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1 Introduction

The DuoVac is a conventional tube tester, light and compact with advanced features.

Its presentation in a compact case provides reliable protection and easy transport.

A filing pocket located in the lid allows you to store mains and connection cords as well as documents. Some tubes can be also slipped into the residual space.

A microcomputer controls a pulse mode of operation that allowsto perform measurements at very high plate current (up to 340 mA) while minimizingvolume, weight, consumption and cost.

This operating mode makes over-dissipation impossible and the tube under test is operating very safely. Tests out of specification can then possibly be carried out without great risk.

Embedded power supplies make it possible to test all audio tubes as wellthat a very large majority of radio tubes, magic eyes, regulators, diodes and valvesunder various heating voltages: 4 V - 5 V - 6.3 V, with a large current capacity of 3 A.

Directly heated tubes can also be measured.

The adjustment of the grid voltage 1 (polarization) is carried out in a flexible and precise manner by a 10-turn potentiometer and is displayed to the nearest decimal place.

The low power supply required makes it possible to power the deviceon a simple small 12 V battery with gel electrolyte (current required approx. 2 A)or by the cigarette lighter of a car via a small 220 V converter, available as a complementary article.

This way tests can be done quickly anywhere: flea markets, garage sales, exhibitions, etc. The profit can be significant for expensive tubes or bulk purchases.

All circuits are protected against overloads and connection errors, however a connection error can be destructive for a tube so it is recommended to be careful.

2 Safety instructions

The DuoVac operates with high voltages, for your safety and to avoid damaging the device, follow the procedures indicated in this manual and ensure you have the skills to use it. Otherwise askthe assistance of an experienced person.

This device is not a toy, so keep it out of the reach of a child.

Before plugging in a tube correctly preset the test values and make sure you have made the correct connections from the electrodes to the test stand.

Use red leads to connect the dangerous voltages delivered to the Plate and G2 terminals.

Always connect the cables of the interconnection matrix and plug in the front tube press the TEST button (button H in figure 1 on page 2.1).

Never touch the contacts of the VT1 & VT2 supports or the end of the interconnections plugs when the device is powered on.

Do not insert anything other than electron tubes in the VT1 & VT2 holders and use adapters for tubes other than noval or octal.

Observe the maximum polarity and voltages when connecting an external power source to the EXT terminals (E terminals in figure 1 on page 2.1).

Avoid using the device with wet hands, this increases the risk of electric shock.

Replace the mains fuse only with a fuse of the same type: 250V / 1A fast.

Observe the mains supply voltage according to the model delivered.

If the power cord or interconnection matrix cords are damaged, replace them identically (available as spare parts).

Tubes can get very hot during measurements, use a cloth or glove wool to handle them.

There is no useful circuit for the user inside the device and any opening and / or intervention will void the warranty.

3 Control panel

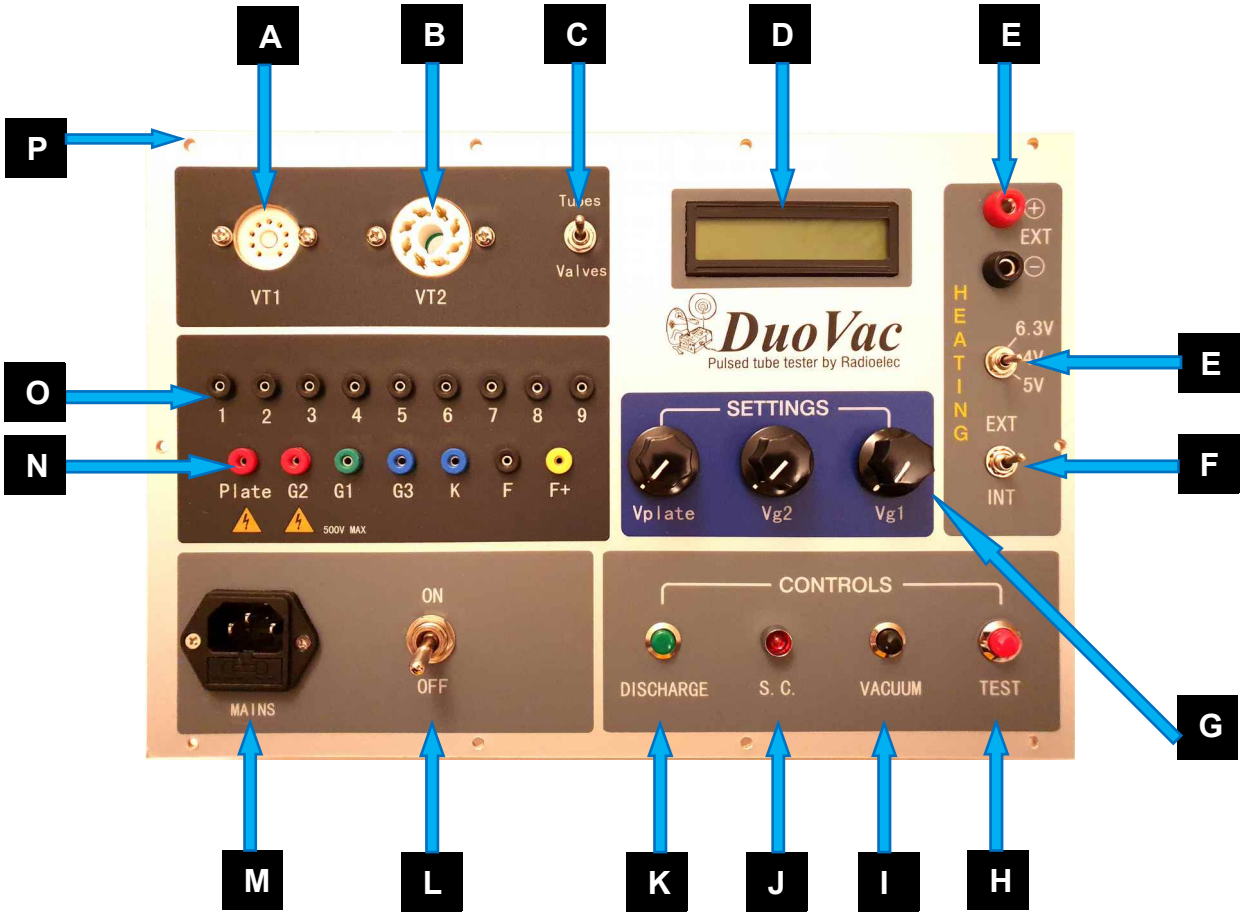

Figure 1

A Noval tube test socket

B Octal tube test socket

C Mode selector Tubes or Valves

D Backlit display

E Heating voltage source selector

F Heating voltage selector

G Plate, G2 & G1 settings

H TEST button

I Vacuum test button

J Short circuit indicator

K Quick discharge button

L Main switch

M Mains socket & general fuse

N Test electrodes connections

O Connections to VT1 & VT2 sockets terminals

P Panel fixing screws

4 Explanation of circuitry

SCREEN APPEARANCE

The DuoVac has all the functionality of a conventional tube tester, but it uses a pulse mode which guarantees great safety to the tube during measurements.

These measurements are carried out at a rate of 0.5 seconds and the data acquisition time is short: 800 µS (0.0008 seconds).

Between measurements grid 1 is at a very negative potential and the tube is in the blocked state (cut-off), its dissipation is zero.

This operating mode makes it possible to draw little energy from high voltage power supplies (plate and G2) and avoids the use of heavy and expensive power transformers while allowing measurements up to high plate voltages and flow rates (500 V / 340 mA).

A PIC microprocessor clocked at 12MHz performs acquisitions, measurements, fault management and lcd display control.

The plate power supply is designed around a self-oscillating converter (Royer) controlled by a servo circuit, a high value capacitor (47 µF) serves as a reservoir and delivers the voltage during the 800 µS test.

This capacitor discharges quite slowly and it is therefore convenient, when the plate voltage needs to be lowered via the Vplate potentiometer, to briefly press the DISCHARGE button, which places in parallel on the output of the power supply a discharge resistor and speeds up the process.

An indication of OVERLOAD (see below) may then display, it will disappear when the button is released.

The lower flow G2 power supply is organized around a conventional circuit: transformer, rectification, filtering and stabilization by a group of zener diodes. A power mosfet controlled by the adjustment potentiometer Vg2 delivers the output voltage at low impedance.

These 2 power supplies, plate and G2, are protected by current limiting circuits, peripheral circuits also benefit from these protections.

The G1 power supply is designed like G2 but since the flow is very low it is not buffered.

The heating voltages are managed by a regulated switching power supply, the heating is carried out in direct current, perfectly clean and stable. This source is floating and testing directly heated tubes is not a problem.

The 5V - 4V - 6.3 V switch is used to select the most common heating voltages but, in the case of specific voltages, it is possible to connect an external power supply to the EXT terminals, the polarity must be respected and when the switch EXT / INT (switch F in figure 1 on page 2.1) is placed on EXT this voltage will be found on terminals F and F + of the matrix.

The vacuum test is carried out by placing a high value resistor in the grid 1 circuit in the presence of gas inside the tube an ionization current is established and changes the grid voltage, which affects the plate flow.

To perform this test, make a first measurement without touching the Vacuum button, note the plate current and repeat the measurement by pressing Vacuum. A variation of +/- 20% of the plate current will indicate a bad vacuum.

A short-circuit tester from the plate to other electrodes inside the tube is performed by a neon indicator (indicator H in figure 1 on page 2.1). This neon lights up steadily in the event of a strong current flowing through the tube, otherwise it flashes or remains off.

This simple circuit is only a test aid and has limitations. It can light up when high power or special type tubes (diodes, magic eyes, etc.) are present.

The adaptation to the specific pinout of a tube is carried out through a die of interconnections consisting of 2 mm banana sockets and suitable cords. This solution was chosen because it is fast, compact and very reliable.

Some tubes are very unstable and the connection wires constitute resonant circuits so each terminal, from 1 to 9, is internally equipped with a ferrite bead filter intended to block possible self-oscillations.

The microprocessor monitors the correct regulation of the plate voltage, any excessive flow will cause this voltage to be limited and OVERLOAD will be displayed on the screen. All measures will be suspended until the problem is resolved.

The design of the electronics is modular: A main board supports all the measurement functions and circuits of the plate power supply.

The heating and power modules of the module and its transformer are separate.

5 Implementation - Test of grid tubes

These are tubes equipped with a control grid such as triodes, tetrodes, pentodes, etc ...

Make sure that no tube is present on either sockets.

Place the changeover switch C (Tubes / Valves) in the Tubes position.

The position of this switch is important because, in the Valves position, a resistance of 5000 Ohm is inserted in series with the plate and the presence of this resistance would introduce measurement error for the controlled grid tubes.

Preset the voltages Vplate (Plate), Vg1 (grid 1) and the heating voltage according to the characteristics of the tube to be tested.

Almost all tube manuals are listed and accessible on the internet via this link:

http://www.tubedata.org/

Make the connections of the test matrix through the leads.

Example - tube el84, the documentation 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 or plate)
Pin 9: G2 (screen or grid 2)

The following connections must therefore be made:

G1 terminal to terminal 2
K terminal to terminal 3
F terminal to terminal 4
F+ terminal to terminal 5
Plate terminal to terminal 7 (by a red cord)
G2 terminal to terminal 9 (by a red cord)

The el84 is heated at 6.3V:

Place switch F (EXT / INT) on INT.

Place switch E (5V-4V-6.3V) on 6.3V.

Let us now see the measurement conditions, in the absence of indications it suffices to refer to the curves. We can, for example, choose a plate voltage of 300 V, a G2 voltage of 250 V and a G1 voltage of - 4.0 V. Under these conditions the nominal flow rate will be 90 mA.

Implementation - Test of grid tubes../…

Place switch C (Tubes / Valves) on Tubes.
.
Turn the Vplate potentiometer to read 300 V on the display.
Turn the Vg2 potentiometer to read 250 V on the screen.
Turn the Vg1 potentiometer to read - 4.0 V on the display.

Plug in the tube and let it heat up for about a minute.

Check that the J (S.C.) light is off or flashing. For some tubes this indicator can come on steadily when there is no short circuit. Usually this phenomenon is caused by high gain tubes or magic valves and eyes.

It is not dangerous to perform the test even if this light is on.

Press button H (TEST) and read the value of the plate current in mA.

More complete measurements: transconductance, internal resistance and gain are possible and simple, these measurements are described in § 6.

Release the button, the test is finished.

Tube pairing is simple: Just test several tubes of the same type without changing the settings and pair or quartet the tubes which have the closest currents.

For double tubes like: ecc81, ecc82, ecc83, ecc88 - 6sl7, 6sn7, etc ... The test of one or the other of the internal triodes is done by moving the connection of the Plate cord to either of the plate pins (on the row of terminals 1 to 9).

All other electrodes are connected together (K to K, G1 to G1)

The test of valves, diodes and rectifier diodes, magic eyes, gas regulators is possible and described in § 7.

6 Basic test of ordinary tubes

In order to facilitate the tests, a set of measurement conditions for the most common tubes is summarized here:

6SL7 - 6SN7 - 6SU7 - 5691 - 5692 – 6188:

G1 terminal to terminal 1 and terminal 4
K terminal to terminal 3 and terminal 6
F terminal to terminal 7
F+ terminal to terminal 8

The test of one or the other of the internal triodes is carried out by connecting the Plate terminal to terminal 2 or terminal 5 (by a red lead).

Tube	Vf / If	Vplate	Vg2	Vg1	Ik
6SL7	6,3V / 0,3 A	300 V	-	- 2,0 V	3,2 mA
6SN7	6,3V / 0,6 A	300 V	-	- 8,0 V	15 mA
6SU7	6,3V / 0,3 A	300 V	-	- 1,0 V	5,5 mA
5692	6,3V / 0,6 A	200 V	-	- 4,0 V	13 mA
6188	6,3V / 0,3 A	300 V	-	- 1,0 V	5,5 mA

ECC81 / 12AT7 – ECC82 / 12AU7 – ECC83 / 12AX7 – ECC99 – 12BH7 - 5963 :

G1 terminal to terminal 2 and terminal 7
K terminal to terminal 3 and terminal 8
F terminal to terminal 4 and terminal 5
F+ terminal to terminal 9

The test of one or the other of the internal triodes is carried out by connecting the Plate terminal to terminal 1 or terminal 6 (by a red lead).

Tube	Vf / If	Vplate	Vg2	Vg1	Ik
ECC81	6,3V / 0,3 A	300 V	-	- 2,0 V	15 mA
ECC82	6,3V / 0,3 A	200 V	-	- 5,0 V	15 mA
ECC83	6,3V / 0,3 A	200 V	-	- 0,5 V	3,2 mA
ECC99	6,3V / 0,8 A	200 V	-	- 4,0 V	42 mA
12BH7	6,3V / 0,6 A	200 V	-	- 5,0 V	18 mA
5963	6,3V / 0,3 A	200 V	-	- 4,0 V	15 mA

Tests des tubes courants../...

ECC85 – ECC88 – E88CC - E188CC – 6DJ8 – 6N1P – 6922 :

G1 terminal to terminal 2 and terminal 7
K terminal to terminal 3 and terminal 8
F terminal to terminal 4
F+ terminal to terminal 5

The test of one or the other of the internal triodes is carried out by connecting the Plate terminal to terminal 1 or terminal 6 (by a red lead).

Tube	Vf / If	Vplate	Vg2	Vg1	Ik
ECC85	6,3V / 0,3 A	250 V	-	- 2,0 V	15 mA
ECC88	6,3V / 0,4 A	250 V	-	- 4,0 V	58 mA
E88CC	6,3V / 0,3 A	250 V	-	- 4,0 V	50 mA
E188CC	6,3V / 0,3 A	150 V	-	- 3,0 V	16 mA
6DJ8	6,3V / 0,4 A	250 V	-	- 4,0 V	58 mA
6N1P	6,3V / 0,6 A	300 V	-	- 2,0 V	28 mA
6922	6,3V / 0,4 A	250 V	-	- 4,0 V	58 mA

EL84 – 6BQ5 – 6P14P - 7189 :

G1 terminal to terminal 2
K terminal to terminal 3
F terminal to terminal 4
F+ terminal to terminal 5
Plate terminal to terminal 7 (by a red lead).
G2 terminal to terminal 9 (by a red lead).

Tube	Vf / If	Vplate	Vg2	Vg1	Ik
EL84	6,3V / 0,76 A	350 V	300 V	- 7,0 V	80 mA
6BQ5	6,3V / 0,76 A	350 V	300 V	- 7,0 V	90 mA
6P14P	6,3V / 0,76 A	300 V	250 V	- 4,0 V	70 mA
7189	6,3V / 0,76 A	350 V	300 V	- 7,0 V	80 mA

Tests des tubes courants../...

EL34 – 6CA7 – KT66/77/88/90/100 – 6L6 – 6V6 – 5881 – 6550:

G3 terminal to terminal 1
F terminal to terminal 2
Plate terminal to terminal 3 (by a red lead).
G2 terminal to terminal 4 (by a red lead).
G1 terminal to terminal 5
F+ terminal to terminal 7
K terminal to terminal 8

Tube	Vf / If	Vplate	Vg2	Vg1	Ik
EL34	6,3V / 1,5 A	300 V	250 V	-10,0 V	130 mA
6CA7	6,3V / 1,5 A	300 V	250 V	-10,0 V	140 mA
KT66	6,3V / 1,3 A	300 V	250 V	- 10,0 V	120 mA
KT77	6,3V / 1,4 A	350 V	250 V	- 10,0 V	150 mA
KT88	6,3V / 1,6 A	350 V	300 V	- 20,0 V	160 mA
KT90	6,3V / 1,6 A	300 V	225 V	- 10,0 V	180 mA
6L6	6,3V / 0,9 A	300 V	250 V	- 5,0 V	120 mA
6V6	6,3V / 0,45 A	300 V	250 V	- 5,0 V	80 mA
5881	6,3V / 0,9 A	300 V	250 V	- 5,0 V	120 mA
6550	6,3V / 1,6 A	350 V	300 V	- 15,0 V	200 mA

7 Advanced testing

The cathodic flow rate of a tube is an important data which makes it possible to determine its state of wear and to carry out a pairing.

However, this parameter only gives an overview of all the performances of which the tube is capable, with the DuoVac you will be able to perform 3 other very complementary measurements, these are:

- The slope or transconductance Gm: expressed in mA / V, µS or µmhos.

- Internal resistance Rp: expressed in Ohms.

- The gain µ which is the product of the 2 previous values.

Slope measurement:

Carry out a first measurement, note the corresponding current Ia1.

Without touching the other settings, increase or decrease the grid voltage by 1 volt (Vg1) and note the new current Ia2.

The slope Gm is the difference between the currents Ia1 and Ia2 expressed in mA / V or in µS or µmhos by multiplying the value by 1000: 1mA / V = 1000 µS = 1000 µmhos.

This characteristic, taken at several points, allows to know the linearity of a tube.

Internal resistance measurement:

Carry out a first measurement, note the plate voltage Vp1 and the corresponding current Ia1.

Without touching the other settings increase or decrease the plate voltage (Vplate) until causing a significant change in the current, note the new value of the plate voltage Vp2 and the new current Ia2.

The internal resistance Rp is the difference in plate voltages divided by the difference in the corresponding currents: Vp1 +/- Vp2 div. Ia1 +/- Ia2, value expressed in Ohms.

Calculation of the gain:

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

All the characteristics of the tube are then known and extremely precise pairing can be achieved.

8 Valves, regulators & cathodic indicators

The DuoVac allows the testing of particular tubes such as diodes, rectifier valves, neon gas regulators and cathodic indicators (magic eye).

Diodes:

These low power tubes can be tested up to a maximum flow of about fifteen mA with the internal DuoVac power supply, for higher currents follow the valve test procedure.

Place the changeover switch C (Tubes / Valves) in the Valves position.

Before plugging in the tube, position the Vplate potentiometer fully anti-clockwise and, if necessary, press the DISCHARGE button several times to bring the plate voltage to a maximum of 5v.

The connection is made like the other tubes: terminal K to the cathode and terminal Plate to the plate (s) (by a red cord).

When the tube is hot gently turn the Vplate potentiometer and observe the increase in current by comparing it to the curve shown in the tube specifications.

Valves :

The valves or rectifier tubes can be tested in 2 modes:

Direct mode:

Place the changeover switch C (Tubes / Valves) in the Tubes position.

Before plugging in the tube, position the Vplate potentiometer fully anti-clockwise and, if necessary, press the DISCHARGE button several times to bring the plate voltage to a maximum of 5v.

The connection is made like the other tubes: terminal K to the cathode and terminal Plate to the plate (s) (by a red cord).

When the tube is hot gently turn the Vplate potentiometer and observe the increase in current by comparing it to the curve shown in the tube specifications.

Metrix mode:

Place the changeover switch C (Tubes / Valves) in the Valves position.

Set the plate to 250V and check that the current in the valve is a few tens of mA.

Valves, regulators & cathodic indicator../...

Gas regulators:

The test of these tubes will be carried out with an appropriate value limiting resistor in series with the anode in order to limit the current, the starting voltage will be read directly on the display. Connections between terminal K and Plate (by a red cord).

It is also possible to use the internal 5000 Ohm limiting resistor by placing switch C to the Valves position.

Magic eyes / Cathodic indicators:

The eye brightness test can be done simply by connecting its electrodes to the appropriate terminals and adding, according to the diagram in the instructions, the resistance (s) for the plates.

The opening and closing command is not possible from the G1 terminal of the Duovac because this voltage is pulsed, but it is possible to connect a small external power supply (0 to 20 V and a few mA). The positive pole will be connected to the G3 terminal and the negative output to the eye control grid.

9 Technical features

Size : 330 x 240 x 140 mm

Weight : 4,3 kgs

Supply : 220V – 230V / 50-60 Hz (115 V sur demande) ou 12V par convertisseur

Consumption : 25 à 35 VA max. (Mains)
2 amperes under 12V througyh a 12 to 230V inverter

Mains fuse : 1 A Fast 5 x 20 mm

Measurement Mode: Pulsed, run by a 8 bits micro-computer clocked at 12 MHz

ADC sampling: 10 bit monotonous (1024 points)

Duration of the measurement window: 800 µS

Interval between measurements: 0.5 second

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

Heating voltages* : 4 V – 5 V – 6,3 V

Heating current : 3,5 A maximum

Heating voltage accuracy : better than 5 % , regulated

Grid 1 voltage: 0 à – 100 volts minimum +/- 5%

Grid 2 voltage : 15 à 350 volts minimum +/- 5%

Plate voltage : 2 à 500 volts minimum +/- 5%

Plate current (maximum) : 340 mA

Display resolution, grid 1 voltage: 0.1 volts + / - 1 digit
Display resolution, grid 2 voltage: 1 V + / - 1 digit

Display resolution, plate voltage: 1 V + / - 1 digit

Display resolution, plate current: 0.1 mA + / - 1 digit up to 34 mA
1 mA + / - 1 digit I > 34 mA

Protection courts-circuits et erreurs de connexion par circuits de limitation de courant.

* : Floating voltage Direct heated tubes (DHT) can also be tested.

10 Troubleshooting

- The device does not turn on:

  Check the connection to the mains and the 1 A fuse located on the base.

  If the device is running on battery through a converter check the battery and converter.

- No measurement:

  Press the "TEST" button only.

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

  Check that switch C is placed in the correct position: Tubes for all grid tubes of control and valves for diodes and rectifier tubes (see § 8).

  Check that the heating voltage is applied and correct: Via switches E and F if the heating voltage is carried out by the DuoVac power supply or by the switch F and the connected power supply to the "EXT" terminals if the power supply is external.

  Check the connections to the electrodes of the tube then the voltages G1, G2 and Plate.

- The display indicates "Overload" (« SURCHARGE «):

  Release the "TEST" button and / or the "DISCHARGE" button then disconnect the cords from the Plate and G2 terminals.

- By pressing "TEST" The indications on the display change rapidly and significantly:

  The most probable cause is an entry into oscillation of the tube during the test, this phenomenon is rare but can occur on steeply sloping tubes: contact Radioelec by e-mail to obtain suggestions..

- The display indications are truncated or abnormal:

  Turn off the device using the ON / OFF switch and then turn it on again after about ten seconds.

- The tube to be tested does not fit into the supports:

  Use an adapter that can be connected to one of the supports

Contact : www.radioelec.com