35V/4.6mA or **7.6kΩ.**

Mutual Conductance - gm

The third parameter is Mutual Conductance or **gm**. This is the change in anode current for a 1V change in grid voltage.

$$gm = \frac{\text{Change in Ia } (\Delta Ia)}{\text{Change in Vg } (\Delta Vg)}$$

Looking at the Va/Ia plot in figure 5, points A and B on the 250V Va line represent grid voltages of -9V and -8V respectively. The corresponding anode currents are 10.2mA and 12.4mA. Therefore a change of 1V in the grid voltage results in a change of 2.2mA in the anode current giving a **gm** of **2.2mA/V**.

As with **µ** the value of **gm** depends on the grid voltage and anode voltage. If we measure the **gm** from point B and C, representing a 1V change in grid voltage but a 2.4mA change in anode current, the **gm** is 2.4mA/V. As the grid voltage increases the **gm** will fall. On the 250V Va line it drops to 1.3mA/V when Vg is -12V.

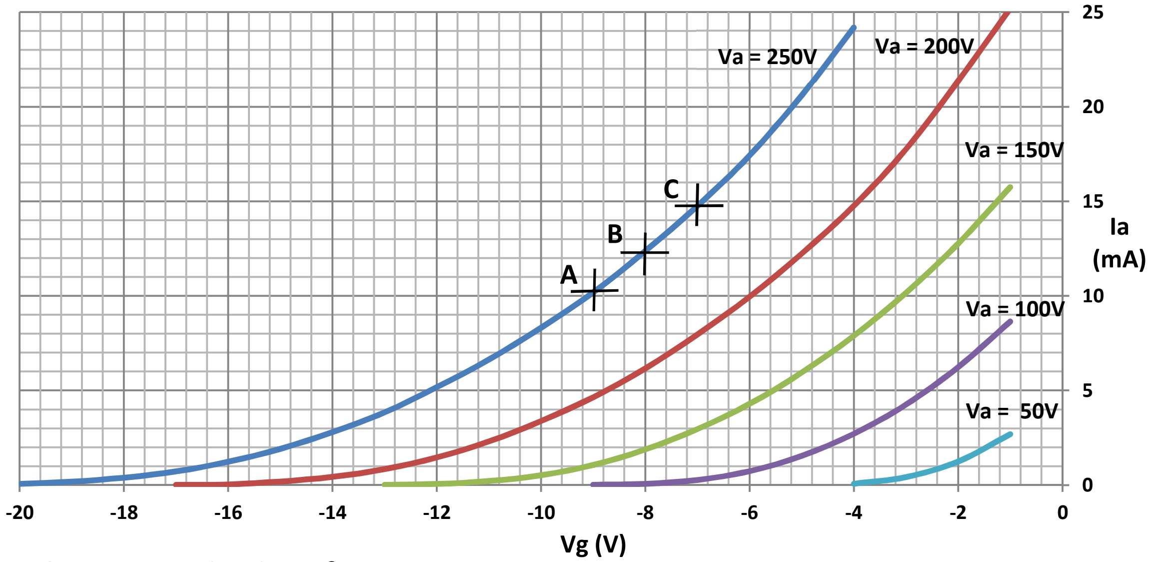


Figure 5 - Derivation of gm

So the three parameters for this valve, at an anode voltage of 250V and grid voltage of -9V, are:-

µ = 17.5 (17)

ra = 7.6kΩ (7.7kΩ)

gm = 2.2mA/V (2.2mA/V)

Which agree quite well with the equivalent parameters from the datasheet shown in brackets. This also indicates that the valve used for these tests is a good one.

Because the parameters are derived from the same three variables, Anode voltage, Anode current and Control Grid voltage, they are related

$$\mu = ra \times gm$$

Note the parameters change depending on the point of the plots they are measured as can be seen from the Mullard datasheet. Thus it is important to quote the test conditions when quoting any of these parameters.

That's covered the basic DC side of valve operation now for the basic AC side. If we couple a 1V peak to peak AC signal to the grid with a dc bias set to -8V, the anode current will vary between 11.2mA and 13.5mA (2.3mA peak to peak), figure 6.

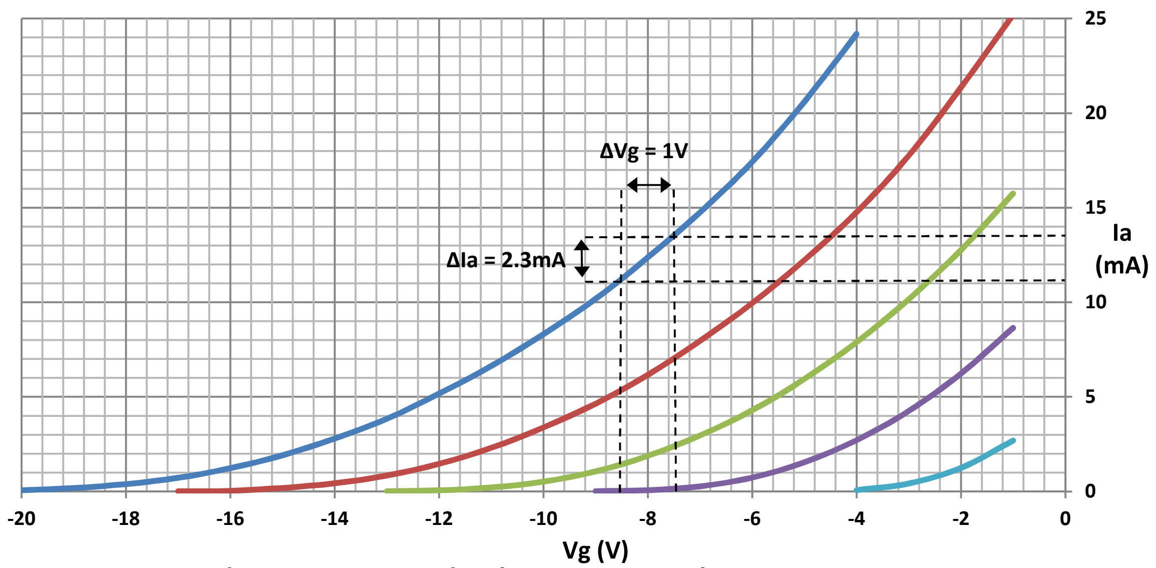


Figure 6 - Anode Current vs Grid Voltage. AC signal

Now for this to be useful as an amplifier this current has to be converted to a voltage by connecting a load resistor between the anode and the HT supply. You may think that the higher the value of the anode resistor the greater the alternating voltage across it and hence the higher the gain. However, as the anode current increases the voltage across the anode load resistor will increase and the anode voltage will drop and, as we have seen earlier, this voltage drop will cause the anode current to fall affecting the anode voltage. Thus calculating the voltage gain is not as straightforward as you would expect.

The detailed analysis to calculate the gain is beyond this simplified theory and to spare you the agony, the formula for the gain of this simple valve amplifier is

$$\textbf{Gain} = \frac{-\mu \times R}{R + ra}$$

Where **R** is the anode load resistor and **μ** and **ra** are the Amplification Factor and Anode Resistance respectively.

The negative sign indicates the output is inverted with respect to the input voltage and the formula also indicates that the gain cannot exceed the amplification factor.

Additional Grids

Useful as it is, the triode has limitations. In particular the anode to grid capacitance causes problems with feedback from the anode circuit to the grid circuit especially when used as an RF amplifier. To overcome this problem an additional grid, the screen grid, is fitted between the grid and the anode creating the tetrode.

Adding this grid has the effect of increasing the amplification factor **μ**, as the anode current is less dependent on the anode voltage, as well as reducing the capacitive coupling between the control grid and anode. The screen grid is normally operated at a voltage less than the mean anode voltage but if the anode voltage does drop below the screen grid voltage a flow of secondary electrons from the anode to the screen grid will cause the anode current to drop and the screen grid current to increase. This can cause increased distortion and a reduction in output power in amplifiers.

To stop this secondary electron flow another grid, the suppressor grid, is placed between the screen grid and the anode. This grid is connected to either ground or the cathode and allows larger anode voltage swings without distortion. This valve then becomes a pentode.

That covers the basic valve theory. For more detailed information on valves and the derivation of the gain formula see one of the many text books such as Foundations of Wireless by M.G.Scroggie or earlier editions of the RSGB Radio Communication Handbook.

Specification and Theory of Operation

Sussex Valve Tester Specification

Functions

Heater Continuity	Checks the continuity of the heater before applying power to the Valve under test.
Anode to Screen Grid Short Circuit	Checks for short circuits or leakage between the Screen Grid and Anode.
Anode and Screen Grid Short Circuit to Cathode	Checks for short circuits or leakage between the Screen Grid and Anode and the Cathode.
Anode Current and gm Measurement	Measures the Anode current and gm at the Anode, Screen Grid and Control Grid voltages set.
Heater Insulation	Checks the Heater Cathode insulation once the valve is powered up.
Gas Test	Checks for Grid current with the valve powered up.

Anode Voltage Range	0V, 50V, 75V, 90V, 100V, 125V, 150V, 175V, 200V, 225V, 250V and 300V.	
Screen Grid Voltage Range	0V, 50V, 75V, 90V, 100V, 125V, 150V, 175V, 200V, 225V, 250V and 300V.	
Grid Voltage Range	0V to -45V continuously variable.	
Heater Voltage Range	1.4V DC@ 0.25A	5V AC@ 3A
	2V DC @ 0.25A	6.3V AC@ 3A
	4V AC@ 3A	12.6V AC@ 1A
	External heater supply.	
Valve Base Types	Any valve base of up to 9 pins to be specified by the individual constructor.	
AC Supply*	200V AC to 250V AC or 110V AC to 130V AC	50Hz to 60Hz

*AC supply dependent on the transformer fitted

Circuit

The original circuit for the tester is shown in figure 35 in the appendix. This circuit is perfectly useable as it stands but several changes have been made to improve the usability and extend the number of tests that can be conducted.

The circuit to be described is one from the tester built by Les Carpenter and includes several additional features. Any differences between the original circuit and this circuit will be detailed in the circuit description.

The basic requirement for the tester is to provide a set of power supplies for the Heater, the Anode, the Screen Grid and the Control Grid for the valve under test. These are applied to the valve under test and the anode current, both the DC and AC components, are monitored and compared to the valve data. The AC component being used to indicate the gm. A decision can then be made as to whether the valve is good or not.

The block diagram, figure 7, shows the circuit blocks of the tester. The mains transformer and rectifiers provide the raw voltages for the variable Anode and Screen Grid supplies and for the variable Control Grid supply. The Control Grid supply also provides an AC signal for checking the gm of the valve under test.

The Heater supply is taken from a separate winding with taps to accommodate different heater voltages. Three other low voltage windings, not shown in the block diagram, provide power for the three digital meters used to monitor the anode current and the grid voltage.

The Anode, Screen Grid and Control Grid voltages pass to the function block where, depending on the function selected, they are connected to the valve under test. The block also includes monitoring for the various functions.

From this block the Heater, Cathode, Control Grid, Screen Grid and Anode connections pass to the Valve Pin Function selection switches. Here these connections are routed to the appropriate pin on the valve. There are 9 switches, one for each valve pin. Each pin can be connected to any one of The Heater, Cathode, Screen Grid, Control Grid or Anode connections. For valves with a top cap, additional sockets are available to connect to the tester Anode or Control Grid connections. The switches are arranged to be compatible with the AVO CT160 Tester settings[3].

The final block is for the bases for the valve under test. As the tester is capable of testing a wide range of valves with different bases the final choice of bases is up to the individual constructor. Any valve base with up to 9 pins can be used. All the bases are wired in parallel with pin 1 of all the bases wired together, pin 2 of the bases wired together etc.

Typical bases suggested are B9A, B7G, B8A and International Octal (IO) bases. Others include, Mazda Octal (MO), B9G etc. For bases not fitted it is possible to use adaptors plugged into one of the fitted bases.

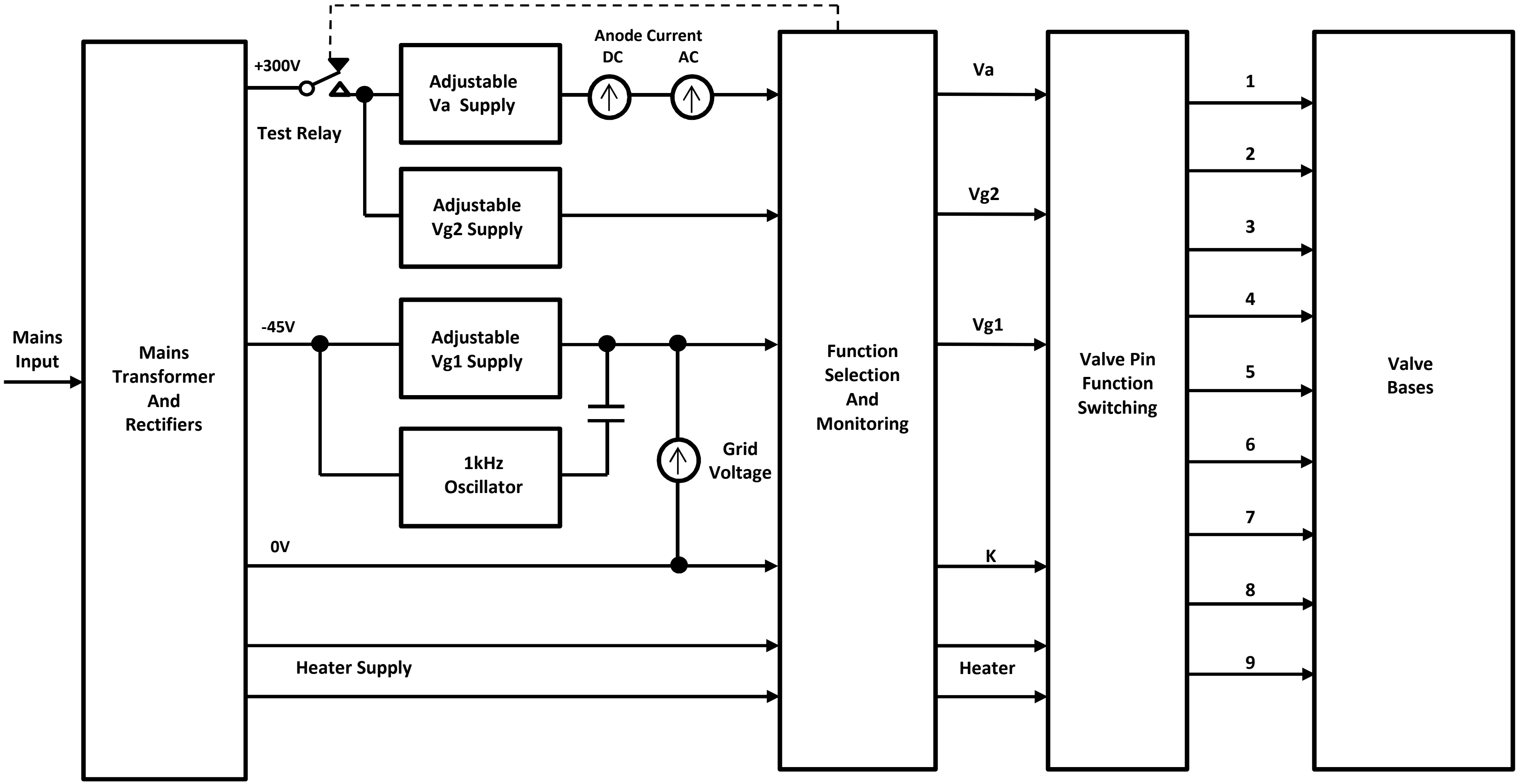


Figure 7 - SUSSEX VALVE TESTER BLOCK DIAGRAM

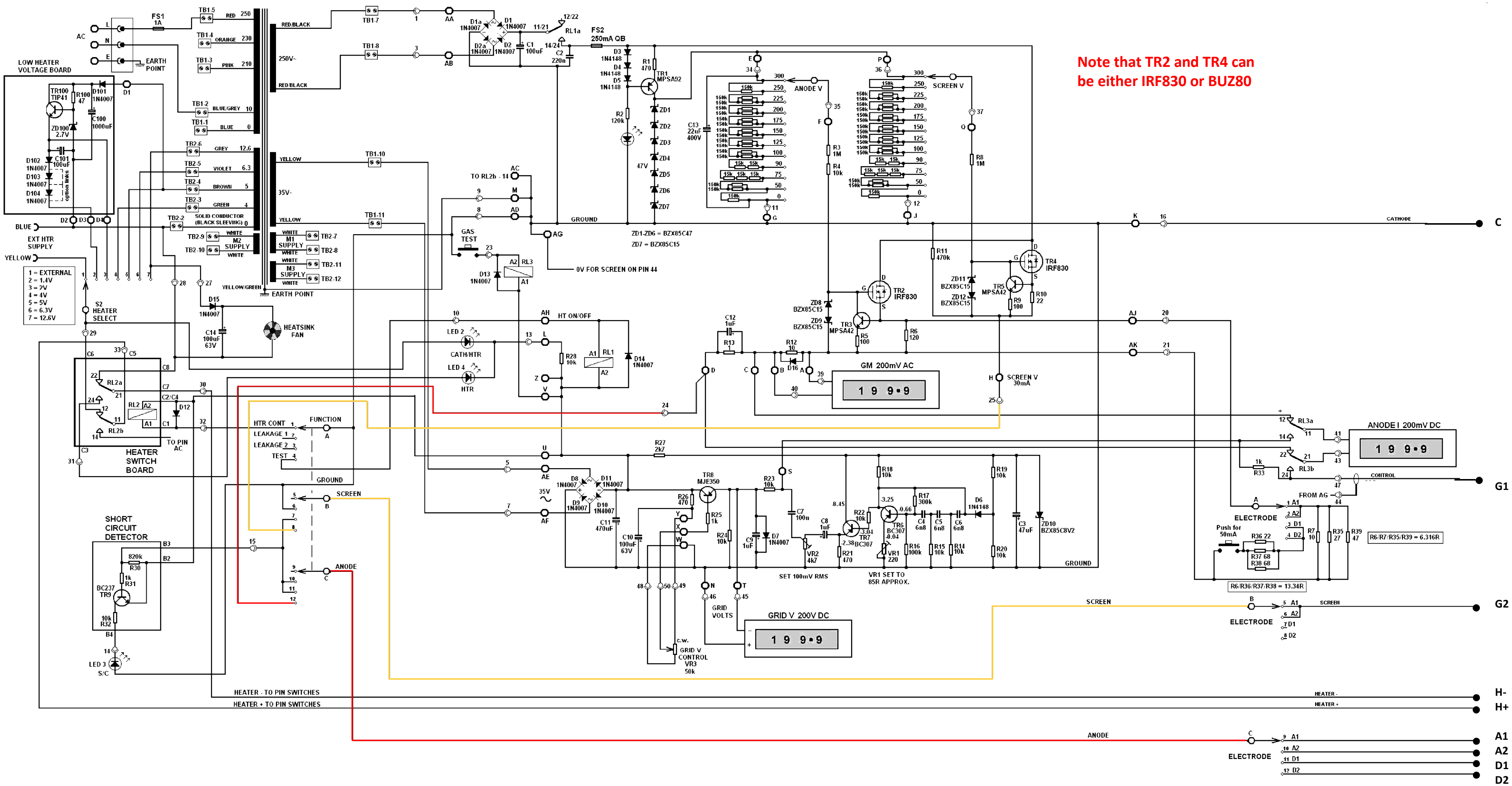


Figure 8 - Sussex Valve Tester circuit – Updated version by Les Carpenter

Circuit Description

The tester uses a single transformer to provide the HT, Heater and Grid supplies. This differs from the original where several transformers were used. The primary is tapped to allow input voltages between 200V and 250V to be used. An alternative transformer is available for use with 110V supplies.

There are six secondary windings, 250V for the Anode and Screen Grid supplies, 35V for the Control Grid supply and to power the relays, a tapped low voltage winding for the Heater supply and three 6V low current windings to power the Digital Panel Meters.

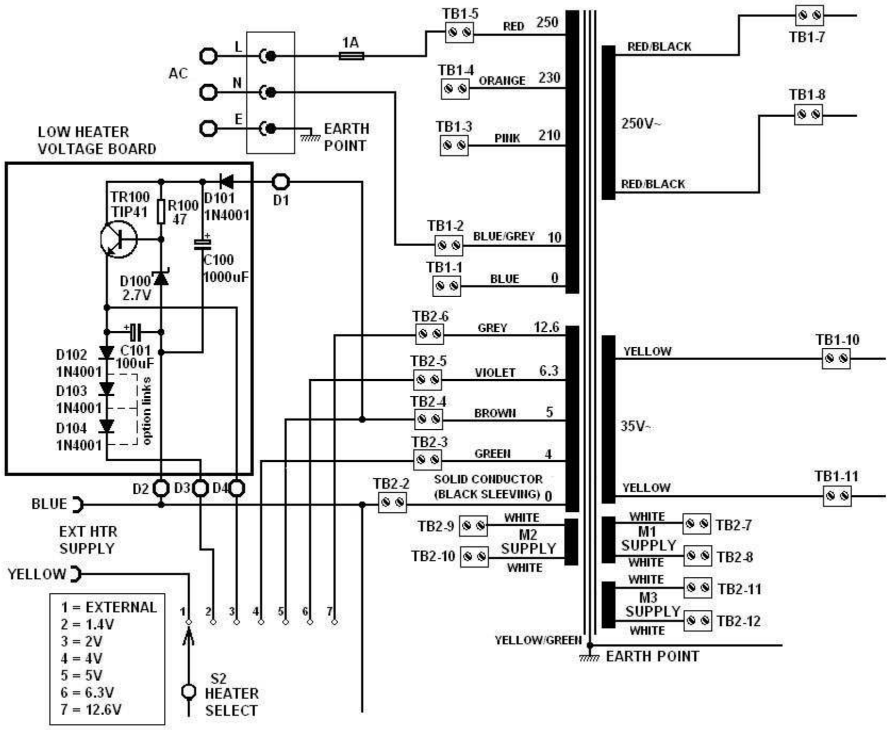


Figure 9 - Transformer and Heater Supplies

The Heater winding is tapped to provide a range of heater voltages up to 12.6V, switch S2 selecting the voltage. For heater voltages not covered by the Tester, S2 can select an external supply and for directly heated valves a low voltage dc supply is provided by the Low Heater Voltage board. A half wave rectifier, D101, and capacitor, C100, on the 5V tapping provide approximately 7V dc which is reduced to 2V by the 2.7V zener diode, D100, and emitter follower, TR100. This is dropped to approximately 1.4V by one or more of the diodes D102 to D104.

An alternative 2V/1.4V regulator is shown at the end of this section.

HT supplies

The 250V winding is rectified by the bridge rectifier, D1, D1a, D2 and D2a with C1 as the reservoir capacitor. This provides approximately 350V dc off load. Note that the original circuit uses two diodes, D1 and D2, with a 250V-0-250V winding.

Relay RL1 switches the HT supply to the Anode and Screen Grid supplies. This relay is controlled by the Function switch to prevent HT being applied during tests other than the characteristic test. The supply is protected from overloads by fuse FS2.

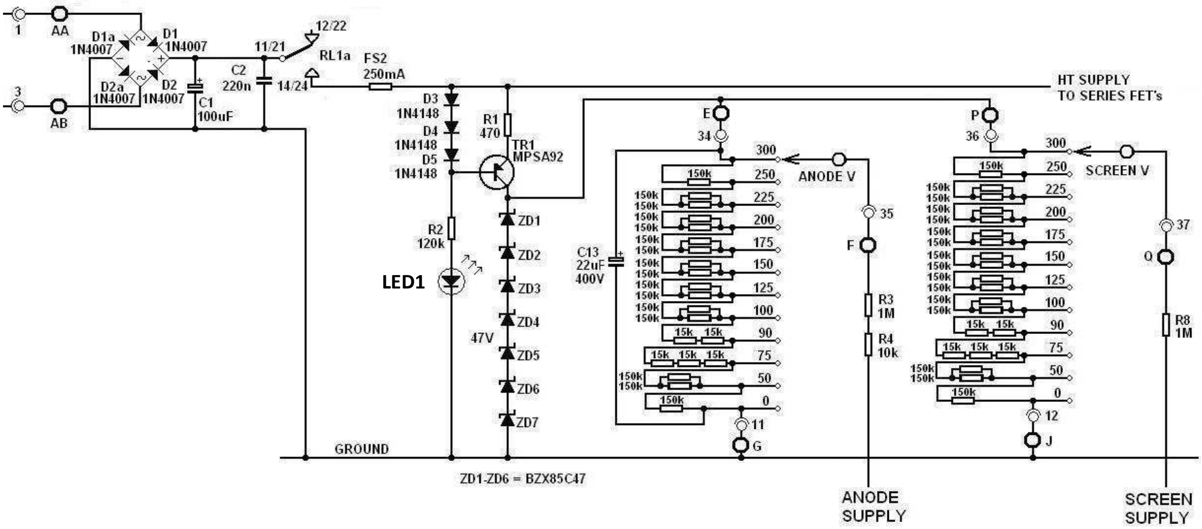


Figure 10 - HT Supply

In order to provide a stable supply for the Anode and Screen Grid supplies some form of regulation is required. A string of zener diodes ZD1 -7, fed by a constant current source TR1, R1, D3-5, R2 and LED1, provides a stable voltage of 297V. The LED also provides an indication that the HT supply is on.

Two switched divider chains across this stable supply feed the gates (G) of two high voltage MOSFETs, TR2 and TR4, mounted on a heatsink, whose drains (D) are connected to the HT supply. The sources (S) of these FETs provide the Anode and Screen Grid voltages via a current limit circuit.

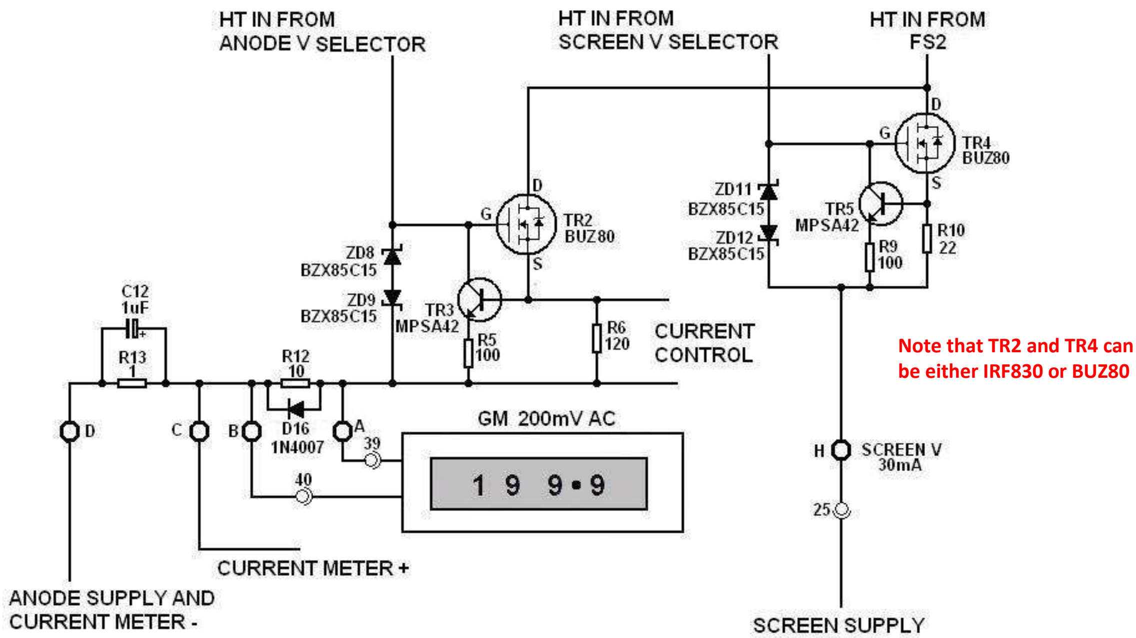


Figure 11 - Anode and Screen Grid Supplies

Each current limiter comprises a sense resistor, R6 in the Anode supply and R10 in the Screen Grid supply, and a transistor whose base and emitter are connected across this resistor. The transistor collector is connected to the gate of the FET. As the current drawn from the supply increases the voltage across the sense resistor will increase. When this voltage reaches approximately 0.65V the transistor will start to conduct and reduce the drive to the gate of the FET and the output voltage will fall. This will limit the current to approximately 27mA for the Screen Grid supply. The Anode current limit has two main settings, 5mA in the D1 and D2 positions for testing small signal diodes, where the current limit is set by R6, and 95mA in the A1 and A2 positions of the Electrode switch, where R7, R35 and R39 are placed across R6. A push button increases the current in the D1 and D2 positions to 50mA for testing power rectifiers.

To Current Control (Fig 11)

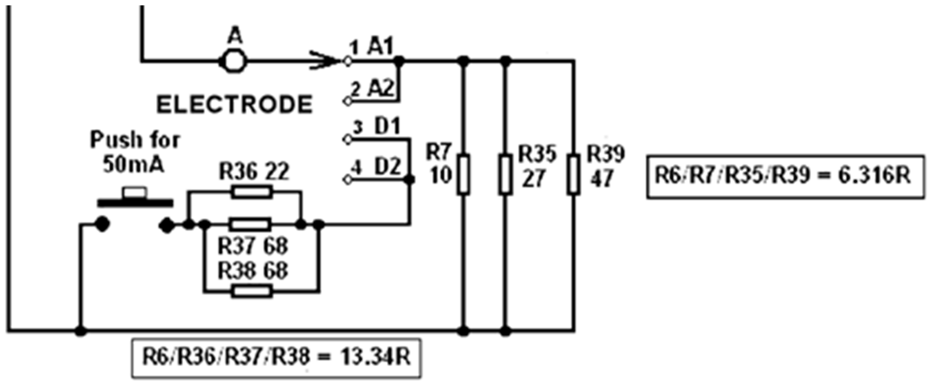


Figure 12 – Anode Current Limit Selection

Control Grid Supply

The 35V winding is rectified by the bridge rectifier, D8 – 11, to give approximately 45V across C11. This is used to power the relays as described later. Note that the positive side of the bridge is connected to ground as the grid voltage has to be negative with respect to the Cathode (ground). A potential divider, R26 and the Grid V Control VR3, provide a variable negative supply with a low output impedance via an emitter follower TR8. Diode D7 prevents the grid voltage from going positive in the event of a fault. The Grid V DPM allows the Control Grid voltage to be set and monitored. The grid voltage is fed to the function switching via a 10k resistor R23.

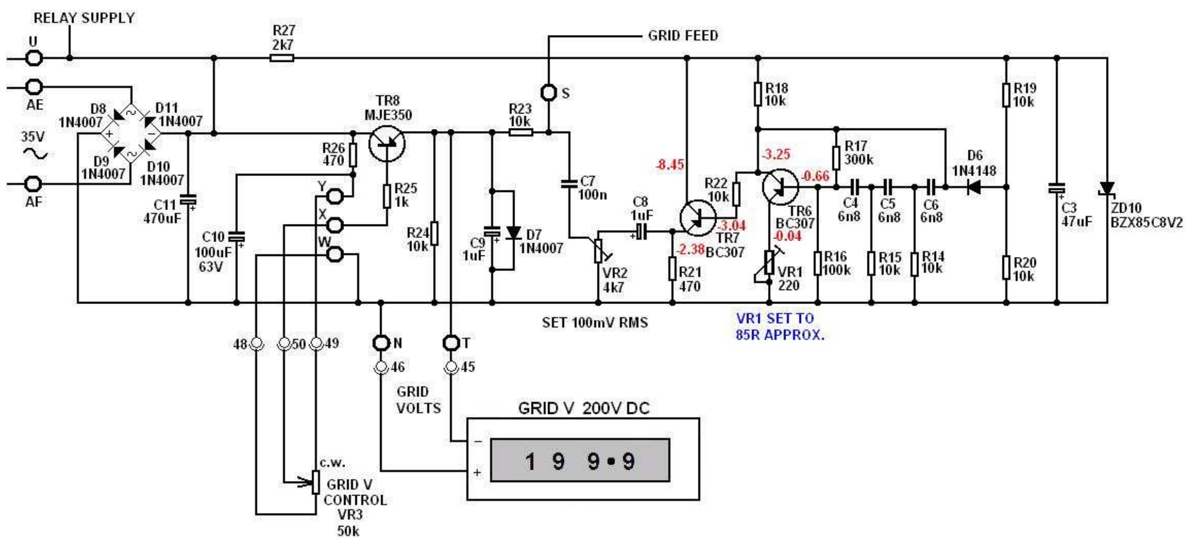


Fig 13 - Control Grid Supply

In order to measure the **gm** of the valve under test, a 100mV RMS AC signal is coupled to the grid from the phase shift oscillator formed by TR6. The 10kΩ resistor, R23, prevents the signal being attenuated by the low output impedance of the grid supply.

The oscillator is powered by an 8V zener stabilised supply derived from the -45V supply and produces a sine wave at approximately 1kHz. VR1 is adjusted for the best waveform. The output from the collector of TR6 is fed via an emitter follower buffer, TR7, and capacitor C8 to VR2 which is adjusted to give 100mV RMS at the grid feed point.

Metering

Three Digital Panel Meters monitor the Control Grid voltage, the Anode DC current and the Anode AC current.

The Control Grid voltmeter, previously mentioned, is set to its 200V range and measures the voltage of the grid supply. Note that the circuit in figure 8 shows the positive input connected to 0v and the negative input connected to the grid supply. As the grid voltage is negative the meter negative input should be connected to 0V and the meter positive input connected to the grid supply. This ensures the meter will show the grid voltage as negative. All references to the grid voltage in this manual will assume the Control Grid voltmeter indicates a negative voltage.

The Anode DC current meter measures the voltage across R13. With a 1Ω resistor this position this gives a voltage of 1mV per mA. With the meter set to its 200mV setting this gives a maximum measured anode current of 200mA.

The Anode AC current meter measures the RMS AC voltage developed across R12 (10Ω) giving 10mV per mA of anode AC current. With the Control Grid AC voltage set to 100mV the meter will allow the gm to be read directly in mA/V, a reading of 1mV on the meter being equivalent to 1mA/V. Due to failures encountered with this meter under fault conditions, for example if the Anode supply FET goes short circuit, a protection diode, D16, is placed across R12. However this has been reported as affecting the gm reading at higher anode currents as the diode forward volt drop affects the AC signal. See the notes on page 23.

As the meters in the anode circuit are at a high voltage relative to 0V, they must be powered by their own independent supplies. Therefore each meter has its own 6V AC winding on the mains transformer. The specified meters have a built in rectifier allowing them to be powered from an AC source. These supplies must not be connected together.

Functions

The Function switch has four positions,

1. Heater Continuity
2. Leakage 1 (Anode to Screen Grid Short Circuit)
3. Leakage 2 (Anode and Screen Grid Short Circuit to Cathode)
4. Test (Anode Current and gm Measurement)

In the Leakage and Test positions there is a Heater Cathode Insulation check and in the Test position, an addition to the original circuit, a Gas Test.

Heater Continuity

In the Heater Continuity position of the Function switch relay RL2 operates disconnecting the heater from the heater supply and connecting it across the 45V supply via R28 and LED4. If the heater is intact the LED will light.

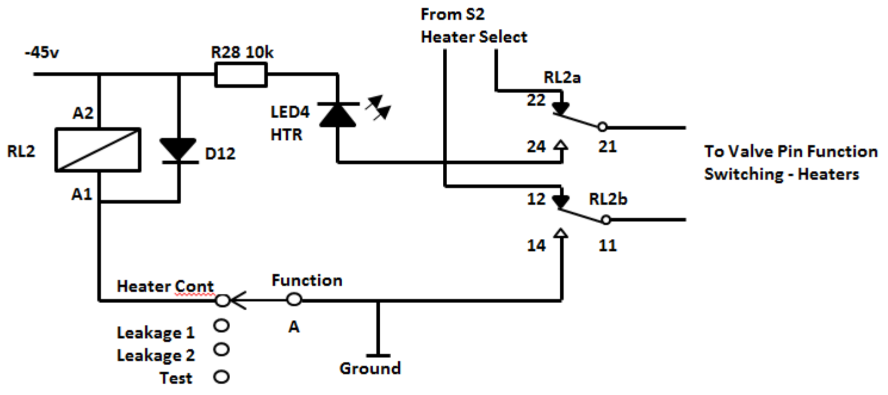


Figure 14 – Heater Continuity Check

This is different to the original Heater Continuity test circuit as a heater cathode short circuit can short out the -45V supply as shown in figure 15.

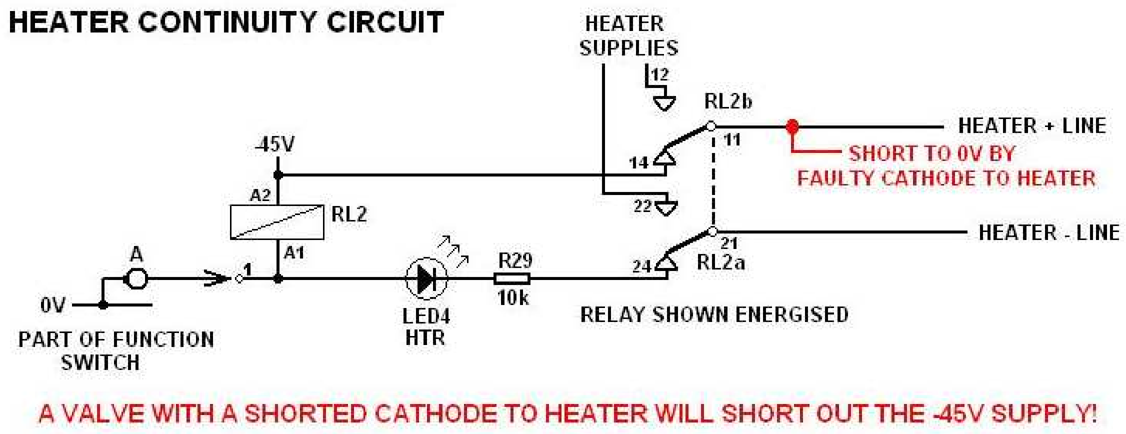


Figure 15 - Original Heater Continuity Circuit

The modified circuit will not short out the -45V supply but may give a false heater continuity indication in the event of an open circuit heater and a heater cathode short circuit. However in this situation when the function switch is moved to the next position the heater cathode insulation LED will light.

If either a 3 pole relay is used for RL2 or an additional relay controlled by the Heater continuity position is added, the extra pole can be used to isolate the cathode during the heater continuity test. This optional extra circuit is shown in figure 16.

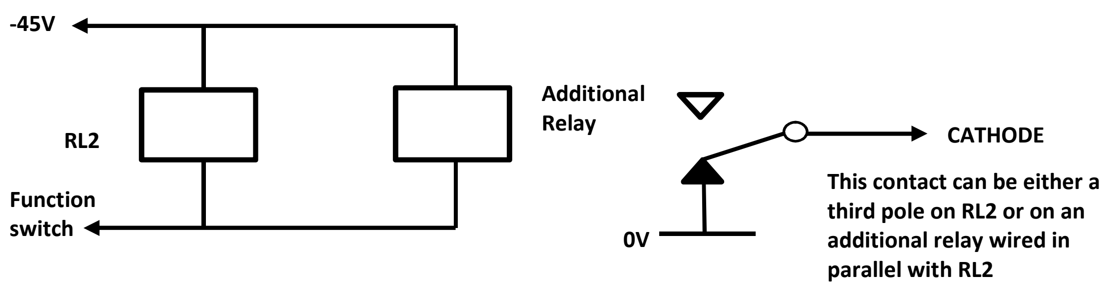


Figure 16 – Optional Cathode Isolator For Heater Continuity Test

Leakage 1

In this position of the Function switch the Heater is on and the Screen Grid is connected to ground.

The Anode is connected to the leakage detector as shown in Figure 17. If the Anode and Screen Grid are shorted together or there is any leakage between them the LED3 will light.

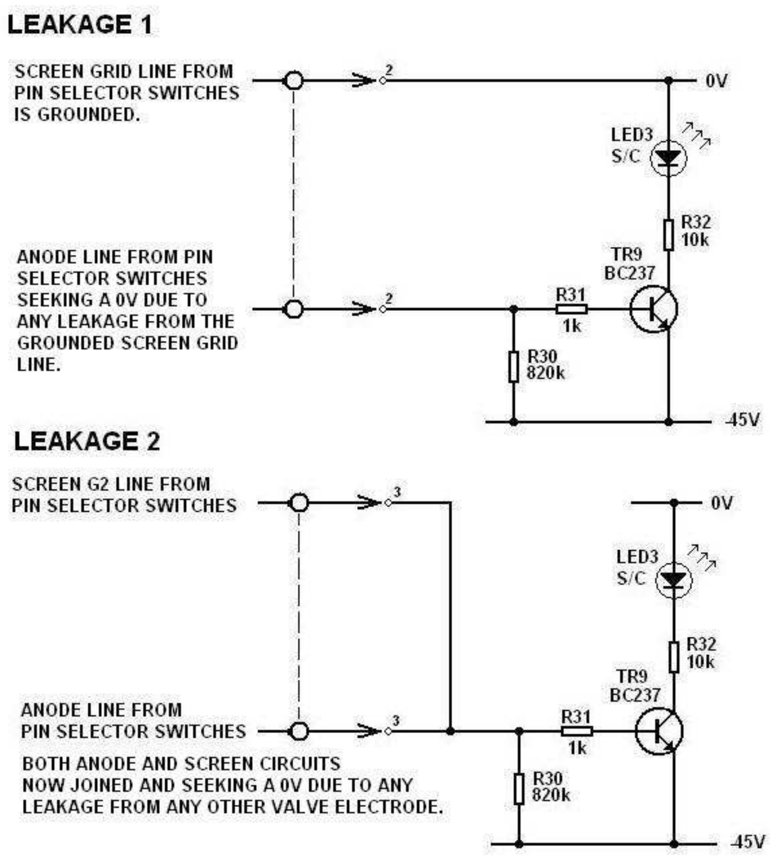


Figure 17 – Leakage 1 and Leakage 2 Configurations

Leakage 2

In this position of the Function switch the Heater is on and both the Anode and Screen Grid are connected together and connected to the leakage detector. If either is short circuit to the Cathode, connected to ground, or there is any leakage to the Cathode, LED3 will light.

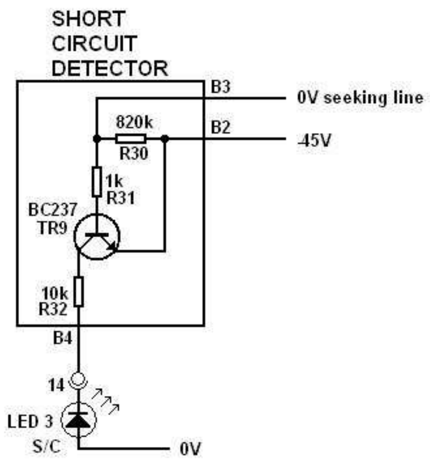


Figure 18 - Short circuit detector

The short circuit/leakage detector works as follows.

The emitter of TR9 is connected to the -45V supply, and the base is tied to this supply through the high value resistor R30. In this condition the transistor is cut off and the LED is extinguished. The base is connected to the "0V seeking line" which is connected to the Anode and Screen Grid of the valve under test via the function switch.

If either the Anode or Screen Grid has a leak to ground, (+ve with respect to emitter and base) a positive voltage will appear at the base and the transistor will conduct thus illuminating the LED. The higher the +ve voltage caused by a lower leakage resistance, then the brighter the LED will shine.

The circuit will detect a leakage resistance of up to 1MΩ.

Test

In this position the Heater is on, the Anode and Screen Grid are connected to their respective supplies and the HT is turned on. The Control Grid is connected to the grid supply with the superimposed 100mV RMS 1kHz sine wave.

The anode meters will then show the AC and DC currents for the conditions set by the Anode, Screen and Control Grid voltages. The AC meter will indicate the gm directly.

Heater Cathode Insulation

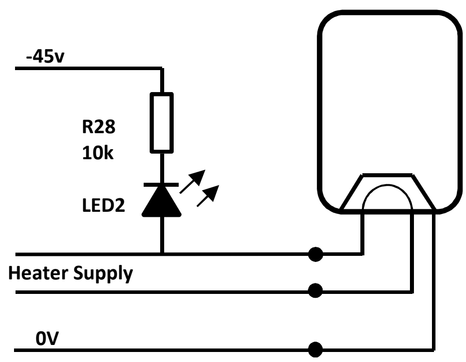


Figure 19 - Heater Cathode Insulation

Operational in all positions of the Function switch the Heater Cathode insulation is checked by connecting the Heater supply to the -45V supply through R28 and LED2. Leakage between the Heater and Cathode of approximately 47kΩ will just light the LED with full brightness achieved if there is a Heater Cathode short circuit.

Testing the Heater Cathode at 45V places the insulation under some stress but as most valves have a Heater Cathode insulation rating greater than 45V, any valve which fails should be considered faulty.

Note that the LED will light when directly heated valves are tested as the Filament is also the Cathode.

Gas Test

The Gas Test is an addition to the original design and checks for grid current by switching the Anode current DPM across a 1kΩ resistor, R33. Any grid current will generate a voltage across this resistor with 1mV representing a grid current of 1µA. With a 200mV meter a grid current of up to 200µA can be measured. Relay RL3, controlled by the Gas Test push button, switches the meter input.

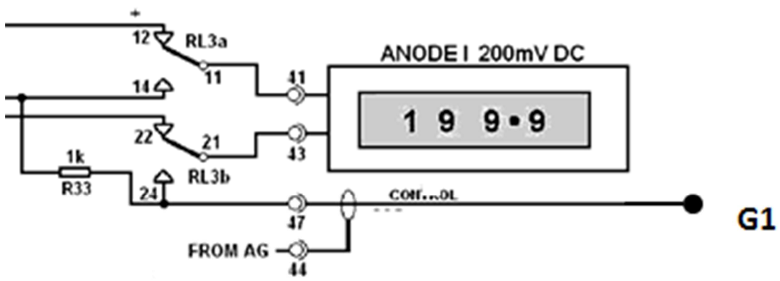


Figure 20 - Gas Test Switching

<u>Valve Pin Function Switching</u>

There are 6 outputs from the Function switch, two Heater connections, the Cathode connection (0V), the Control Grid connection, the Screen Grid connection and the Anode connection. To cater for valves with more than one section, such as double triodes and rectifiers, the Anode and Screen Grid connections pass through the Electrode switch which switches the Anode connection to either of two Anode connections, A1 and A2, for multi section valves or to either of two rectifier Anode connections, D1 and D2. In the D1 and D2 positions the Screen Grid connection is disconnected as shown in figure 21. The Electrode switch also switches the current limit for the Anode supply as shown in figure 12.

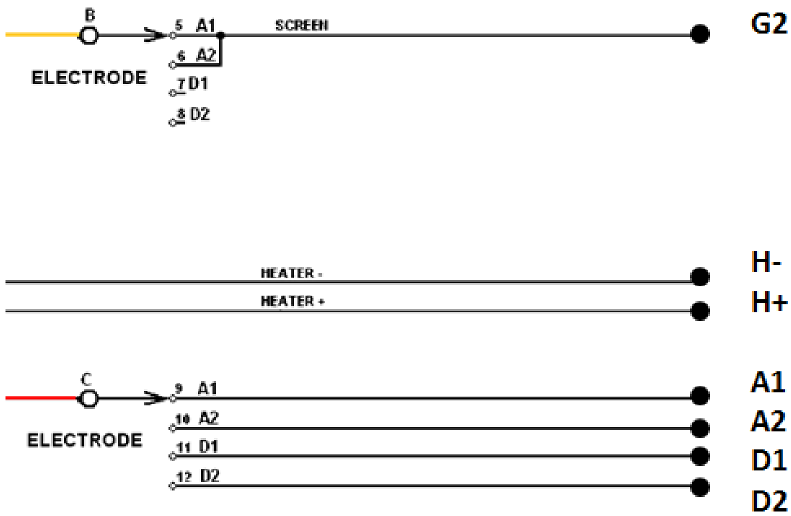


Figure 21 - Anode and Screen Grid switching

There are thus 9 connections which can be connected to the valve under test. These are connected to the valve base by nine switches, one for each pin. There are also three sockets for Cathode, Control Grid and Anode to cater for valves with a top cap, figure 22.

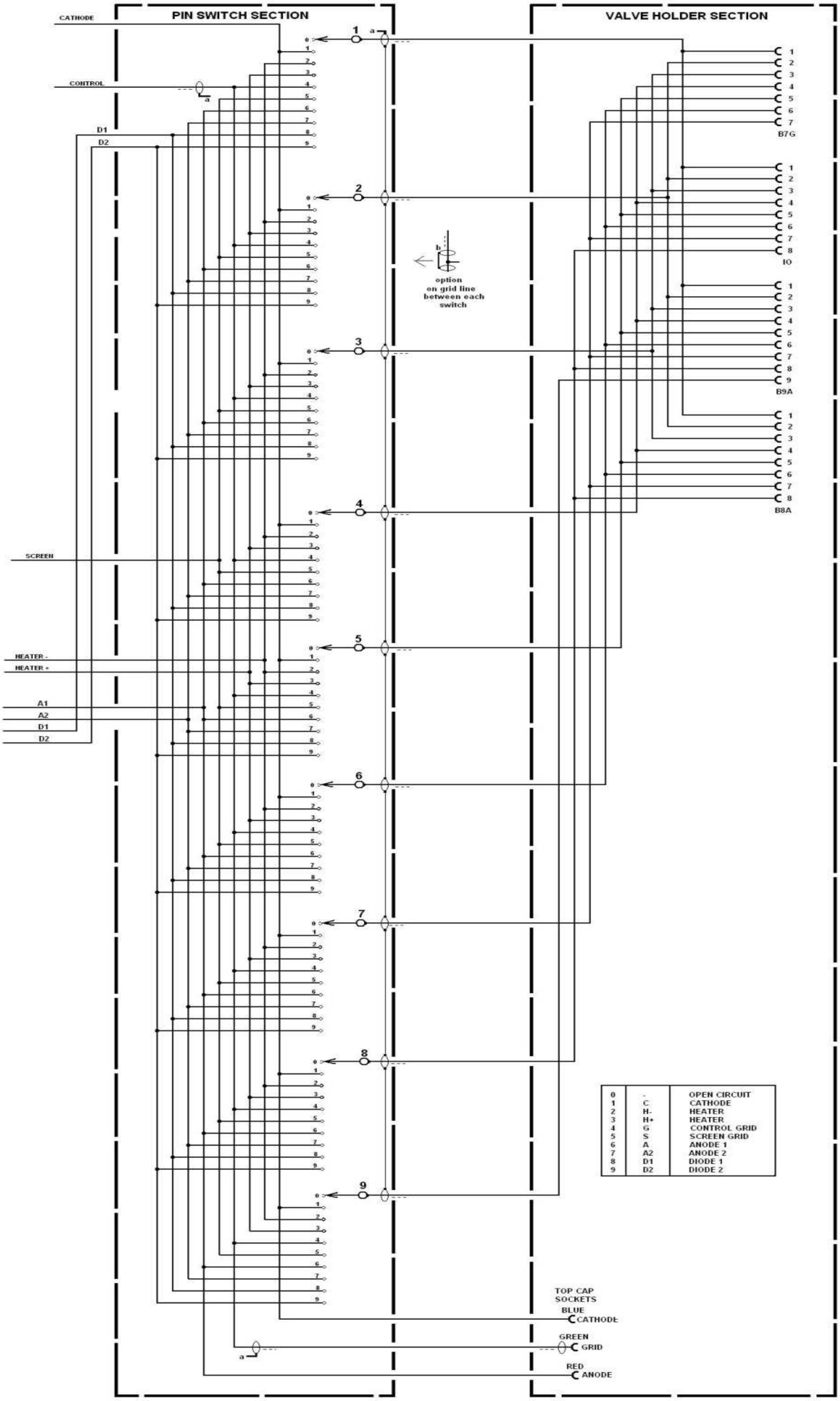


Figure 22 - Valve Pin Function Switching And Valve Base Wiring

Each Valve Pin switch has ten positions, wired to be compatible with the AVO CT160 settings.

Position	Function
0	No Connection
1	Cathode
2	Heater -
3	Heater +
4	Control Grid (G1)
5	Screen Grid (G2)
6	Anode 1 (A1)
7	Anode 2 (A2)
8	Diode 1 (D1)
9	Diode 2 (D2)

This allows the AVO Manual settings to be used for testing.

All the valve bases are wired in parallel. The exact types of valve base are up to the individual constructor but it is suggested that B7G, B9A, International Octal and B8A bases should be fitted to cover most of the more common valves. Other bases can be added later.

Cooling Fan

The two FETs in the Anode and Screen Grid supplies are mounted on a heatsink as they can run hot, especially if operated at higher currents and low output voltages. To reduce the temperature rise within the case a fan can be fitted to cool the heatsink. A 12V DC fan is used, powered from the 12.6V heater winding via a half wave rectifier, D15, and capacitor C14.

Alternative Circuits

Here alternatives to various circuit elements are detailed. Note that not all of these circuits have been tried. If you do try them and find they are an improvement please contact me and I'll include them in any future revisions.

Increased Anode Current Limit

It was felt that a bit more A1/A2 anode current would be beneficial when testing some valves so R39 was deleted and R35 changed from 27Ω to 11Ω which with R6 gives approximately 120mA. To avoid having three resistors in parallel for the diode current, R38 was deleted and R36 and R37 made 27Ω each. Please note that the valve tester should not be used at this current for extended periods as damage may occur as the specified transformer is rated at 100mA.

Drifting Oscillator Amplitude

Reports of varying 1kHz sine wave amplitude with temperature have been received from numerous constructors. Although the author (Les) has not had this problem with the Sussex after a suitable warm up time, one answer is to modify the oscillator into a temperature controlled Wien bridge circuit. The following is an example of what may possibly be done to the present main board oscillator section. The underside view shows in Red what tracks need to be cut and those lines in Green show new connections, some using short lengths of hook up wire.

Caution: This arrangement has not been tried so there may be unknown errors!

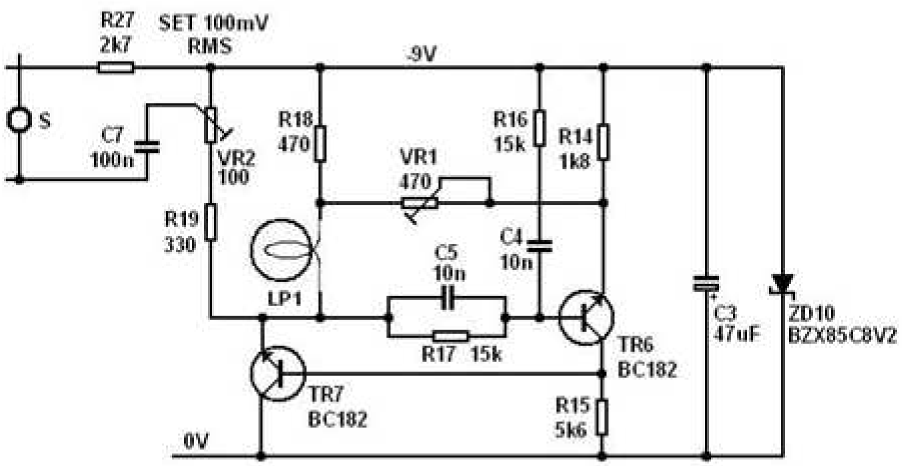
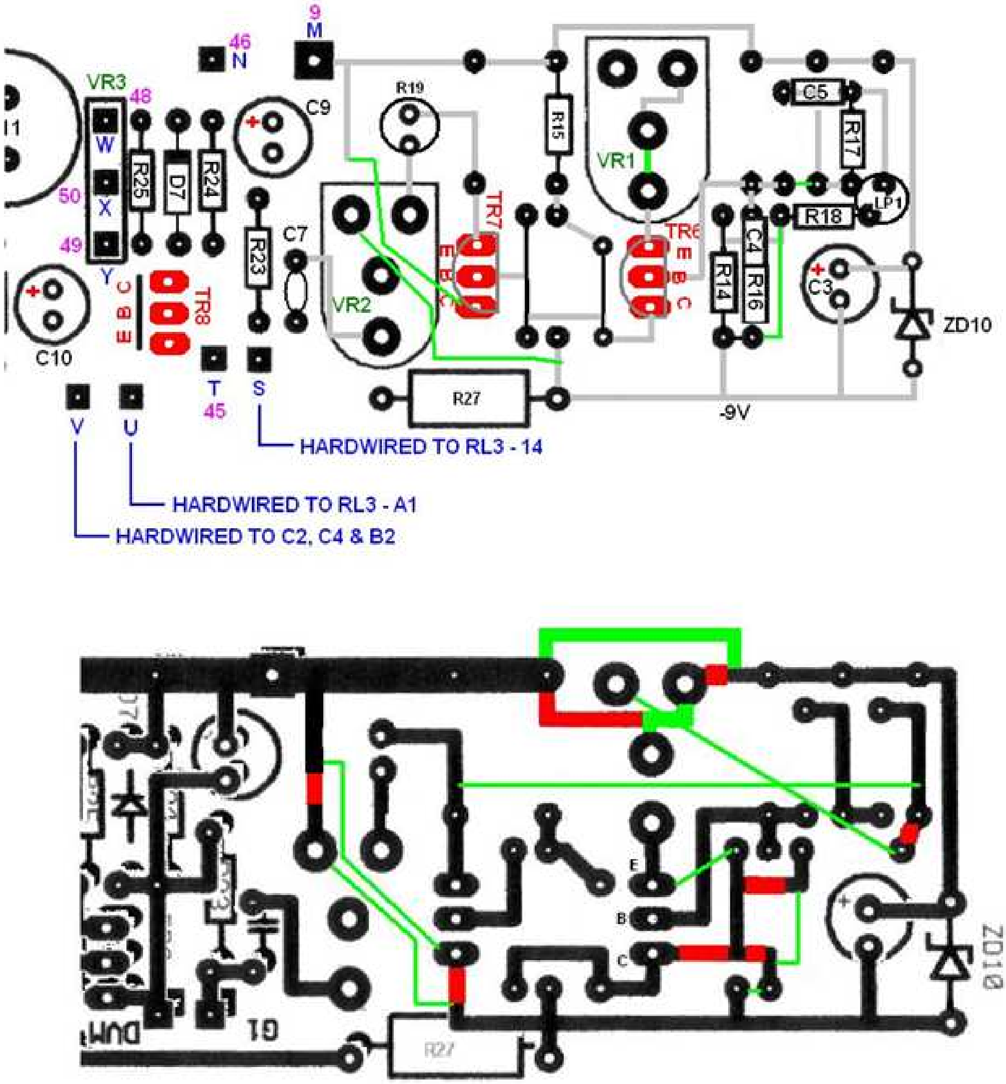


Figure 23 - Alternative Sine Wave Oscillator



Figures 24 & 25 - Amended PCB Layouts

2V & 1.4V Filament Regulator

This alternative regulator can replace TR100, D100 and R100. This circuit can produce a more stable filament voltage but requires an extra pole on the Heater Select switch.

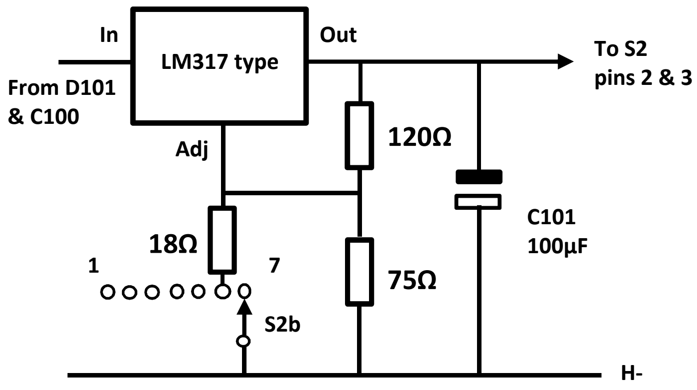


Figure 26 – 2V & 1.4V regulator

The regulator is an LM317 low dropout type with its output voltage set to 2V by the 120Ω and 75Ω resistors. An extra pole on the heater select switch switches an 18Ω resistor across the 75Ω resistor in position 6 to reduce the voltage to 1.4V. The regulator may need to be fitted with a small heatsink.

Magic Eye Adaptor.

As it stands the Valve Tester cannot directly test Magic Eyes as there is no load resistor for the triode section. In order to test them an adaptor is required.

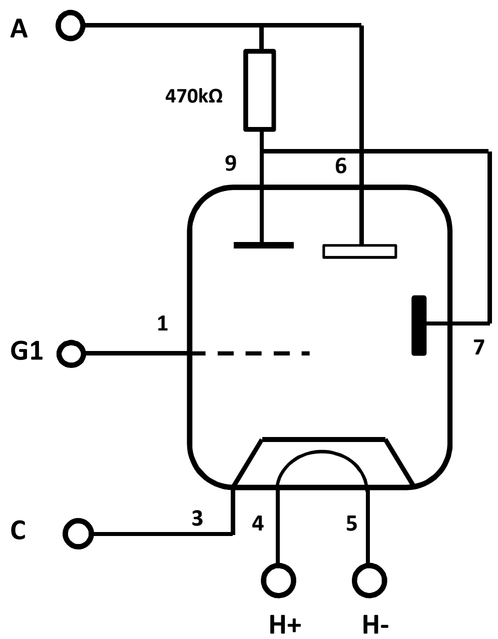


Figure 27 - Magic Eye Adaptor - (EM84/87)

This adaptor includes the Anode resistor. Some Magic Eyes specify 100kΩ for the anode resistor but 470kΩ will normally work with these types. The pin numbers shown are for the EM84/87 with a B9A base but can be changed for other types. The alternative is to create an adaptor for each type of Magic Eye with the Anode resistor specified for that type.

When testing, the Anode voltage and the Control Grid voltage are set in accordance with the Magic Eye data sheet. The eye pattern should alter from minimum to maximum as the Control Grid voltage is altered.

D16

As mentioned earlier, D16 is fitted across R12 to protect the gm meter from a fault in the anode circuit. However as the anode current increases the voltage across R12 increases to the point where D16 starts conducting affecting the signal level into the gm meter and hence the gm reading. Removing the diode restores the correct gm reading but leaves the meter vulnerable to damage in the event of a fault.

Alternative solutions have been proposed to protect the meter without affecting the gm reading. These include fitting two diodes in series or feeding the low level ac signal to the meter via a transformer. None of these possible solutions have been fully tested but when a suitable solution has been tested this manual will be updated.

Components and Construction

Not all constructors will want to make an exact copy of Mike's original tester and there is plenty of scope for interpretation of the design to meet individual requirements. This section covers construction of the fully featured tester circuit of figure 8.

The Sussex Valve tester uses readily available components wherever possible and a Bill of Materials with suggested suppliers is in the appendix. This includes all the changes shown in the circuit diagram of figure 8 compared to the original circuit. Alternative components can be used with the following provisos.

Any resistors used in the Anode and Screen Grid supplies must be rated at 350V or greater.

Alternative capacitors should be of the same type and value and have the same or higher voltage rating.

The switches used for the Heater voltage selection and the Valve Base pin selection must be rated to carry the maximum heater current. It should be noted that it is not recommended to change any of the settings with the Function switch in the Leakage or Test positions as this may damage the switches.

The wiring to the valve bases and the valve pin selection must be rated to carry the maximum heater current.

The Digital Panel Meters have different sensitivities

The Anode current meter is 200mV DC full scale.

The Control Grid voltage meter is 200V DC full scale.

The gm meter is 200mV AC full scale.

The meters used in the original tester were bought from an Ebay supplier and had a built in rectifier to allow them to be powered from a 6V AC supply. Alternative meters with the same sensitivities can be used but may require an external rectifier and capacitor if these are not built in.

Note that most AC meters are set to display the RMS value when the input is a sine wave, as produced by the oscillator. Also ensure the meter is capable of accurate readings at the oscillator frequency of 1kHz.

Any number of valve bases can be fitted and should be wired in parallel with pin 1 on each base connected to the pin 1 switch, pin 2 on each base connected to the pin 2 switch etc. The design, as published, has provision for 9 pins but valve bases with more than 9 pins, e.g. the B10B base as used by valves such as the PFL200, can be accommodated by adding an extra switch for pin 10 wired as the other 9 switches.

Components for the case are not specified here as individual constructors may have a suitable case available. The case should be able to hold the transformer and the PCBs with a panel to hold all the valve holders and a front panel capable of holding all the controls and the DPMs. The appendix has pictures of completed testers to give you some idea of the variety of cases used.

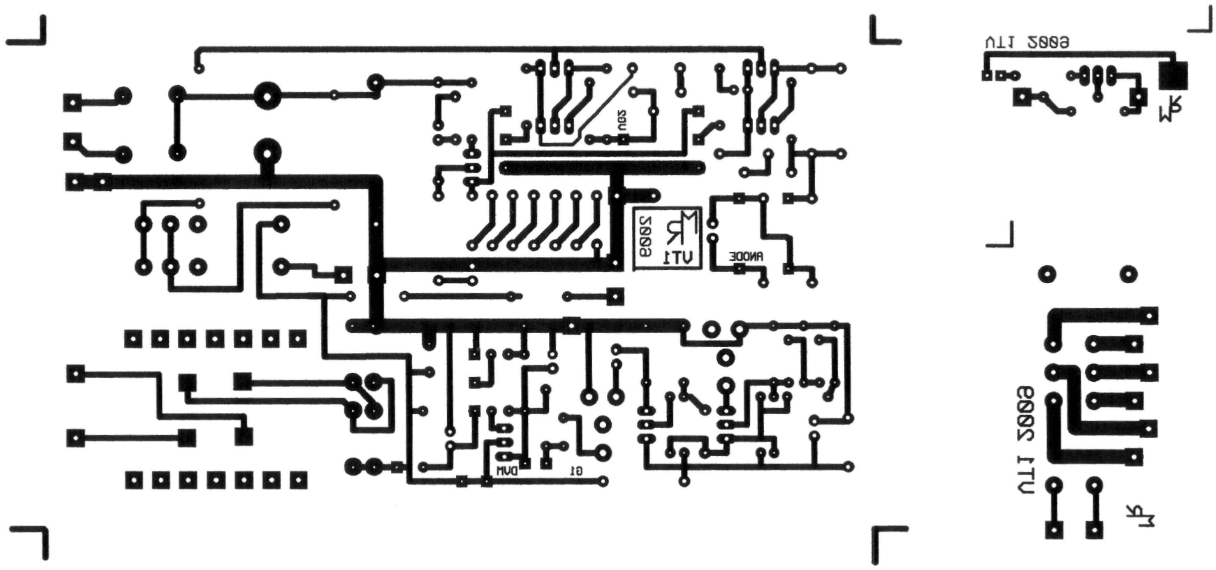
Whatever case is used it is recommended that a mains on/off switch is fitted. This can be separate or combined with an IEC mains connector and fuse FS1.

PCB - Tracking and Layout

It is recommended that the Printed Circuit Board set designed for the tester is used to ensure consistent results. However alternative boards, such as Veroboard, can be used. If using Veroboard please ensure there is sufficient clearance between the tracks in the high voltage parts of the circuit.

There are a number of boards used for the additional and modified circuit elements. It is not always practical to produce a custom PCB for these, so Veroboard can be used for these additional boards.

The PCB in figure 26 is the board designed by Mike Rowe for his original circuit and does not include the later changes. However the layouts include the modifications.



Note this is **NOT** to scale

Figure 26 - PCB Tracking. Main Board, Leakage Amplifier (top right), Heater Relay (bottom right)

The main PCB includes tracking for a mains transformer for the -45V supply. As this is incorporated in the transformer from Ed Dinning this area of the board is not populated. If you are not using the specified transformer you may need to fit a transformer on the PCB.

It is suggested that the two smaller sections of the PCB be cut from the main board and kept as a single board as this will allow the space between the two tracked areas to be used for some of the additional components.

The PCB layout is shown in figure 27 and includes the additional diodes, D1a and D2a, which are fitted between the 250V inputs from the transformer and 0V to create the bridge rectifier.

The FETs, TR2 and TR4, are mounted on a heatsink, which should be mounted next to the PCB. It is not recommended to separate the PCB and heatsink and connect the FETs with long flying leads as this could result in instability.

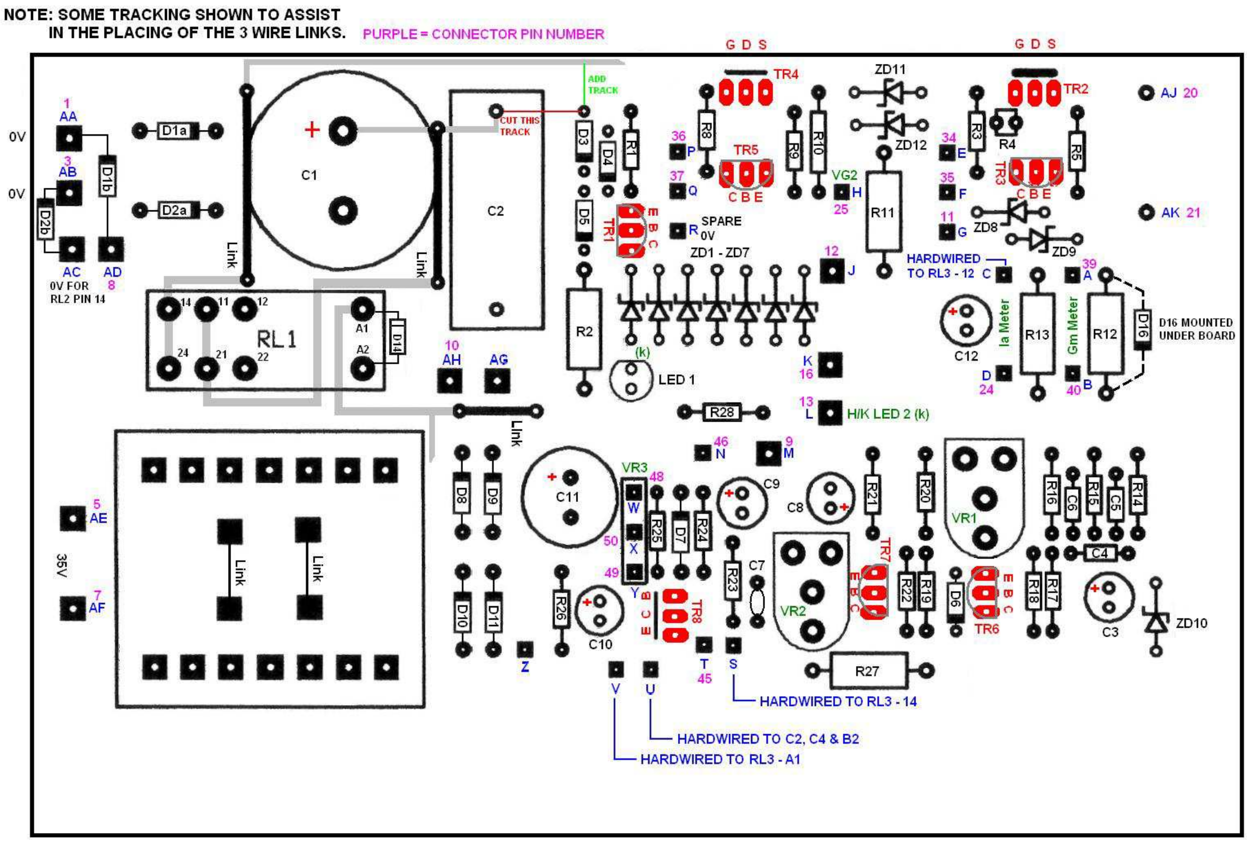


Figure 27 - Main PCB Layout (note the changes between C2 and D3)

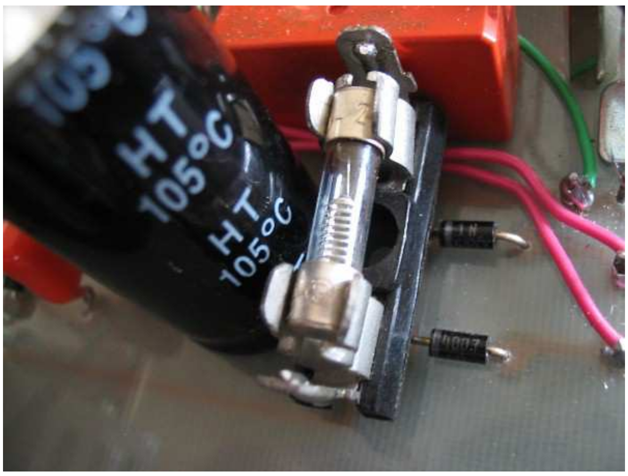


Figure 28 - HT Fuse Location

The link connecting RL1 pin 14 to the Drains of TR2 and TR4 has been replaced with an open type of fuse holder which takes a 20mm 250mA Quick Blow fuse, as shown in figure 28. This fuse could also be re-sited, if desired, to a dedicated panel mount fuse holder mounted on the rear panel of the tester case.

A circuit board tracking error exists which connects the Anode of D3 to C2(+) and which negates the power control provided by RL1. To correct for this, the track linking D3 to C2 should be cut. A new track connection for D3 Anode should be made by using a short wire link, thus connecting D3 Anode to the main HT+ line that feeds the Drains of TR2 and TR4.

A diode has been placed across R12 in an attempt to protect the AC mV meter in the event of a malfunction in the voltage control circuits. Note that this may cause anomalous gm readings with some valves. Alternative methods to protect the meter input are being investigated (page 23).

The Relay Daughter board, figure 29, contains both the Heater relay and the Leakage detector. There is also enough room to mount the Gas Test relay and the Fan supply components.

This PCB layout is modified to incorporate the modified Heater Continuity circuit shown in figure 15.

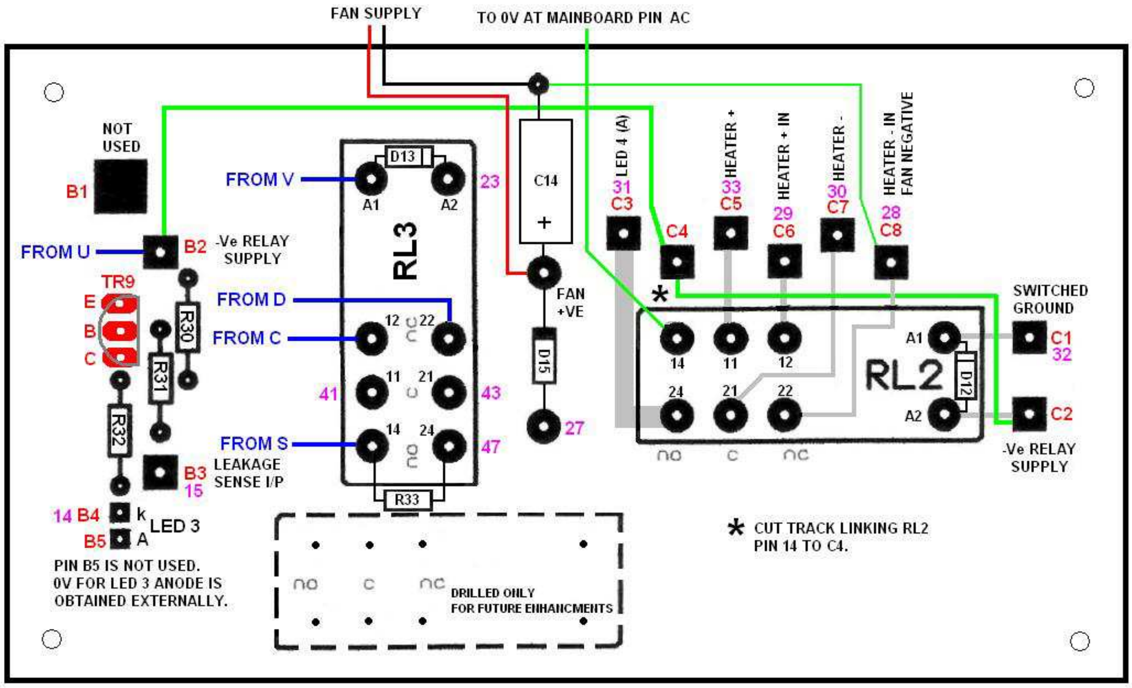


Figure 29 - Relay Daughter Board

Low Voltage Heater Board

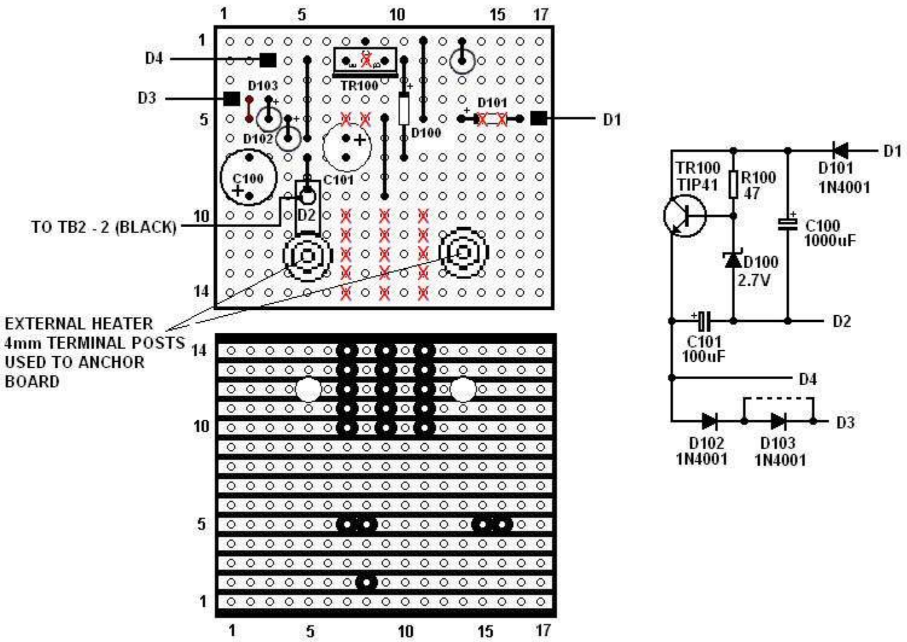


Figure 30 - Low Voltage Heater Board Layout

There is no PCB layout for the Low Voltage Heater board so this is built on Veroboard. It can be mounted on the terminal posts used for the external Heater Supply. Provision is made on the board to short out one or more of the series diodes for the 1.4V heater supply. Note that figure 30 shows two series diode whereas the circuit, figure 8, shows three. Only two need to be fitted.

Valve Bases

It is up to the individual constructor which valve bases are fitted. The more common bases such as B7G, B9A, IO and B8A are recommended but, providing there is space on the case, any valve base can be fitted. If necessary, adaptors can be made to accommodate less common types. These can be wired pin to pin to a B9A plug which is then plugged into the B9A valve base.

Details of the variety of bases available including the pin numbering details are in the appendix[4].

Wiring to Valve Bases

The wiring to the valve bases must be rated to carry the maximum current that could be drawn by the valve. The heater circuit usually draws the most current so the wiring should be rated to carry up to 3A. Because of the low signal level the Control Grid connection from the PCB to the Pin selection switches should be made with screened cable.

The bases are wired in a daisy chain fashion with pin 1 of all bases connected together, pin 2 of all bases connected together etc.

Wiring to the pins should follow the resistor colour coding to ease construction and fault finding.

Some users have reported instability when testing high gm valves. This may be due to feedback via the base wiring in conjunction with the length of the wiring. One cure for this is to fit a stopper resistor in the control grid connection to each base. However the grid is not connected to the same pin on every valve and as that pin may be used for the heater additional resistance is not advisable. The recommended alternative is to fit a ferrite bead on the wiring to each pin of each base.

Case Wiring

As there are no hard and fast rules for the case it is difficult to show the exact details for the internal layout and wiring. However the following guidelines should help when fitting the components into the case.

Before making holes for the meters, controls and connectors it is worth laying out all the case mounted components in order to optimize the layout taking into account factors such as how easy is it to see the meters while operating the controls. The pictures in the appendix show the variation in the case and construction styles.

Mount the PCBs and controls to minimize long cable runs between them. Colour coding of the cables can help when wiring up the modules, checking the wiring and fault finding.

It is suggested that the PCBs be built before the internal layout is determined to avoid any problems with PCB mounted components fouling the case or any component mounted on it.

Figure 31 shows the inter module and control wiring and figures 32 and 33 show the internal views of the front panel layout, the layout of the PCBs and transformer of Les Carpenters Sussex Tester. Note that Les used a multi way connector to connect the front panel to the PCBs and transformer. This is one suggested method of connecting the various modules and other method can be used. Details of this optional connector are in the appendix.

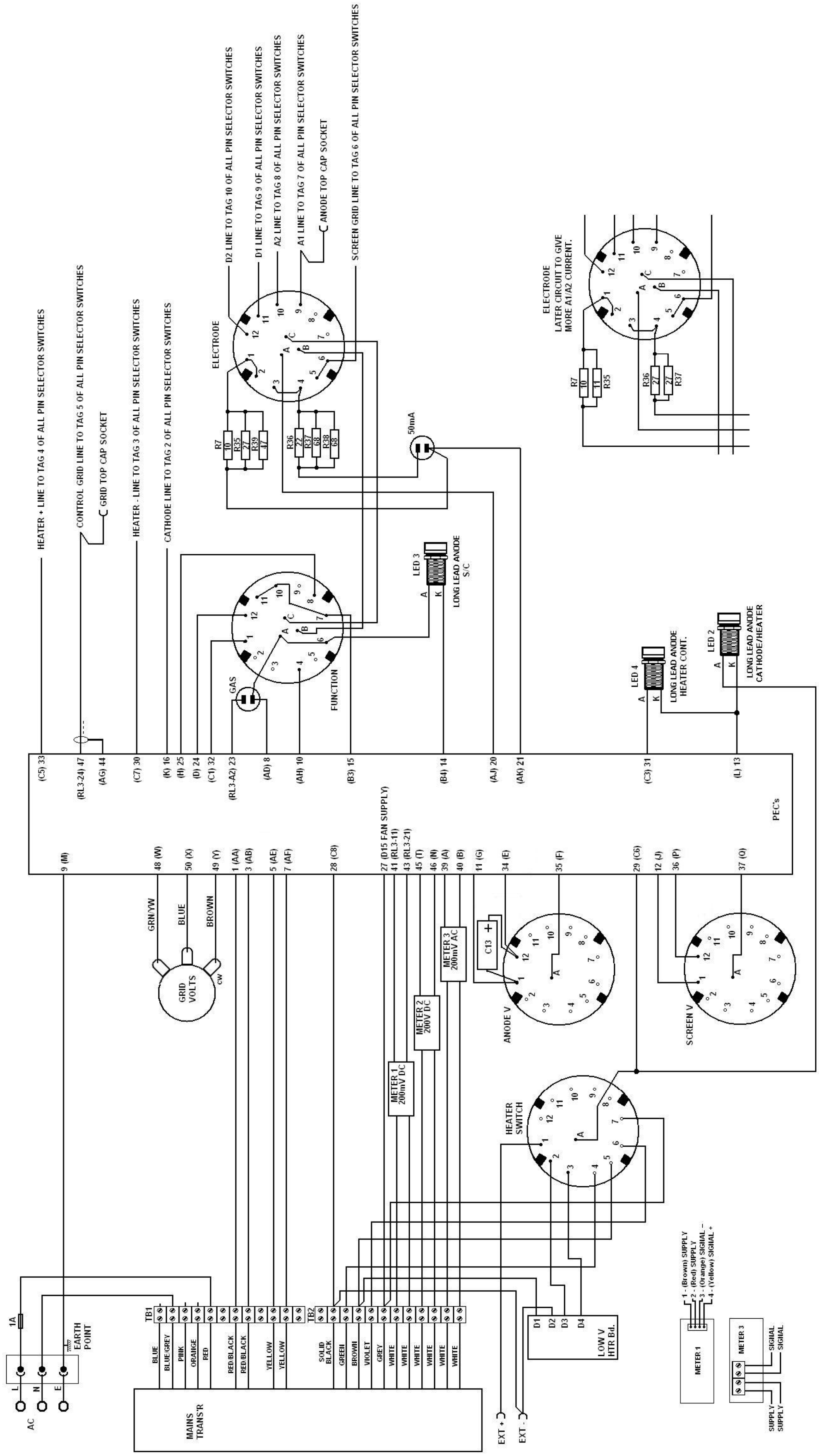


Figure 31 - Internal Wiring

Transformer Wiring

Because the custom made transformer has no tags for connections, use can be made of two 12-way terminal blocks as shown in figure 33. Terminal Block one (TB1) carries the mains input and also the HT and Control Grid/Relay supplies which are both bridge rectified on the main board. Terminal Block two (TB2) carries the heater and meter supplies. The use of connector blocks for the transformer connections can make the commissioning procedure described in the next section easier.

The circuit diagram also shows the Terminal Block connections.

TB1		TB2	
1	Primary 0V	1	Not Used
2	Primary 10V	2	Heater 0V common
3	Primary 210V	3	4V Heater Tap
4	Primary 230V	4	5V Heater Tap
5	Primary 250V	5	6·3V Heater Tap
6	Not Used (Guard)	6	12·6V Heater Tap
7	250V HT Winding	7	6V Winding for Meter 1
8	250V HT Winding	8	6V Winding for Meter 1
9	Not Used (Guard)	9	6V Winding for Meter 2
10	35V Relay/Bias Winding	10	6V Winding for Meter 2
11	35V Relay/Bias Winding	11	6V Winding for Meter 3
12	Not Used	12	6V Winding for Meter 3

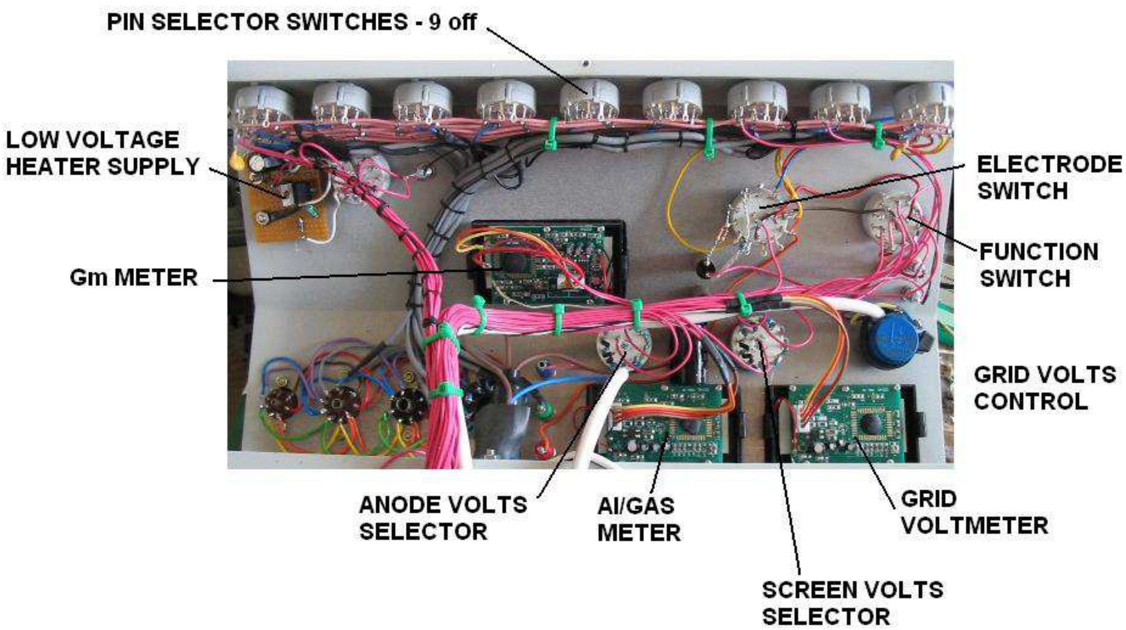


Figure 32 - Internal View of the Front Panel of Les Carpenters Sussex.

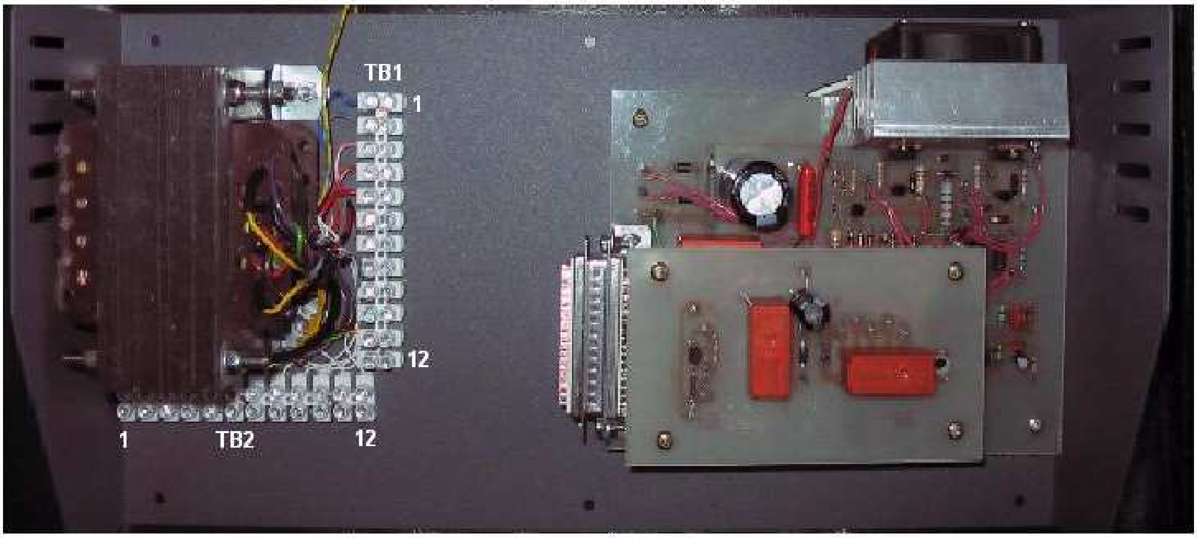
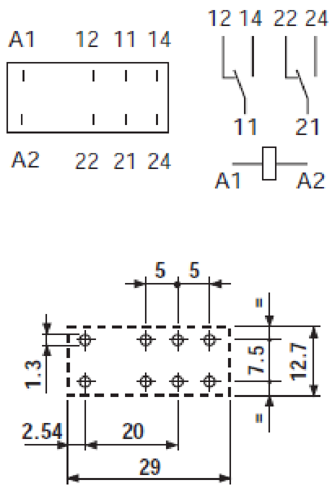


Figure 33 - PCBs and Transformer Layout Showing the Heatsink and Optional Fan

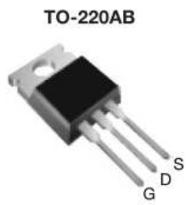
Take care when wiring the modules as it is easy to make a mistake as there are a lot of connections to make. Check each connection or group of connections before moving to the next.

Component Pin Outs

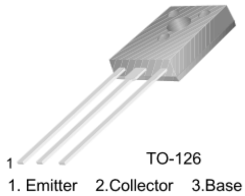
Note the difference between the BC307/237 and the MPSA42/92 transistors. If using alternative components check the pin outs especially with the transistors and relays as the PCB has been laid out for specific pin outs.



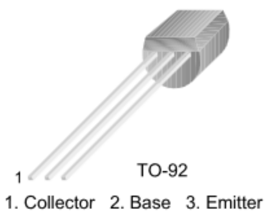
Copper side view



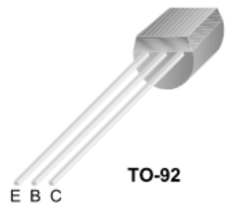
BUZ80/IRF830



MJE350 (TIP141 similar)



BC307/BC237



MPSA42/MPSA92

Relays

Transistor Pin Outs

Commissioning and Troubleshooting

Prior to commissioning the Tester visually check all the wiring and the PCBs for correct components and assembly.

Equipment Required

Multimeter	Low Voltage Power Supply	1MΩ 0.6W resistor
Oscilloscope	10kΩ 2W resistor	Known good ECC82
Variac (optional)	10Ω 1W resistor	

High voltages are present in the tester when switched on. Take care during the commissioning procedure.

It is advisable to disconnect or switch off the mains supply to the Valve Tester while setting up the test connections between each of the following checks to avoid electric shock.

Unless stated otherwise, before re-applying the mains set the Function switch to Heater Continuity.

Unless stated otherwise the Multimeter –ve connection should be connected to the Cathode Top Cap 4mm Terminal (Blue).

The commissioning procedure assumes terminal blocks are used for the connections to the mains transformer.

Mains Transformer Checks

1. Isolate the HT (TB1 – 7 and 8) and the Control Grid supply 35V (TB1 – 10 and 11) windings on mains transformer.

2. Set the Valve Pin selector switches to 000000000.

3. Apply the mains to the correct taps on mains transformer e.g. Live to 230V* (TB1-4) and Neutral to 0V (TB1-1).

   *This of course will be 120V for some other countries using the alternative transformer.

4. Measure the heater voltage between TB2-2 and TB2-5 and check it is within expected tolerances, 6.3v ±10%. Note that the voltage will be slightly high as there is no load on the transformer. If necessary try different mains transformer taps to achieve best figure.

5. Check that all three panel meters are lit and reading zero and the internal fan, if fitted, is running.

<u>Valve Base Checks</u>

1. With a Multimeter, set to resistance, connected to the Cathode Top Cap (Blue) 4mm socket, verify that it measures infinite resistance on all pins of the valve bases.

2. Set the Valve Pin selector switches to 100000000 and verify the Multimeter indicates continuity <u>only</u> on Pin 1 of all valve bases.

3. Set the Valve Pin selector switches to 010000000 and verify the Multimeter indicates continuity <u>only</u> on Pin 2 of all valve bases.

4. Set the Valve Pin selector switches to 001000000 and verify the Multimeter indicates continuity <u>only</u> on Pin 3 of all valve bases.

5. Set the Valve Pin selector switches to 000100000 and verify the Multimeter indicates continuity <u>only</u> on Pin 4 of all valve bases.

6. Set the Valve Pin selector switches to 000010000 and verify the Multimeter indicates continuity <u>only</u> on Pin 5 of all valve bases.

7. Set the Valve Pin selector switches to 000001000 and verify the Multimeter indicates continuity <u>only</u> on Pin 6 of all valve bases.

8. Set the Valve Pin selector switches to 000000100 and verify the Multimeter indicates continuity <u>only</u> on Pin 7 of all valve bases.

9. Set the Valve Pin selector switches to 000000010 and verify the Multimeter indicates continuity <u>only</u> on Pin 8 of all valve bases. (IO, B8A and B9A bases only)

10. Set the Valve Pin selector switches to 000000001 and verify the Multimeter indicates continuity <u>only</u> on Pin 9 of all valve bases. (B9A base only)

<u>Control Grid Supply Checks</u>

1. Connect the Control Grid supply 35V winding on the mains transformer to TB1 – 10 and 11.

2. Apply the mains supply to the valve tester and verify that the Control Grid voltage control can be set to provide 0 to -45V on the Grid Voltage Panel Meter.

3. Connect the Multimeter between the Cathode Top Cap 4mm Terminal (Blue) and the Control Grid Top Cap 4mm Terminal (Green). Adjust the Control Grid voltage control and verify the voltage can be varied between 0V and -45V and agrees with the Grid Voltage Panel Meter.

4. Set the Pin selector switches to 400000000 and the Function switch to Heater Continuity. Set the Multimeter to Volts and verify this negative voltage is available at Pin 1 of each valve holder with respect to the Cathode Top Cap 4mm Terminal (Blue).

5. Connect an RMS meter between the Top Cap Grid 4mm terminal (Green) and the Top Cap Cathode 4mm terminal (Blue). The RMS meter should read 100mV and may be adjusted if required by VR2 on the main board.

6. Alternatively connect an oscilloscope between the Top Cap Grid 4mm terminal (Green) and the Top Cap Cathode 4mm terminal (Blue) and adjust VR2 for a signal of 282mV peak to peak.

7. If the RMS meter does not indicate anything then it may be necessary to adjust VR1 to ensure good oscillator start up and best waveform.

Heater Supply Checks

1. Set the Pin selector switches to 200000030 and connect the Multimeter between Pins 1 (-ve) and 8 (+ve) of the Octal valve base.

2. Set the Function switch to the Leakage 1 or Leakage 2 position and verify that the heater voltages obtained agree with the setting of the Heater Voltage switch, bearing in mind that the 1·4V and 2V settings will be DC as opposed to AC for the other settings and may appear high due to no loading.

3. Connect an External Power Supply to the External Heater Terminals, set the Heater Voltage switch to External and verify that the Multimeter shows the voltage set on the Power Supply.

Anode and Screen Grid Supply Checks

1. Connect the HT winding on mains transformer to TB1 – 7 and 8.

2. Connect the Multimeter, set to Volts, to the Cathode connection of D1.

3. Apply the mains supply and confirm that the voltage rises to a maximum of approximately 340V.

4. Optionally the mains can be applied via a Variac wound up from 0V to 230V. At 230V input the Multimeter should be reading approximately 340V.

Disconnect the mains supply from the Valve Tester.

1. Connect the Multimeter to the input side of either the Anode or Screen Voltage selector switch.

2. Set the Function switch to Test.

3. Set the Electrode switch to A1.

4. Apply the mains supply to the tester and confirm that Relay RL1 operates and LED1 is lit. Confirm that the voltage is 300V ±10V.

Disconnect the mains supply from the Valve Tester.

1. Transfer the Multimeter from the Voltage selector switch and connect it to Pin 1 of the Octal Valve holder. Set the Pin selector switches to 500000000.

2. Apply the mains supply to the Valve Tester, set the Function switch to Test and check the Multimeter shows the voltage as selected by the Screen Grid Voltage switch from 0V to 300V.

3. Set the Electrode switch to A2 and verify the Screen Grid voltage is unchanged.

4. Verify the Screen Grid voltage is removed when the Electrode switch is in the D1 and D2 position.

5. Set the Pin selector switches to 600000000 and check the Multimeter shows the voltage as selected by the Anode Voltage switch from 0V to 300V only when the Electrode switch is set to A1.

6. Set the Pin selector switches to 700000000 and check the Multimeter shows the voltage as selected by the Anode Voltage switch from 0V to 300V only when the Electrode switch is set to A2.

7. Set the Pin selector switches to 800000000 and check the Multimeter shows the voltage as selected by the Anode Voltage switch from 0V to 300V only when the Electrode switch is set to D1.

8. Set the Pin selector switches to 900000000 and check the Multimeter shows the voltage as selected by the Anode Voltage switch from 0V to 300V only when the Electrode switch is set to D2.

Anode Current Meter Check

1. Connect a 10k 2W resistor in series with the Multimeter on its 100mA current range between the Cathode Top Cap 4mm terminal (Blue) and the Anode Top Cap 4mm terminal (Red).

2. Set the Anode Voltage switch to 100V.

3. Apply the mains supply to the Valve Tester, set the Function switch to Test and the Electrode switch to A1 and check the Anode current meter shows approximately 10mA. Check that the reading on the Multimeter and the Anode current meter agree.

Disconnect the mains supply from the Valve Tester.

4. Remove the resistor.

Heater Continuity Check

1. Set the Function switch to Heater Continuity.

2. Set the Pin selector switches to 200000030 and connect a 10Ω resistor between Pins 1 and 8 of the Octal valve base.

3. Apply the mains supply to the Valve Tester and check that the Heater Continuity LED is lit.

Disconnect the mains supply from the Valve Tester.

4. Remove the resistor.

Leakage Indicator Check

1. Set the Pin selector switches to 651000000 and connect a 10kΩ resistor between Pins 1 and 2 of the Octal valve base.

2. Set the Electrode switch to A1.

3. Apply the mains supply to the Valve Tester.

4. Set the Function switch to Leakage 1 and check that the leakage LED is lit.

5. Connect the 10kΩ resistor between Pins 1 and 3 of the Octal valve base.

6. Set the Function switch to Leakage 2 and check that the leakage LED is lit.

7. Connect the 10kΩ resistor between Pins 2 and 3 of the Octal valve base and check that the leakage LED is lit.

Disconnect the mains supply from the Valve Tester.

8. Remove the resistor.

Heater Cathode Insulation Indicator Check

1. Set the Pin selector switches to 310000000 and connect a 10kΩ resistor between pins 1 and 2 of the Octal valve base.

2. Apply the mains supply to the Valve Tester.

3. Set the Function switch to Leakage 1 and check that the Heater Cathode Insulation LED is lit.

Disconnect the mains supply from the Valve Tester.

4. Remove the resistor.

Gas Test Check

1. Set the Pin selector switches to 000000000 and connect a 1MΩ resistor between the Top Cap Grid 4mm terminal (Green) and the Top Cap Cathode 4mm terminal (Blue).

2. Set the Control Grid voltage to -10v.

3. Press the Gas Test button and verify that the Anode current/Grid current meter shows 10µA (10mV).

4. Remove the resistor.

Gm Check

Once all these checks have been completed successfully the gm meter can be checked. This requires the use of a known working valve and uses the same procedure as for testing the valve. An ECC82 is suggested although other similar types can be used. A NOS valve should be satisfactory.

1. Set the Function switch to Heater Continuity and the Electrode switch to A1.
2. Set the Valve Pin selector switches on lower front panel to suit the valve used, **741226413** should be used for an ECC82.
3. Set the Heater Voltage switch to the 6·3V position.
4. Set the Control Grid voltage to -8.5V using the Grid V control.
5. Set the Anode Voltage switch to the 250V position and the Screen Grid Voltage switch to the 0V position.
6. Insert the valve into the B9A valve base and verify that the heater continuity LED is lit.
7. Check the Heater Cathode Insulation LED is extinguished.
8. Set the Function switch to the Leakage 1 position then the Leakage 2 position, checking that the Inter Electrode Leakage LED remains extinguished in both positions.
9. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!
10. Allow the valve to reach operating its temperature. Then set the Function switch to the Test position.
11. Check the Anode current is approximately 10.5mA and the gm meter shows approximately 2.2.
12. Set the Function switch back to the Heater Continuity position. Note that this will turn the heater off.
13. Set the Electrode switch to A2 position, which is the other half of the double Triode.
14. Set the Function switch to the Leakage 1 position then the Leakage 2 position, checking that the Inter Electrode Leakage LED remains extinguished in both positions.
15. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!
16. Allow the valve to reach its operating temperature. Then set the Function switch to the Test position.
17. Check the Anode current is approximately 10.5mA and the gm meter shows approximately 2.2.
18. Set the Function switch to the Heater Continuity position and allow the valve to cool before removal.

That completes the commissioning procedure for the Sussex Valve Tester. If any of the tests /checks were not passed the faults must be rectified before proceeding to test valves. In cases of difficult or obscure faults a mention on the UKVRRR forum[1] can usually elicit suggestions to help resolve the problem.

Trouble Shooting Guide

General

Check the PCBs for any solder splashes and check the wiring for any bad joints.

If using Veroboard check the track breaks have been made correctly.

Check polarized components e.g. diodes, electrolytic capacitors, transistors and LEDs, have been inserted correctly,

Note all symptoms which may point to one area of the tester. E.g. Relays not operating and no grid voltage may be a fault with the -45v supply.

Symptoms	Possible cause
No operation at all.	Check the mains fuse and mains lead.
No HT and LED1 not illuminated in Test position.	Check FS2. Check relay RL1 is operating.
Anode or Screen Grid supply high and uncontrollable.	Check FETs TR2/TR4 for Drain to Source short circuit. Check the voltage selection switch connection to 0V.
Anode Current Meter reading is different to multimeter reading during commissioning.	Check the value of R13. If the reading is too high reduce the value of R13 by fitting parallel resistors. If the reading is too low increase the value of R13 by fitting resistors in series.
Anode current reading too high.	Check the sensing resistor. May have gone high especially after an overload.
Relays not operating. Heater continuity not operating. Heater Cathode Insulation indicator not operating. No Control Grid voltage. No AC signal on control Grid. Leakage Test indicator not working.	Check the 45v supply across C11.
No AC signal on control Grid.	Check the output of oscillator. Adjust VR1 if necessary. Check the setting of VR2.
Control Grid voltage not controllable.	Check TR8. Check connections to VR3.
Intermittent operation when testing valve.	Check the valve base for loose or faulty pins.
Leakage Test indicator not working.	Check TR9 and associated resistors.
Gas Test not operating.	Check RL3.
Gm meter not reading during commissioning.	Check R12. Check connections to meter. Check using a different test valve.
Gm meter reading incorrectly when testing a valve.	Disconnect D16 and retry. Check R12.

Operating the Sussex Valve Tester

The tester can be used in two ways, the principal use being to check valves by testing them under specific conditions and comparing the results with the published values and the secondary use being to generate characteristic plots, similar to figures 2 & 3 in the theory section.

It is not intended for continuous operation and is therefore not suitable for burning in valves. For burning in valves a specialised rig should be used.

Figure 34 - Front Panel View (Les Carpenters Sussex Tester)

The Controls

1. Valve Pin switches. Each pin of the valve bases is given an independent switch which may be set to the required supply.

2. Heater Cathode Insulation indicator, which in normal circumstances should remain extinguished unless there is a heater cathode leak in an indirectly heated valve*.

3. External Heater Terminals for the application of an external heater voltage not provided by the Sussex Valve Tester. Blue being the –ve terminal and Yellow the +ve terminal.

4. Heater Voltage switch.

5. The Valve Bases. Comprising B7G, B9A, B8A and International Octal bases. Other valve bases may be fitted or an adaptor used to test valve with other bases.

6. Top Cap connectors allowing valve top caps to be connected to the Anode (Red), Grid (Green) or Cathode (Blue) connections of the tester by way of a plug/crocodile clip lead.

7. Anode Voltage selector switch.

8. Anode Current meter (mA). Also doubles as the grid current meter during a Gas Test.

9. Screen Grid Voltage selector. Gives the same ranges as the Anode Voltage selector switch (7).

10. Control Grid Voltage meter. Indicates the negative bias voltage applied to the valve under test.

11. Multi-turn Control Grid Voltage control giving 0 to -45V.

12. Heater Continuity LED. This should illuminate when the Function switch is in the Heater Continuity position and a valve is inserted with the heaters correctly defined and set on the pin selector switches.

13. Inter Electrode short LED. This should remain extinguished throughout tests.

14. Function switch. Selects the test to be applied to the valve.

15. Electrode switch. Selects which of the Anode connections the Anode supply connects to.

16. Gm meter giving direct reading of Mutual Conductance as ma/V.

17. Gas Test button to check integrity of valves vacuum or internal presence of gas using the Anode current meter. In this case a meter indication of 1mA indicates a Grid current of 1µA.

18. 50mA Test button. When using D1 or D2 the current is limited to 5mA to protect signal diodes. However, when testing rectifiers used in power supplies, the button provides a limited current of 50mA.

* The only other time when it would illuminate is when testing directly heated valves, these must have one side of their filament connected to the Cathode line for Anode current to flow. When testing directly heated valves e.g. DF96, it is necessary to apply an external jumper between both Blue terminals (Top Cap Cathode connection to External Heater –ve connection).

Test Procedures

Prior to testing a valve, ensure that

1. The Function switch is set to Heater Continuity.

2. The Electrode switch is set to A1.

To Test a Valve

With the Tester connected to the mains and switched on.

1. Set the Heater voltage to suit the Valve Under Test. Use an external supply connected to the External Heater terminals if the voltage is not available from the tester. Take note of the polarity if testing a directly heated valve.

2. If testing a directly heated valve link the External Heater –ve terminal (Blue) to the Cathode terminal (Blue) next to the valve bases.

3. Set the Pin Switches for the valve using data from the AVO Handbook for the CT160[3].

4. Set the Control Grid, Anode and Screen Grid (if appropriate) voltages to the values specified in the AVO handbook. Note that the control grid voltage is actually a negative voltage.

5. Insert the valve to be tested into the appropriate valve base and verify that the Heater Continuity LED is lit. If the LED does not light the heater is open circuit.

6. Check that the Heater Cathode Insulation LED is extinguished. This should be checked as the test proceeds in case breakdown occurs. Note that this LED will be lit when testing directly heated valves.

7. Set the Function switch to the Leakage 1 position then the Leakage 2 position. Note that the heater should light up.

8. Check that the Inter Electrode Leakage LED remains extinguished in both positions.

9. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!

10. Allow the valve to reach its operating temperature. Then set the Function switch to the Test position. The Anode current and gm meters should then indicate the Anode current and gm respectively. These should be compared with the figures given in the AVO handbook and if they are within approximately 50% of the published figures the valve can be considered good[*].

11. If required, a check for the presence of gas in the valve can be made by pressing the Gas Test button and noting the reading on the AI/GAS meter. As previously stated, 1mA indicates a Grid current of 1µA.

12. Set the Function switch to Heater Continuity and allow the valve to cool before removal.

Do not leave the valve under test for longer than necessary especially higher power valves as this may damage the tester.

Never change the Heater Voltage, Pin Switch or Electrode settings with the Function Switch in the Leakage 1, Leakage 2 or Test positions as this may damage the tester.

* The anode current and gm are subject to a tolerance. NOS valves should read close to the manufacturer's specified values but used valves will probably read lower values. It is up to the user to decide if the valve is acceptable. Any valve which gives a reading that is significantly below the specified value is probably unusable.

Examples

1) Testing an EL34 valve

1. Set the Function switch to Heater Continuity.

2. Set the Electrode switch to A1.

The remaining switches are set depending on the valve parameters. The data for an EL34 is first found in the AVO Handbook for the CT160.

VALVE TYPE	VCM163 only		VCM.s Mk 1-4 incl and CT/VT 160		Vf	Vg1	Va	Vg2	Ia mA	gm mA/V ↑Ra MΩ	BASE	TYPE
	SELECTOR SWITCH	TOP CAP	SELECTOR SWITCH	TOP CAP								
EL34	128 740 310 0000	00	126 540 310		6	13.5	250	250	75	11	A08	P

AVO Handbook EL34 settings. Ignore the settings for the VCM163.

1. Set the Valve Pin selector switches to **126540310.**

2. Set the Heater Voltage switch to the 6·3V position.

3. Set the Control Grid voltage to -13·5V using the Grid V control.

4. Set the Anode Voltage switch to the 250V position.

5. Set the Screen Grid Voltage switch to the 250V position.

6. Insert the valve to be tested into the International Octal valve base and verify that the heater continuity LED is lit.

7. Check the Heater Cathode Insulation LED is extinguished.

8. Set the Function switch to the Leakage 1 position then the Leakage 2 position, checking that the Inter Electrode Leakage LED remains extinguished in both positions.

9. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!

10. Allow the valve to reach its operating temperature. Then set the Function switch to the Test position.

11. From the given AVO Handbook data figures, check the Anode current is approximately 75mA and the gm meter shows approximately 11.

12. If required, a check for the presence of gas in the valve can be made by pressing the Gas Test button and noting the reading on the AI/GAS meter. As previously stated, 1mA indicates a Grid current of 1µA.

13. Set the Function switch to Heater Continuity and allow the valve to cool before removal.

2) Testing a double Triode valve such as the ECC83

1. Set the Function switch to Heater Continuity.

2. Set the Electrode switch to A1.

The remaining switches are set depending on the valve parameters. The data for an ECC83 is first found in the AVO Handbook for the CT160.

VALVE TYPE	VCM163 only		VCM.s Mk 1-4 incl and CT/VT 160		Vf	Vg1	Va	Vg2	Ia mA	gm mA/V †Ra MΩ	BASE	TYPE
	SELECTOR SWITCH	TOP CAP	SELECTOR SWITCH	TOP CAP								
ECC82	851 228 413 0000	00	741 226 413		6	8.5	250		10.5	2.2	B9A	TT
ECC83	851 228 413 0000	00	741 226 413		6	2	250		1.2	1.6	B9A	TT

AVO Handbook ECC83 settings. Once again, ignore the settings for the VCM163.

1. Set the Valve Pin selector switches on lower front panel to **741226413.**

2. Set the Heater Voltage switch to the 6·3V position.

3. Set the Control Grid voltage to -2V using the Grid V control.

4. Set the Anode Voltage switch to the 250V position.

5. Set the Screen Grid Voltage switch to the 0V position.

6. Insert the valve to be tested into the B9A valve base and verify that the heater continuity LED is lit.

7. Check the Heater Cathode Insulation LED is extinguished.

8. Set the Function switch to the Leakage 1 position then the Leakage 2 position, checking that the Inter Electrode Leakage LED remains extinguished in both positions.

9. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!

10. Allow the valve to reach operating its temperature. Then set the Function switch to the Test position.

11. From the given AVO Handbook data figures, check the Anode current is approximately 1·2mA and the gm meter shows approximately 1·6.

12. If required, a check for the presence of gas in the valve can be made by pressing the Gas Test button and noting the reading on the AI/GAS meter. As previously stated, 1mA indicates a Grid current of 1µA.

13. Set the Function switch back to the Heater Continuity position. Note that this will turn the heater off.

14. Set the Electrode switch to A2 position, which is the other half of the double Triode.

15. Set the Function switch to the Leakage 1 position then the Leakage 2 position, checking that the Inter Electrode Leakage LED remains extinguished in both positions.

16. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!

17. Allow the valve to reach its operating temperature. Then set the Function switch to the Test position.

18. From the given AVO Handbook data figures, check the Anode current is approximately 1·2mA and the gm meter shows approximately 1·6.

19. If required, a check for the presence of gas in the valve can be made by pressing the Gas Test button and noting the reading on the AI/GAS meter. As previously stated, 1mA indicates a Grid current of 1µA.

20. Set the Function switch to the Heater Continuity position and allow the valve to cool before removal.

<u>To Measure the Characteristics of a Valve</u>

Prior to plotting the characteristics, ensure that

1. The Function switch is set to Heater Continuity.

2. The Electrode switch is set to A1.

With the Tester connected to the mains and switched on.

1. Set the Heater voltage for the Valve Under Test. Use an external supply connected to the External Heater terminals if the voltage is not available from the tester. Take note of the polarity if testing a directly heated valve.

2. If testing a directly heated valve link the External Heater –ve terminal (Blue) to the Cathode terminal (Blue) next to the valve bases.

3. Set the Pin Switches for the valve using data from the AVO Handbook for the CT160[3].

4. Set the Control Grid voltage to approximately -12V for small signal valves or approximately -20V for higher power valves, sufficient that no or very little anode current will flow. Set the Anode and Screen Grid (if appropriate) voltages to typically 250V for indirectly heated valves or 90V for battery valves such as the DF96.

5. Insert the valve to be tested into the appropriate valve base and verify that the Heater Continuity LED is lit.

6. Check that the Cathode/Heater leak LED is extinguished. This should be checked as the test proceeds in case breakdown occurs. Note that this LED will be lit when testing directly heated valves.

7. Set the Function switch to the Leakage 1 position then the Leakage 2 position. Note that the heater should light up.

8. Check that the Inter Electrode Leakage LED remains extinguished.

9. IF THIS LED ILLUMINATES DO NOT CONTINUE – THE VALVE HAS AN INTERNAL SHORT!

10. Allow the valve to reach operating temperature. Then set the Function switch to the Test position. The Anode current meter may indicate a small current. The gm meter reading can be ignored.

11. Adjust the grid voltage in 1v steps to 0V. Record the Control Grid voltage and the Anode current.

12. Repeat at different Anode and Screen Grid voltages. Generally the Screen Grid voltage will be the same as the Anode voltage. At low Control Grid voltages keep an eye on the Anode current to ensure it does not exceed the maximum anode current of the valve or the Tester.

Once you've recorded the Anode current at several different Anode and Control Grid voltages, transfer the currents and voltage into a spreadsheet and, using the chart function, plot the Anode current vs Anode voltage at different Control Grid voltages and the Anode current vs Control Grid voltage at different anode voltages.

Measurements made on an ECC82 and the resulting plots are shown in Figure 36 in the appendix.

Appendix

Bill of Materials

Each board has its own Bill of Materials with a separate list of all the components required.

Main Board

Resistors

All resistors 0.6W metal film unless stated otherwise

R1, R21, R26	470R	**R10**	22R
R2	120k 2W Carbon Film	**R11**	470k
R3, R8	1M	**R12**	10R
R4, R14, R15, R18, R19, R20, R22, R23, R24, R28	10k	**R13**	1R
		R16	100k
		R17	300k
		R25	1k
R5, R9	100R	**R27**	2k7
R6	120R		
VR1	220R Preset	**VR2**	4k7 Preset

Capacitors

C1	100µF 400V Electrolytic	**C7**	100n 63V Polyester
C2	220nF 630V Polyester	**C8, C9, C12**	1µF 63V Electrolytic
C3	47µF 25V Electrolytic	**C10**	100µF 63V Electrolytic
C4, C5, C6	6n8 100V Polyester	**C11**	470µF 63V Electrolytic

Diodes

D1, D1a, D2, D2a, D7, D8, D9, D10, D11, D14, D16*	1N4007	**ZD1, ZD2, ZD3, ZD4, ZD5, ZD6**	BZX85C47
		ZD7,ZD8, ZD9, ZD11, ZD12	BZX85C15
D3, D4, D5, D6	1N4148	**ZD10**	BZX85C8V2

Transistors

TR1	MPSA92	**TR6, TR7**	BC307
TR2, TR4	BUZ80 or IRF830	**TR8**	MJE350
TR3, TR5	MPSA42		

Miscellaneous

FS2	250mA Quick blow	**RL1**	8A DPDT 48V
Printed Circuit board			

*See page 23

Low Heater Voltage Board

Resistors
All resistors 0.6W metal film unless stated otherwise

R100	47R		

Capacitors

C100	1000µF 25V Electrolytic	**C101**	100µF 63V Electrolytic

Diodes

D101, D102, D103, D104	1N4007	**ZD100**	2V7

Transistors

TR100	TIP41		

Miscellaneous
Veroboard

Heater, Leakage, Gas Test and Fan Supply Board

All resistors 0.6W metal film unless stated otherwise

Heater Relay

D12	1N4007	**RL2**	8A DPDT 48V

Leakage Detector

R30	820k	R32	10k
R31	1k		
TR9	BC237		

Gas Test Relay

R33	1k	**RL3**	8A DPDT 48V
D13	1N4007		

Fan Supply (optional)

C14	100µF 63V Electrolytic	**D15**	1N4007

Miscellaneous
Printed Circuit board

Case Components. The following components are fitted to the case.

All resistors 0.6W metal film unless stated otherwise

Anode Voltage Selector

15k	5 off	**150k**	2 off
75k*	7 off		

C13 22 µF 400V Electrolytic

SP 12 Way Rotary Switch MBB

Screen Grid Voltage Selector

15k	5 off	**150k**	2 off
75k*	7 off		

SP 12 Way Rotary Switch MBB

*An alternative for each 75k resistor is two 150k resistors in parallel

Control Grid Voltage Control

VR3 50k Multiturn

Function Switch

3P 4 Way Rotary Switch BBM

Electrode Switch

3P 4 Way Rotary Switch BBM

Heater Voltage Select

1P 12 Way Rotary Switch BBM (Only 7 ways are used)

Pin Select Switches

SP 12 Way Rotary Switch BBM 9 off

Push Button Switches

SPST Momentary push switch 2 off Gas Test, 50mA Test

LEDs

LED 1, LED 4	Standard 5mm Green LED	HT on, Heater Continuity
LED 2, LED 3	Low Current Red LED	HK S/C, Leakage
	LED Mounting bezels	4 off

Transformer

Custom transformer from Ed Dinning. 230v or 115v primary. 6 secondaries

Panel Meters

M1	200V DC	Grid Volts
M2	200mV DC	Anode current/Gas test
M3	200mV AC	Gm

The case is not specified in detail as individual constructors are free to use whatever they have available and customize the tester to suit their own requirements. The following components are down to the individual constructors preferences.

Terminals

4mm Terminal Post - Blue	Ext Heater -ve
4mm Terminal Post - Yellow	Ext Heater +ve
4mm Socket – Red	Top Cap - Anode
4mm Socket – Blue	Top Cap -Cathode
4mm Socket – Green	Top Cap -Grid

Control knobs	15	To suit switches and controls	
Ferrite beads	32	(Rapid Electronics 23-0730)	One for each valve base pin.
Valve bases		To suit users requirements. B7G, B9A, IO and B8A suggested.	
Connector blocks	2	12 way 6A	
Mains connector **Mains fuse & holder** **Mains switch**		These three items can be separate items of can be one combined into one item.	
Wire - assorted colours		Rated at 3A	
Fan for heatsink		12V type to suit heatsink	

To allow constructors to purchase all components together and possibly take advantage of price breaks for larger quantities the table below shows a full list of the main components. Provided they meet the value and rating individual constructors are free to source components from any supplier. Suggested suppliers are Rapid Electronics, Farnell, RS Components or CPC. For some of the more specialised parts a supplier and part number are given.

Circuit Designator	Quantity	Value	Rating/type	Notes
Resistors				
R1, R21, R26	3	470R	0.6W metal film	
R2	1	120k	2W carbon film	
R3, R8	2	1M	0.6W metal film	
R4, R14, R15, R18, R19, R20, R22, R23, R24, R28, R29, R32	12	10K	0.6W metal film	
R5, R9	2	100R	0.6W metal film	
R6	1	120R	0.6W metal film	
R7, R12	3	10R	0.6W metal film	
R10	1	22R	0.6W metal film	
R11	1	470k	0.6W metal film	
R13	1	1R	0.6W metal film	
R16	1	100k	0.6W metal film	

Circuit Designator	Quantity	Value	Rating/type	Notes
R17	1	300k	0.6W metal film	
R25, R31, R33	3	1k	0.6W metal film	
R27	1	2k7	0.6W metal film	
R30	1	820k	0.6W metal film	
R35 (early design)	1	27R	0.6W metal film	
R35 (later design)	1	11R	0.6W metal film	R35 – R39
R36 (early design)	1	22R	0.6W metal film	See **Increased Anode**
R36 (later design)	1	27R	0.6W metal film	**Current Limit** note on
R37 (early design)	1	68R	0.6W metal film	page 20.
R37 (later design)	1	27R	0.6W metal film	
R38 (deleted on later design)	1	68R	0.6W metal film	Use later design values for higher current
R39 (deleted on later design), R100	2	47R	0.6W metal film	limit.
Voltage selector switches	10	15k	0.6W metal film	
Voltage selector switches	4	150k	0.6W metal film	
Voltage selector switches	14	75k	0.6W metal film	Alternatively use 28x 150k*
VR1	1	220R	Preset	
VR2	1	4k7	Preset	
VR3	1	50k	Multi-turn	Rapid 65-1060
Capacitors				
C1	1	100uF 400V	Electrolytic	
C2	1	220nF 630V	Polyester	
C3	1	47uF 63V	Electrolytic	
C4, C5, C6	3	6.8nF 100V	Polyester	
C7	1	100nF 63V	Polyester	
C8, C9, C12	3	1uF 63V	Electrolytic	
C10, C14	1	100uf 63V	Electrolytic	
C11	1	470uF 63V	Electrolytic	
C13	1	22uF 400V	Electrolytic	
C100	1	1000uF 16V	Electrolytic	
C101	1	100uF 16V	Electrolytic	
Semiconductors				
D1, D1a, D2, D2a, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D101, D102, D103, D104	18	1N4007		
D3, D4, D5, D6	4	1N4148		
ZD1 -ZD6 (47V 1W Zener)	6	BZX85C47		alternative 1N4756A
ZD7 - ZD9, ZD11, ZD12 (15V 1W Zener)	5	BZX85C15		alternative 1N4744A
ZD10 (8V2 1W Zener	1	BZX85C8V2		alternative 1N4738A
ZD100 (2V7 1W Zener	1	BZX85C2V7		

Circuit Designator	Quantity	Value	Rating/type	Notes
TR1	1	MPSA92		
TR2, TR4	2	IRF 830		Alternative to BUZ80
TR3, TR5	2	MPSA42		
TR6, TR7	2	BC307		
TR8	1	MJE350		
TR9	1	BC237		
TR100	1	TIP41A		
Leds				
LED 1, LED 4	2		5mm Green	Rapid 56-0205
LED 2, LED 3	2		Low Current Red	Rapid 56-0430
LED Panel Mount	4			Rapid 55-0265
Panel Meters				
M1	1	200V DC		
M2	1	200mV DC		
M3	1	200mV AC		
Switches				
Anode/G2 Voltage	2	1P 12W MBB	LORLIN CK1034**	Rapid 79-0100
Valve Pin Selector	9	1P 12W BBM	LORLIN CK1024**	Rapid 79-0220
Heater Voltage	1	1P 12W BBM	LORLIN CK1024**	Rapid 79-0220
Function/Electrode	2	3P 4W BBM	LORLIN CK1026**	Rapid 79-0222
Gas Test/ 50mA Diode	2	Push to make		
Relays				
RL1, RL2,RL3	3	48V DPCO 8A		
Transformer				
Custom made	1			Ed Dinning
FS1 – 2A A/S 20mm	1			
FS2 – 250mA QB	1			
Miscellaneous hardware				
Fuse holder for FS2	20mm open fuse holder or panel mounted			
Fuse holder for FS1 Mains connector Mains switch	IEC type	Fuse, switch and mains connector can be combined into one unit		
Heatsink	1	To suit case and fit TR2 and TR4		
Fan	1	12v type to suit heatsink		
Terminal block	2	12W 6A	RS 4649867	
Control knobs	15	To suit switches and controls		
4mm Terminal Post - Yellow	1			External Heater +ve
4mm Terminal Post - Blue	1			External Heater -ve

Circuit Designator	Quantity	Value	Rating/type	Notes
4mm Socket – Red	1			Top Cap - Anode
4mm Socket – Blue	1			Top Cap - Cathode
4mm Socket – Green	1			Top Cap - Control Grid
4mm Plug - Red	1			
4mm Plug - Blue	1			For connecting to the top caps
4mm Plug - Green	1			
Crocodile clip - insulated	3			
Wire	As required multi colours rated at 3A			
Valve bases				
B7G	1	Other valve bases can be added to suit individual requirements subject to sufficient space being available on the valve base panel. Alternatively an adaptor can be made for additional valve bases, figure 37.		
B9A	1			
B8A	1			
IO	1			
Ferrite Beads	One bead for each valve base pin. (Rapid 23-0730)			

*The voltage section switch requires 7off 75k resistors. Each resistor can be either a single 75k resistor or two 150k resistors in parallel.

**The Lorlin switches are available from Farnell.

The case is not specified here to allow constructors to use a case which best suits their requirements. The case used by Les Carpenter was a Deltron 5190920 (350 x 180 x 100/50 mm) RS232-774.

PCB

The PCB is available from Martin. As the boards are made in batches please contact him via the UKVRRR forum (G8UWM-Mild Martin) or by email g8uwm@hotmail.com for the current availability.

Digital Panel Meters

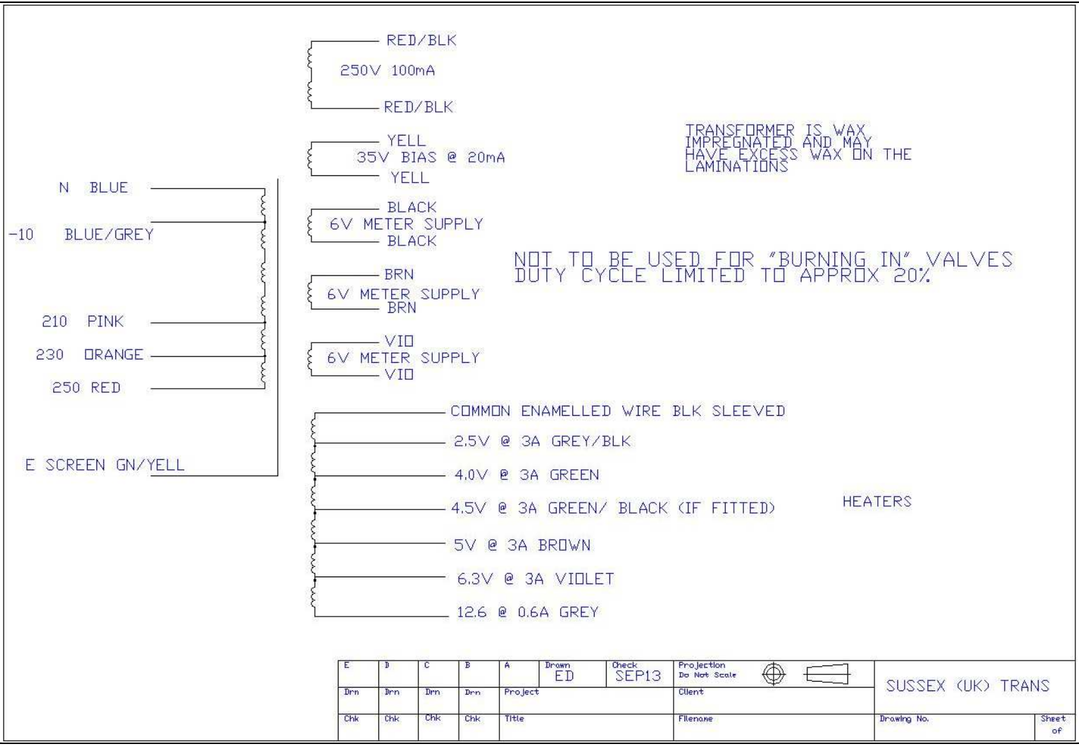
The DPMs for the original were obtained from an Ebay supplier, giorgio11185 (email the seller to get combined shipping).

An alternative Ebay supplier is

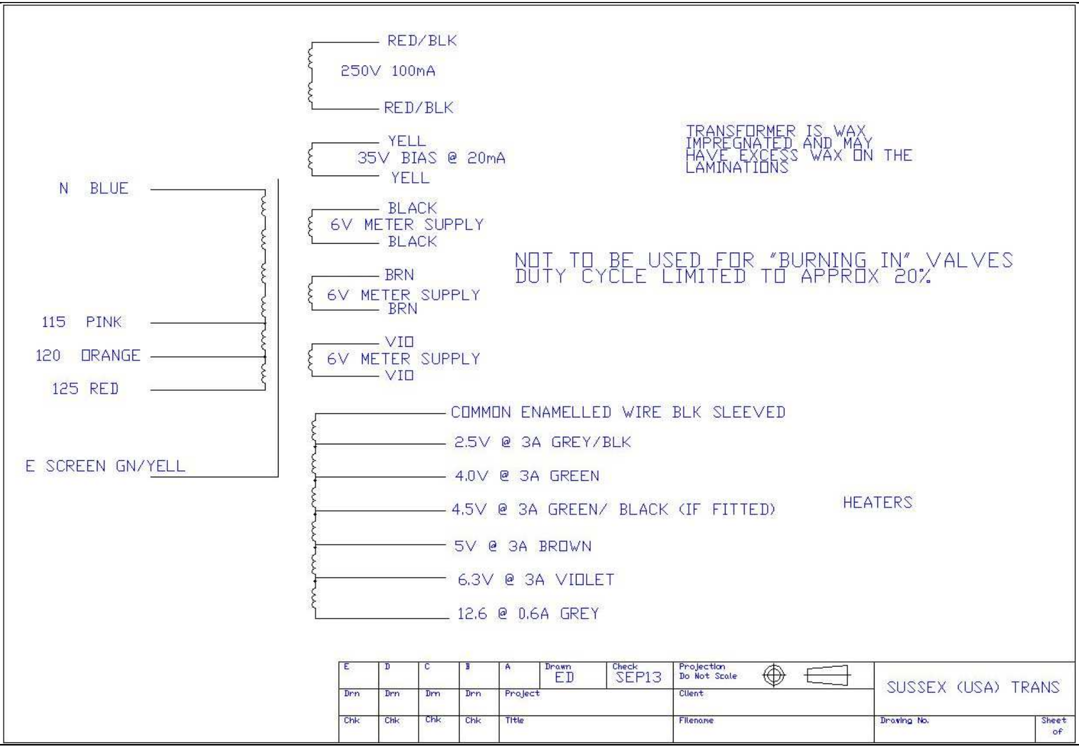
http://shop.accessory4you.com/05-chanpin/p-002.asp?styleid=51&cp_id=2

Or do a search on Ebay for "Blue LCD Meters".

Transformer Specification



UK (230v) version



US (120v) version

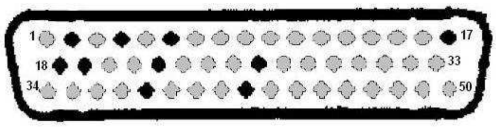
The transformer is wound to order and is available from Ed Dinning. Contact via the UKVRRR forum or by email ed_dinning@yahoo.co.uk .

On request the transformer can be wound with an extra 6v winding for an additional voltmeter.

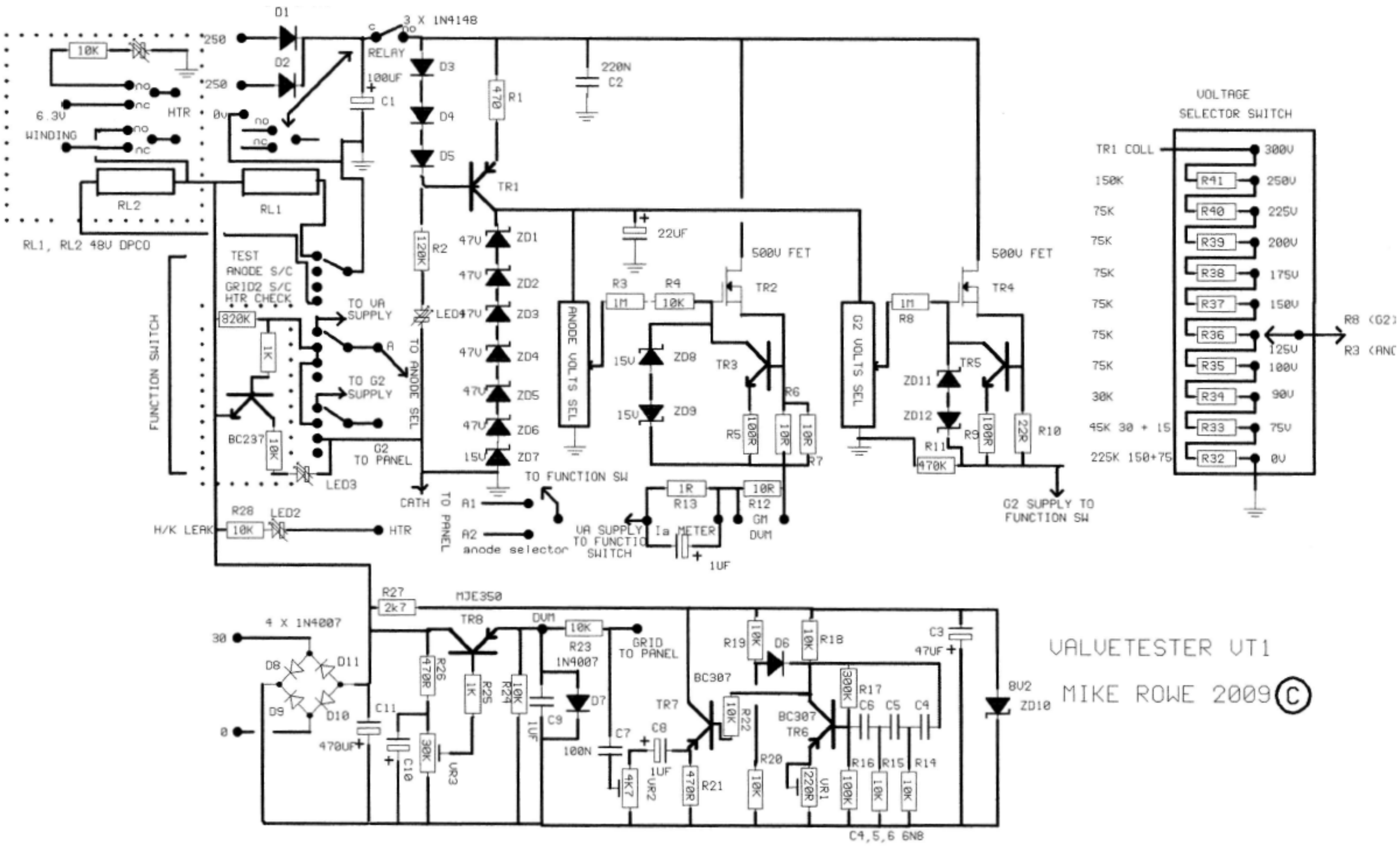
Optional Connector Between Boards and Front Panel

In his version of the Sussex, Les Carpenter fitted a 50W Cannon connector between the front panel and the main circuit boards as can be seen in figure 33. This can make maintenance easier.

Details of the connections used by Les follow for those constructors who wish to fit such a connector. The grey shaded pins are those that are used in the Sussex.



Pin	Colour	Remarks	Board Ident
1	Red	HT Input from Transformer TB1-7	AA
2	N.U.		
3	Red	HT Input from Transformer TB1-8	AB
4	N.U.		
5	Red	35V AC Input from transformer TB1-10	AE
6	N.U.		
7	Red	35V AC Input from transformer TB1-11	AF
8	Green	0V to gas test and function switches	AD
9	Green	Ground Connection	M
10	Red	TEST Enable from Function Switch	AH
11	Green	0V to Anode Volts Selector Switch	G
12	Green	0V to G2 Volts Selector Switch	J
13	Green	To Cathode/Heater LED Cathode	L
14	Green	To Short Circuit LED Cathode	B4
15	Red	Short Circuit Detector to Function Switch	B3
16	Red	Cathode to Pin Selector Switches (1)	K
17,18 & 19	N.U.		
20	Red	Anode Current Limit control	AJ
21	Red	Anode Current Limit control	AK
22	N.U.		
23	Red	Input from Gas Test Switch	RL3 - A2
24	Red	Anode Voltage to Function Switch	D
25	Red	Screen Voltage to Function Switch	H
26	N.U.		
27	Red	12V AC to Fan Rectifier from TB2-6	D15 ANODE
28	Green	Heater Return from TB2-2	C8 & FAN 0V
29	Red	Heater Volts IN from Selector Switch	C6
30	Green	Heater Return to Pin Selector Switches (2)	C7
31	Green	To Heater LED Cathode	C3
32	Red	To Heater LED Anode and Function Switch	C1
33	Red	Heater Volts OUT to Pin Selector Switches (3)	C5
34	Red	HT to Anode Volts Selector Switch	E
35	Red	HT from Anode Volts Selector Switch	F
36	Red	HT to G2 Volts Selector Switch	P
37	Red	HT from G2 Volts Selector Switch	Q
38	N.U.		
39	Red	To Gm Meter	A
40	Red	To Gm Meter	B
41	Red	To Anode Current Meter (+)	RL3 - PIN 11
42	N.U.		
43	Red	To Anode Current Meter (-)	RL3 - PIN 21
44	Green	0V (screen leads) from AG	AG
45	Blue	Voltage to Grid Voltage Meter	T
46	Green	0V to Grid Voltage Meter	N
47	Green	Control Voltage to Pin Selector Switches (4)	RL3 - PIN 24
48	Green	0V to Grid Voltage Control	W
49	Blue	Voltage to Grid Voltage Control	Y
50	Blue	Voltage from Grid Voltage Control	X



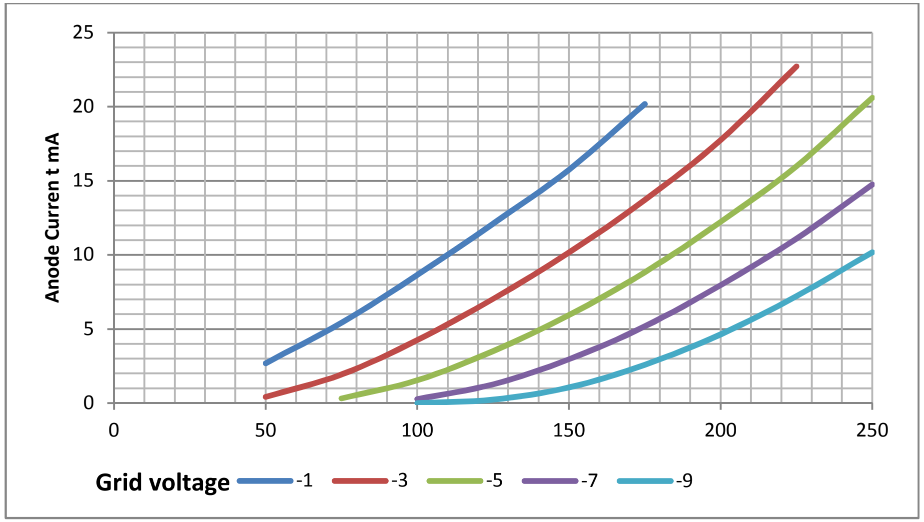
Note. D1 & D2 are IN4007.

Figure 35 - The original circuit published by Mike Rowe in 2009

	Va								
Vg	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**
-21	0	0	0	0	0	0	0	0	0.02
-20	0	0	0	0	0	0	0	0	0.07
-19	0	0	0	0	0	0	0	0.02	0.18
-18	0	0	0	0	0	0	0	0.07	0.39
-17	0	0	0	0	0	0	0.01	0.19	0.72
-16	0	0	0	0	0	0	0.03	0.14	1.23
-15	0	0	0	0	0	0.01	0.19	0.77	1.91
-14	0	0	0	0	0	0.06	0.43	1.23	2.8
-13	0	0	0	0	0.01	0.19	0.84	2.08	3.84
-12	0	0	0	0	0.06	0.46	1.46	3.06	5.17
-11	0	0	0	0.01	0.21	0.93	2.3	4.24	6.63
-10	0	0	0	0.06	0.52	1.64	3.38	5.65	8.31
-9	0	0	0.01	0.24	1.06	2.59	4.64	7.22	10.18
-8	0	0	0.07	0.61	1.88	3.77	6.16	9.03	12.37
-7	0	0	0.27	1.27	2.96	5.18	7.96	11.1	14.75
-6	0	0.07	0.73	2.22	4.29	6.89	9.95	13.41	17.42
-5	0	0.32	1.54	3.51	5.94	8.83	12.23	15.98	20.6
-4	0.07	0.91	2.71	5.08	7.89	11.13	14.76	19.05	24.18
-3	0.42	1.93	4.25	7.03	10.16	13.71	17.75	22.71	0
-2	1.24	3.41	6.23	9.57	12.76	16.61	21.35	0	0
-1	2.69	5.42	8.65	12.11	15.75	20.18	25.2	0	0
0	3.61	6.7	10.2	13.92	17.85	22.61	0	0	0

ECC82 Anode Current for
Grid Voltage 0V to -21V and Anode Voltage 50V to 250V

Note that readings were not taken for anode currents above 25mA as the maximum cathode current is specified as 20mA.



Anode current vs Anode voltage at different Control Grid voltages

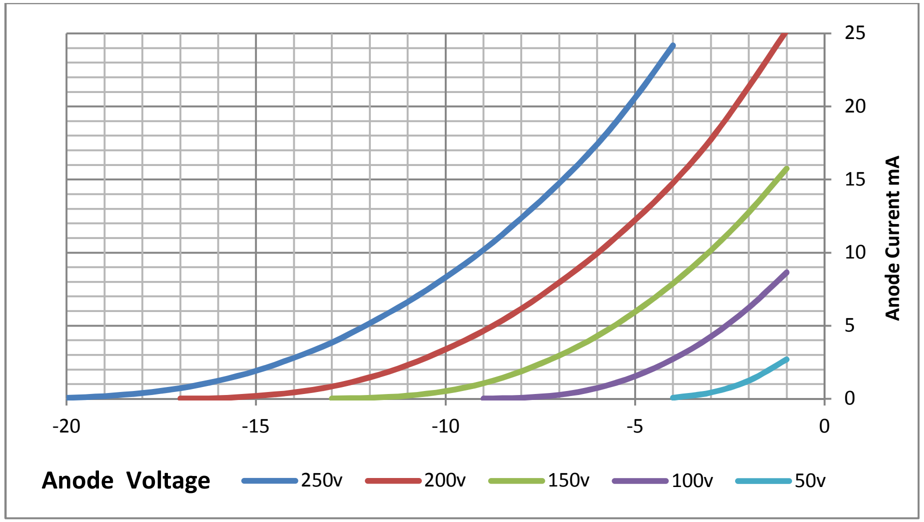


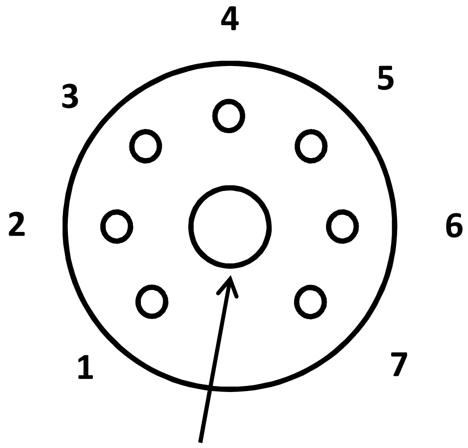
Figure 36 - Characteristic Plots for ECC82

Anode current vs Control Grid voltages at different Anode voltages

Valve Bases

Valve pins are numbered in a clockwise direction viewed with the pins facing towards you. Some valve bases may have the pin numbers moulded into the base.

E.g. B7G base



Central spigot on valve base

Viewed from pins of valve or underside of valve base

Details of the majority of valve bases are in the reference section[4].

Valve Number Coding Details

There are several coding systems for valves. European manufacturers tended to use the Pro-Electron/Mullard code comprising a series of letters followed by numbers. These allowed the type of valve to be easily identified.

e.g. EABC81.

> The first letter is the heater rating. In this case it is a 6.3v heater.
>
> The second and subsequent letters identify the type of devices in the valve. More than one letter can be used in the case of multiple valves contained within the same envelope. In this case A is a single diode, B is a dual diode with a common cathode and C is a triode.
>
> The first number identifies the base type. In this case it is a B9A base.
>
> So this valve is a triple diode triode. Its intended function is as an AM/FM demodulator and audio pre-amp valve in an AM/FM radio.

Other numbering systems such as the GEC, Mazda and US exist and details of these are given in the reference section[5].

Adaptors

To test valves with different bases to those fitted an adaptor can be made using a B9A plug and the required valve base or bases.

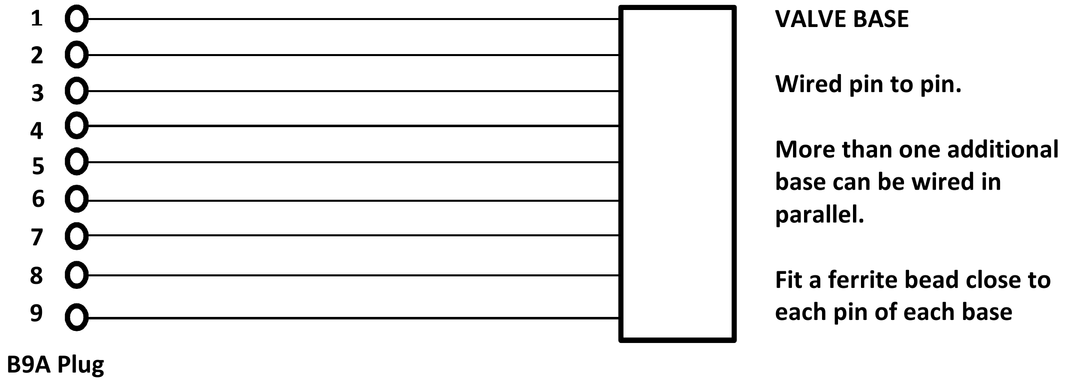


Figure 37 - Adaptor for additional valve bases

It is suggested that the wiring for adaptors uses colours in accordance with the resistor colour code.

1	Brown	**6**	Blue
2	Red	**7**	Violet
3	Orange	**8**	Grey
4	Yellow	**9**	White
5	Green		

References

1) Mike Rowes original Valve tester

The "Sussex" Homebrew Valve Tester. - UK Vintage Radio Repair and Restoration Discussion Forum

2) One good source of valve data, including the Mullard (Philips) datasheet for the ECC82, is the following website.

http://www.mif.pg.gda.pl/homepages/frank/index.html

3) The AVO manual including the switch settings is available from the following website.

http://bama.edebris.com/manuals/avo/vcm-data-new-edition/

4) The following link gives details of the majority of valve bases.

http://www.radiomuseum.org/forumdata/upload/uk_valve_bases_pin_numbering.pdf

5) Details of valve numbering systems can be found by following this link.

http://www.vintage-radio.com/repair-restore-information/valve_valve-numbering.html

Acknowledgements

Mike Barker for the copy of the BVWS Bulletin.

Les Carpenter for his manual.

Richard Smith and Martin Forsberg for proof reading.

Alan Douglas, David Taylor, Robert Vine for photos of valve testers.

David Benson, Howard (G7AJN/M3OCL) and Richard Smith for pictures of their Sussex valve testers.

Photo Gallery of Testers

Here are pictures of a few of the testers built to Mike's design.

Mike Rowes Original Sussex Valve Tester

David Bensons Sussex Valve Tester

Cut down version from Howard (G7AJN/M3OCL) for testing a limited number of valves.

Richard Smiths Sussex Valve Tester

Notes

This page is for you to record details of your specific Sussex tester.