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1 PRECAUTIONS AND INTRODUCTION

Dangerous voltages are present at all points of the module and on the peripheral elements. Do not touch any of the connections while power is on, and wait for at least one minute after switching off the power in order to allow the condensers to discharge.

Likewise, ensure that you have the necessary competence to assemble and use this item. Otherwise, ask for the help of an experienced person.

During the first test, make sure that the module is placed on an insulated surface and that no object or conducting particle is on this surface.

The module functions on an impulse mode. This mode is caried out by a fast microprocomputer which controls all the functions, and allows high plate current measurement (340 mA) while minimizing the volume, weight, consumption and cost.

This type of operation prevents all kinds of overdissipation, and insure perfect security for the tube. Tests can also be undertaken without risk even with parameters over specification limits.

The embedded supply for the plate, screen and grid 1 allows testing of most audio tubes as well as of a significant majority of radio tubes, cathodic indicators, regulators, diodes, rectifiers, and valves.

A supply module, proposed as a complementary accessory, enables the delivery of 3 heating voltages : 4V, 5V, 6.3V / 3 A minimum current.

The heating circuit is floating. Thus, direct heating tubes can also be measured.

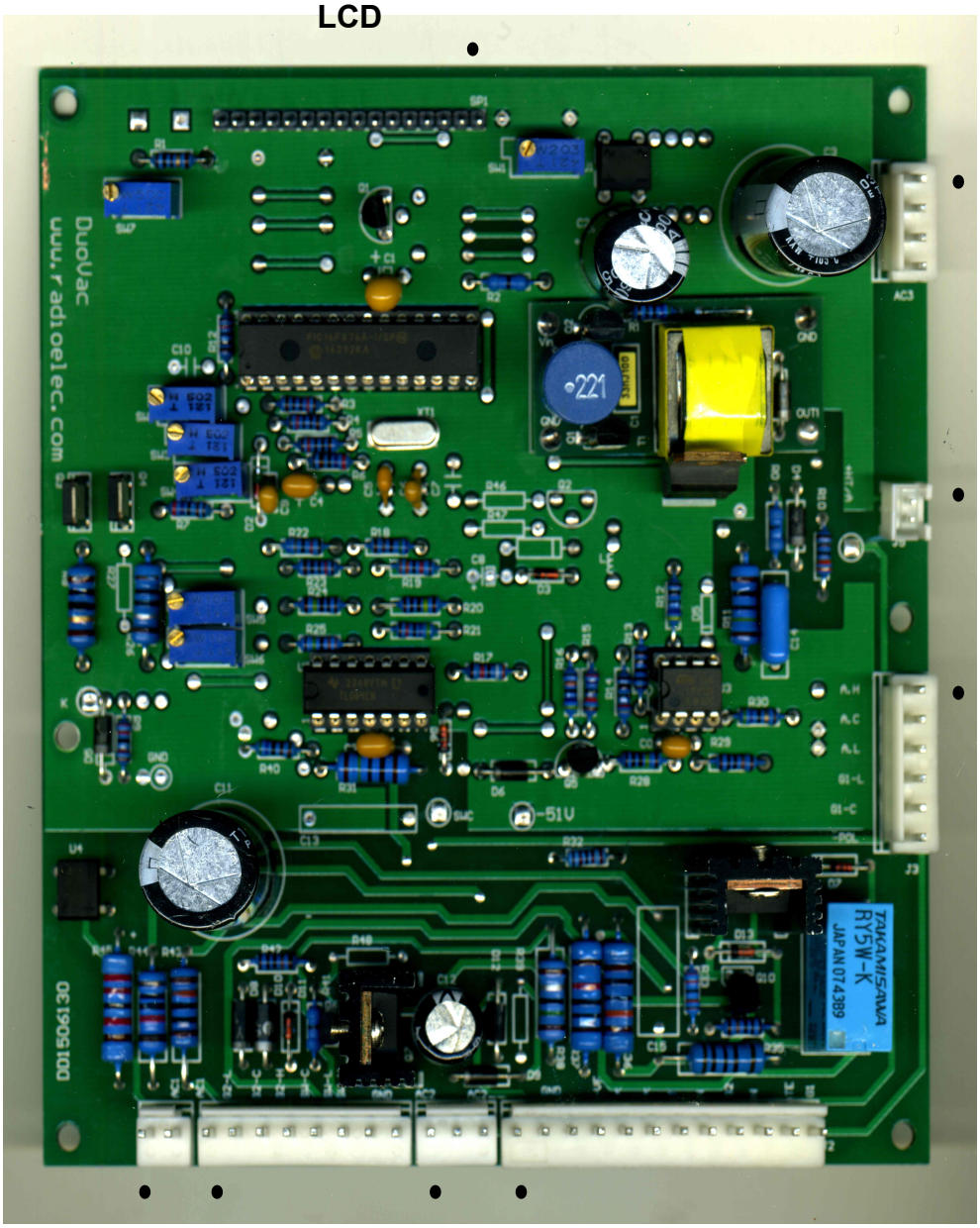
Grid 1 voltage (bias) setting is done in a flexible and precise manner by a 10-turn potentiometer with decimal display in real time.

Because of the small power required, the module can be powered by a simple 12V battery (required current of approximately 2A), or by a cigarette lighter of a car - through a small 12V to 220V converter, available as a complementary accessory.

In this way, measurements can be done quickly and wherever you are : in a flea market, garage sale, exhibit, etc. This is useful for expensive tubes or when buying many tubes.

All circuitry is protected against overload as well as against connection errors. That said, however, an error in connection could damage a tube, so care is highly recommended.

2 CONNECTING THE MODULE



View of the PCB and the connectors

- • = Pin 1

Plate current

Plate or G2 (screen) voltage

Grid 1(bias) voltage

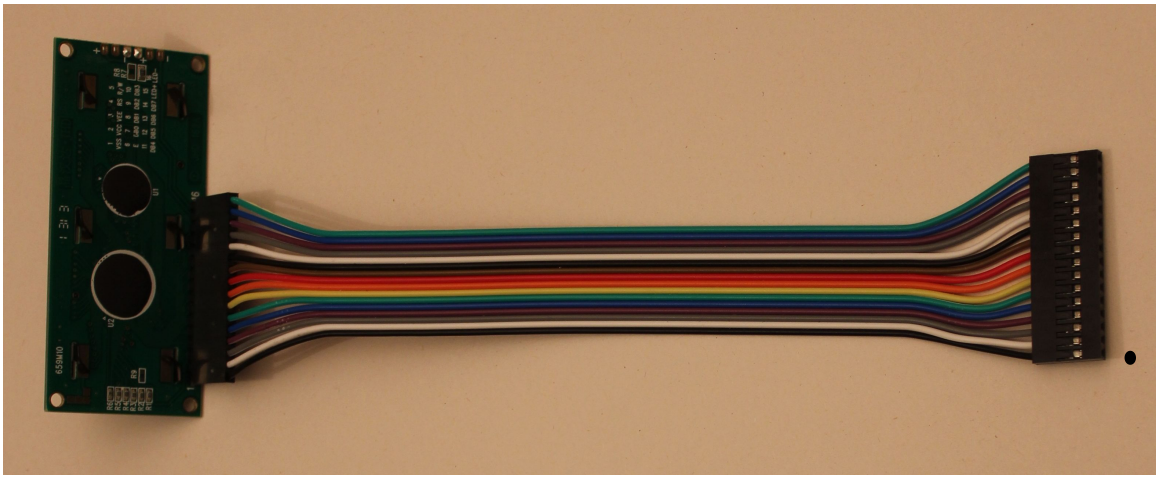
View of the display

Screen type : 2 lines with 16 characters.

Blue, with backlight

Dimensions: 70 x 25 mm

Driver: HD44780



LCD

• **Pin 1**

Display (back view) with the flat cable

Flat cable lenght (with connectors) : 20 cms

Connectors description (dot :● indicates pin 1):

AC1:

1: 310V / a.c.

2: 310V / a.c.

J1:

1: Vg2 potentiometer – low end (blue)

2: Vg2 potentiometer - wipper (yellow)

3: Vg2 potentiometer – high end (brown)

4: Voltage display selector - common (white)

5: Voltage display selector - G2 (green)

6: Voltage display selector - Plaque (red)

7: GND

8: GND

AC2:

1: 120V /a.c.

2: n.c.

3: 120V /a.c.

J2:

1: GND (black) + " TEST " switch

2: GND (black) + " Discharge " switch

3: GND

4: "Discharge" switch (yellow)

5: Cathode (blue)

6: Cathode

7: " TEST " switch (green)

8: Neon bulb (violet)

9: G2 (brown)

10: Neon bulb (violet)

11: Plate (red)

12: G1 (white)

J3:

1: Vplate potentiometer – high end (red)

2: Vplate potentiometer - wipper (green)

3: Vplate potentiometer – low end (black)

4: Vg1 potentiometer - high end (blue)

5: Vg1 potentiometer - wipper (white)

6: Vg1 potentiometer – low end (yellow)

J5:

1: GND

2: Synchro for measurement window

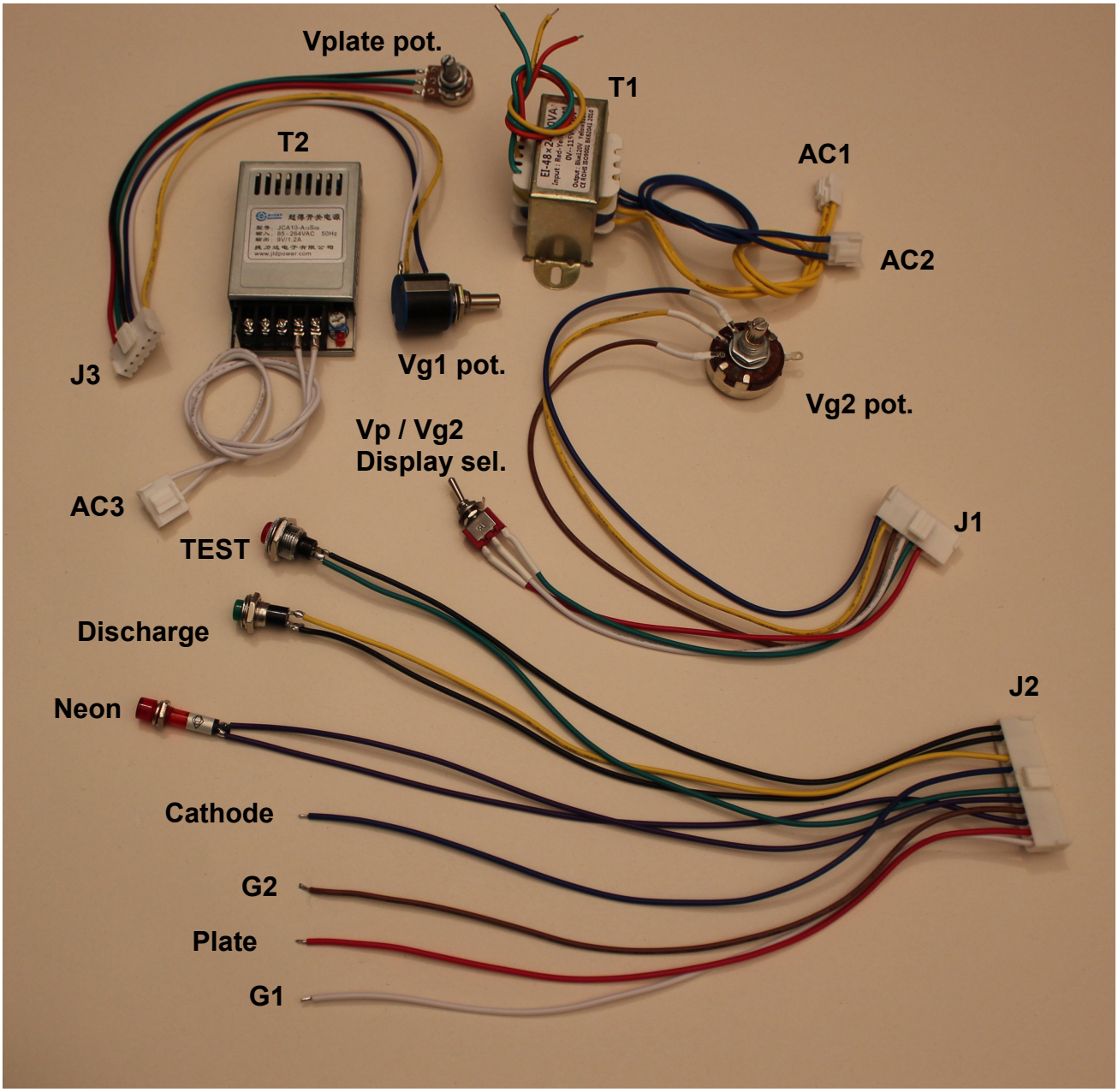
AC3:

1: 9V d.c. - 1

2:

3: 9V d.c. - 2

4:



Connections & supplies

T1: 120 V + 310 V transfo./ 110 V primary(red / yellow) - 230 V (red / green)

T2: AC / DC regulated supply 9V d.c. / Primary 85 V - 260 V (AC inputs)

3 ferrite beads and 3 knobs are not shown but will be delivered with the kit.

3 GETTING STARTED AND OPERATING THE SYSTEM

Getting started is very simple, because most of the elements are already connected. You only need to plug the different connectors , followed by the T1 and T2 to the mains using a switch and a fuse 1A.

Connect the four wires (cathode, G2, plate and G1) to the appropriate tube socket pins. Do not forget to slide the ferrite beads on to the wires (except for the cathode).

Connect a transformer or an appropriate power supply to the tube's filament socket.

Make sure that the module is on an insulated support and that there is no short circuit that can possibly occur. Switch on power.

Pre-adjust the V plate voltage (Plate), Vg2 (grid 2)*, and Vg1 (grid 1) according to the characteristics of the tube to be tested.

Almost all tubes datasheets are classified and accessible at the following website :

http://www.tubedata.org/

Example of measurement :

EL84 tube, the datasheet indicates :

Pin 2 : G1 (grid 1)
Pin 3 : K-G3 (cathode and grid 3)
Pin 4 : F (filament)
Pin 5 : F' (filament)
Pin 7 : A (anode and plate)
Pin 9 : G2 (screen or grid 2)

Test conditions : In the absence of indications just refer to the curves. According to these curves, it would be possible, for instance, to choose a plate voltage of 300V, a G2 voltage of 250V and a G1 voltage of -4.0V. Under these conditions, the nominal debit would be 90 mA.

1 Set the display voltage selector as to show the plate voltage.

2 Turn the Vplate potentiometer to get a 300V reading on the screen.

3 Set the display voltage selector as to show the G2 voltage.

4 Turn the Vg2 potentiometer to get a 250V reading on the screen.

5 Turn the Vg1 potentiometer to get a -4.0V reading on the screen.

6 Plug the tube and leave it to heat up for about one (1) minute.

*Choose the corresponding displays by using the voltage switch.

Check that the neon indicator is turned off or is blinking. For certain tubes, this light could be turned on continuously without blinking even if there is no short circuit. In general , this kind of phenomenon is created by tubes which have high transconductance or power or by valves and cathodic indicators.

It is not dangerous to carry out tests even if the light is turned on.

- Push on the « TEST » button and read the value of the plate current in mA.
- Release the button. The test is completed.

More measurements : transconductance , internal resistance and gain are possible and simple.

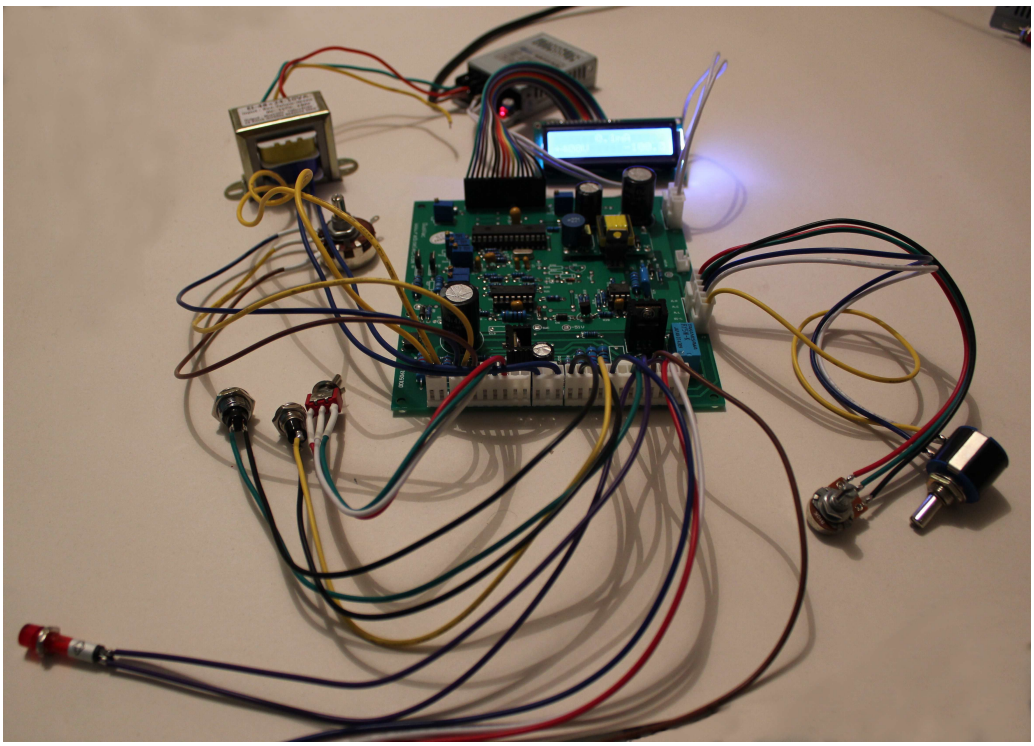
These measurements/tests are described on§ 6.

Tubes matching is done by a simple method. Test several tubes of the same type without changing the adjustments in order to pair up (or in quartets) tubes with plate currents whose measurements are closest.

For double tubes like : ecc81, ecc82, ecc83, ecc88 – 6sl7, 6sn7, etc…The measurement of any of the internal triodes can be undertaken by swaping the connection to either the plateof triode 1 or triode 2 (all other same electrodes connected together). This can be easily undertaken with a simple inverter.

More comprehensive measurements are described in §5.

The testing of valves, diodes , cathodic indicators, gas regulators is possible and described on §6.



The tube tester fully assembled and ready-to-use

Example of a ready-to-use tube tester using this module.
This item uses an interconnection matrix to adapt different types of tubes.

4 OPERATING PRINCIPLES

Using an impulse mode, the tests are carried out every 0.5 seconds. The time lag for obtaining the results is very short : 800 uS (0.0008 seconds).

Between the test windows, grid 1 is at a negative potential and the tube is in a cut-off state. Its dissipation is almost non-existent.

This mode allows for the use of very little energy on the high voltage supply (plate and G2), and prevents the use of heavy and costly transformers, while at the same time allows for tests using high voltage and plate current (450V / 340mA).

A microcomputer PIC clocked at 12MHz carries out the acquisiton , measurement and management of defects and of the commands for the LCD display.

The plate supply is organised around an self-oscillation converter (Royer) controlled by a comparator. A high-value condenser (47µF) serves as a reservoir and supplies the voltage during the800µS test. This condenser discharges slowly. When the plate voltage has to be lowered, through the Vplate potentiometer, it would be useful to briefly push the DISCHARGE button, which would put a discharge resistance in parallel with the supply output and accelerate the process. SURCHARGE warning (see below) could then be displayed, and will disapear when the button is released.

The G2 supply, which has a lower debit, is organized around a conventional circuit : transformer, rectifier, filter, stabilization using a group of zener diodes. A power mosfet controlled by the Vg2 potentiometer delivers the G2 voltage.

These two supplies, plate and G2, are protected by current limiters. The peripheral circuits also have this type of protection.

The display of the plate and G2 voltage is carried out in an alternating manner through selection, using the voltage switch (connector J1 - pins 4, 5 and 6). The G1 supply circuitry is like G2 but because of the low current, it is not buffered.

A short circuit tester for the plate and the internal electrodes of the tube is effected through a neon light (connector J2, pins 8 and 10). This neon lights up continuously in the event of a strong current. Otherwise, it will blink or will remain extinguished. This simple circuit is just an aide for the tests and has its limits. It could stay lighted up continously when used with high power tubes or tubes of a specific type (diodes, magic eyes…) are present.

Some tubes are very unstable and the connection wires can be seen as resonant circuits. Likewise, the plate, G2 and G1 wires have to be equipped with a ferrite bead filter to block any possible auto-oscillation. These beads have to be positioned beside the tube socket closest to the connections.

The microcomputer monitors the plate voltage current. All excess will automatically limit the output voltage, SURCHARGE will appear on the screen, and all tests will be suspended until the problem disappears or until the TEST button is released.

5 ADVANCED TESTS

The cathodic current of a tube is an important element to determine its state and to carry out matching.

Nonetheless, this parameter gives only a preview of the tube overall performance. With the DuoKit you will be able to carry out three other very complementary tests, which are :

- The slope or transconductance : Gm : expressed in mA/V, uS or umhos
- The internal resistance Rp : expressed in Ohm
- The gain µ which is the result of the two preceding values

Testing the slope :

Carry out a first test, and note the corresponding cathode current Ik1.

Without making other adjustments, increase or decrease the voltage on grid 1 (Vg1) by one volt, and note the new cathode current Ik2.

The Gm (transconductance) is the difference between the Ik1 and Ik2 currents, expressed in mA / V, or in uS, or in umhos, by multiplying the value by 1000 : 1mA/V = 1000 uS = 1000 umhos.

This feature, measured on several points, enables one to know the linearity of a tube.

Testing internal resistance :

Carry out an initial test, note the Vp1 plate voltage and the corresponding Ik1 current.

Without making other adjustments, increase or decrease the plate voltage (Vplate) until a significant change in the current is created. Note the new value of the Vp2 plate voltage and the new Ik2 current.

The internal resistance Rp is the difference of the plate voltage divided by the difference of the corresponding currents : Vp1 - Vp2 divided by Ik1 – Ik2

Calculating the gain :

As indicated above, the µ gain is equal to Gm (in mA/V) x Rp

All tube features are then known, and a very precise matching can thus be made.

6 VALVES, REGULATORS AND CATHODIC INDICATORS

Testing particular tubes like diodes, valves, rectifiers, gas-regulated tubes and cathodic indicators can be done with the DuoKit.

Diodes :

With the internal module supply, low-power tubes can be tested to a maximum current of approximately 15 mA,. For currents above this, follow the procedure for valves testing.

Before plugging the tube, turn the Vplate potentiometer fully anti-clockwise and, if needed, push the DISCHARGE button several times to bring the plate voltage to a value < 5 volts.

The connection is done similarly as for other tubes : wire K to the cathode and the Plate wire towards the plate (s).

When the tube is hot, slowly turn the Vplate potentiometer and observe the increase of the current, comparing it to the curve presented in the tube specifications.

Valves :

Valves or rectifiers tubes can be partially tested with an internal plate supply of the module. However, the absence of the command grid prevents the operation of the impulse mode, and the permanent debit may exceed the capacity of this supply.

In this case, use an external variable d.c. supply. This d.c. supply will be adjustable from 0V to the desired voltage (depending on the curve of the tube).

Minus of the supply will be connected to GND (J2 pin1 or 2), and the positive pole to the terminal corresponding to the plate (s). To the tube socket but not to the module plate wire.

The connection and the sequence of tests are identical to the diodes.

Gas-regulated :

The test of these tubes is carried out with a resistor in order to limit the current. The xxx voltage will be seen directly on the display. Connections between terminal K and plate.

Cathodic indicators :

The test for luminosity of these tubes can be done simply by connecting its electrodes to the appropriate terminal and by adding the resistance to the plates, according to the schematics of the manual.

7 Technical features

Dimensions : 146 x 133 x 28 mm (h. maxi)

Supply : 220V – 230V ou 115V / 50-60 Hz or 12V d.c. via d.c. to a.c. converter

Power request : 25 to 35 VA maxi. (mains supply)
Approx. 2 amps under 12V d.c. via d.c. to a.c. converter

Protection fuse : 1 A fast 5 x 20 mm

Measurement mode : pulsed, 8 bits / 12 MHz micro-computer

Adc sampling : 10 bits monotone (1024)

Measurement window : 800 µS

Interval between measurements : 0, 5 second

Measurement accuracy : better than 5% +/- 1 digit

Grid 1 voltage: 0 to – 100 volts minimum

Grid 2 voltage : 15 to 350 volts minimum

Plate voltage :0 to 450 volts minimum

Maximal mesurable plate current : 340 mA

Grid 2 supply max. current: 60 mA

Grid 1 display resolution: 0,1 V +/- 1 digit

Grid 2 display resolution: 1 V +/- 1 digit

Plate display resolution: 1 V +/- 1 digit

Plate current display resolution: 0,1 mA +/- 1 digit until 34 mA
1 mA +/- 1 digit for I > 34 mA

Internal short-circuit protection by current limiters and voltage surge absorbers

Optional AC-DC regulated supply for tubes heating :

Heating voltages : 4 V – 5 V – 6,3 V/ Output current: 3,5 A maximum

Output voltage tolerance : better than 5 % (regulated)

8 PROBLEMS AND SOLUTIONS

1. The tester does not switch on :

   Check the connection to the power supply and the fuse 1A.

   If the tester works on battery through a converter, check the battery and the converter.

2. No measurements :

   Check settings, tube heating and push only the « TEST » button, then try another tube.

3. The tube does not heat up or the results seem wrong :

   Using an ohmeter, check that the tube filament is not cut and that the heating voltage is applied and is correct.

   Then check the connections of the tube to the module wires.

   Check the values of the test voltage Vg1, Vg2 and V plate.

4. The display indicates « SURCHARGE » :

   Release the « TEST » button as well as the « DISCHARGE » button.

5. Upon pushing the « TEST » button, the values on the display change quickly and quite significantly :

   The most probable cause is that the tube is oscillating during the test. This phenomenon is rare but can happen for tubes with significant slopes. Ensure that the ferrite beads are present and close to the tube under test.

   Reduce the Vg1 voltage (more negative, turn Vg1 potentiometer anti-clockwise), then slowly turn the potentiometer Vg1 clockwise while maintaining the « TEST » button pressed.

6. The display values are abnormal or truncated :

   Turn off power, and after around 10 seconds, turn on power again.