Thyratron

Definition

A Thyratron is a heated triode or tetrode type gas filled tube (Argon, Helium, Krypton, Neon, Xenon or Mercury) that has only two states of operatioen: On/Off.

(there also exist cold cathode thyratrons also referred to as relay tubes which will not be discussed here).

Thyratrons exist in many variations from very small to very big. The big ones can switch very high currents and voltages.

Principle of Operation

The tube is heated with a filament. As with vacuum tubes there exist direct and indirect heated thyratrons. The cathode is connected to ground. If there is a G2 grid present it is normally also connected to ground. The anode is connected to a positive voltage as usual. At the initial state the control grid (or better named ignition grid) has a negative voltage applied. The thyratron is insulating.

When the negative voltage at the control grid is reduced towards ground level the thyratron will ignite (switch on). Then a current flows from the anode to the cathode that can not be controlled by the control grid any longer. Therefore the current must be limited by a resistor (load). The voltage drop across an ignited thyratron, also called running voltage, is small (e.g. for a PL21: ca. 8V).

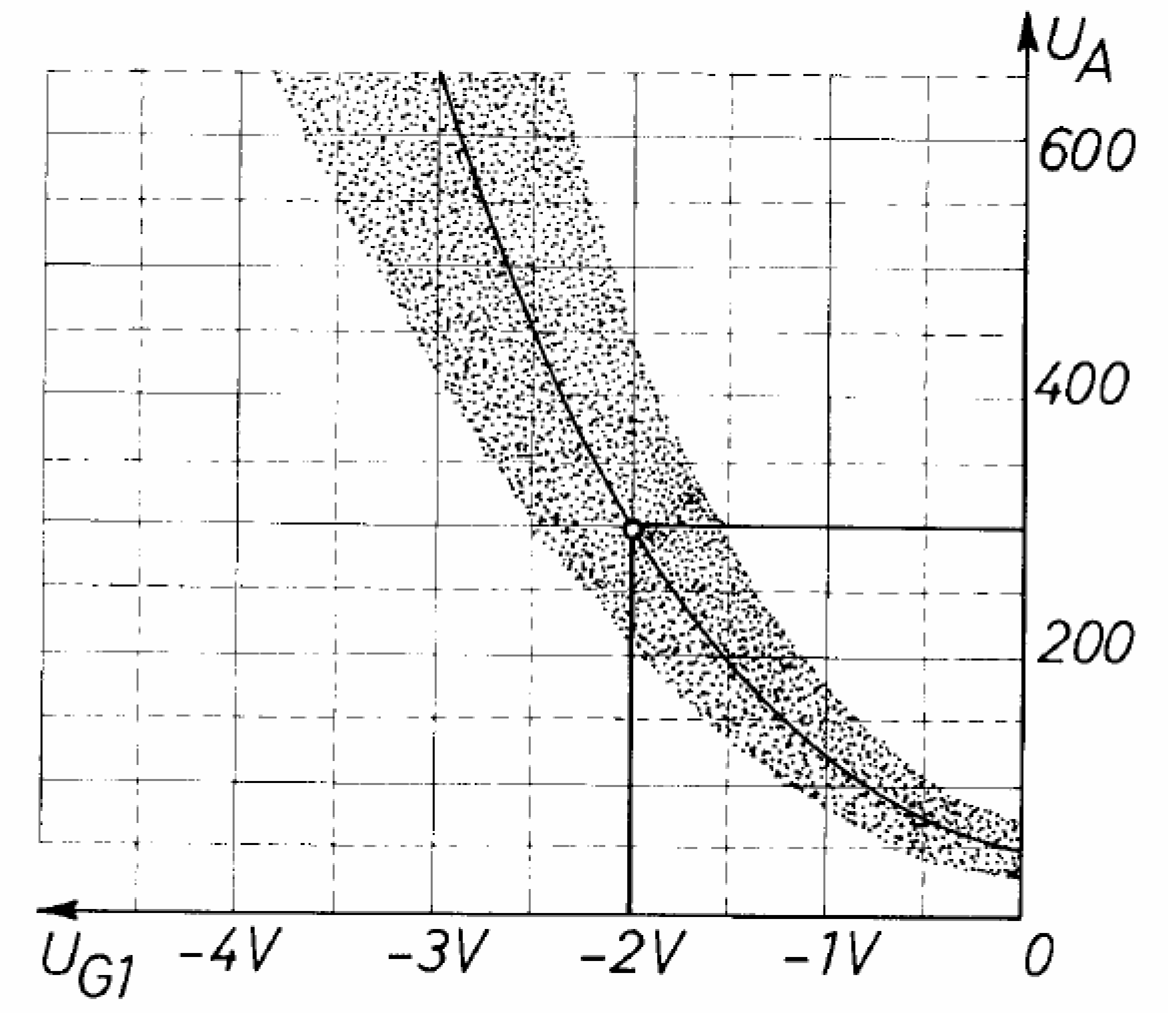
The thyratron cannot be switched off by the control grid voltage. Switching off is only possible by greatly reducing or interrupting the anode voltage. When the thyratron is operated with alternating voltage the interruption occurs at every negative half cycle. Power control is possible with the thyratron by varying the ignition timing at the control grid (phase angle control).

Control grid ignition voltage

Ignition is achieved by reducing the negative grid voltage towards ground level. The grid ignition voltage threshold depends on the construction of the thyratron, the amount of the anode voltage, component tolerances, temperature and the voltage at G2 (if present).

The following diagram from the data sheet of a PL21 shows the relationship of anode voltage and control grid voltage. The gray area marks the possible range of the tube's variation.

At a given anode voltage Ua of 300V ignition would on average happen at Ug of about -2V.



Testing a Thyratron with the RoeTest (since Software V 10.1.0.0)

Testing is possible in “**manual mode with series resistor**” (up to 300V anode voltage).

For that purpose an external resistor must be connected between jacks number 9 and 10.

Testing can be done with a small current. Neither the thyratron (PL21: max. 100mA), nor the resistor or the RoeTest (max. 300mA) must be overloaded!

Example:

At max. Ua = 300V: series resistor 10000 Ohm = max I: 30mA; dissipation 0,03A x 300V = 9W

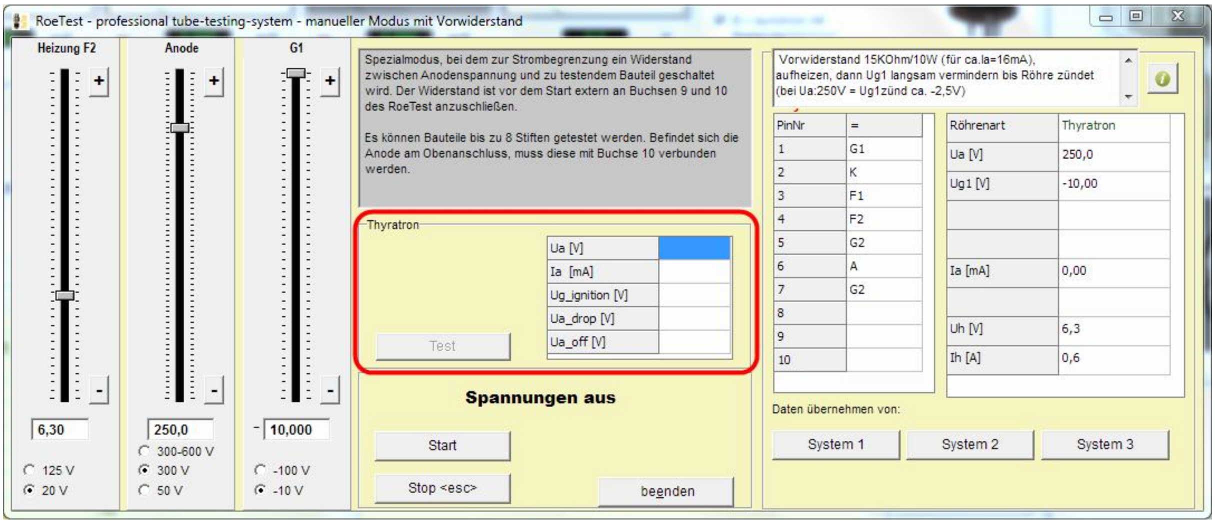
A 10KOhm/10W resistor will be sufficient.

If the thyratron has a top cap for the anode the cap must be connected to jack number 10 of the RoeTest. Thyratrons of up to 8 used pins can be tested in standard sockets (pin 9 and 10 are used internally in the RoeTest). Example: The PL21 has 9 Pins (Noval socket) but only pins 1-7 are used. So the PL21 can be tested with a standard socket. When pins 9 and 10 were used an adapter would be needed.

Test Procedure:

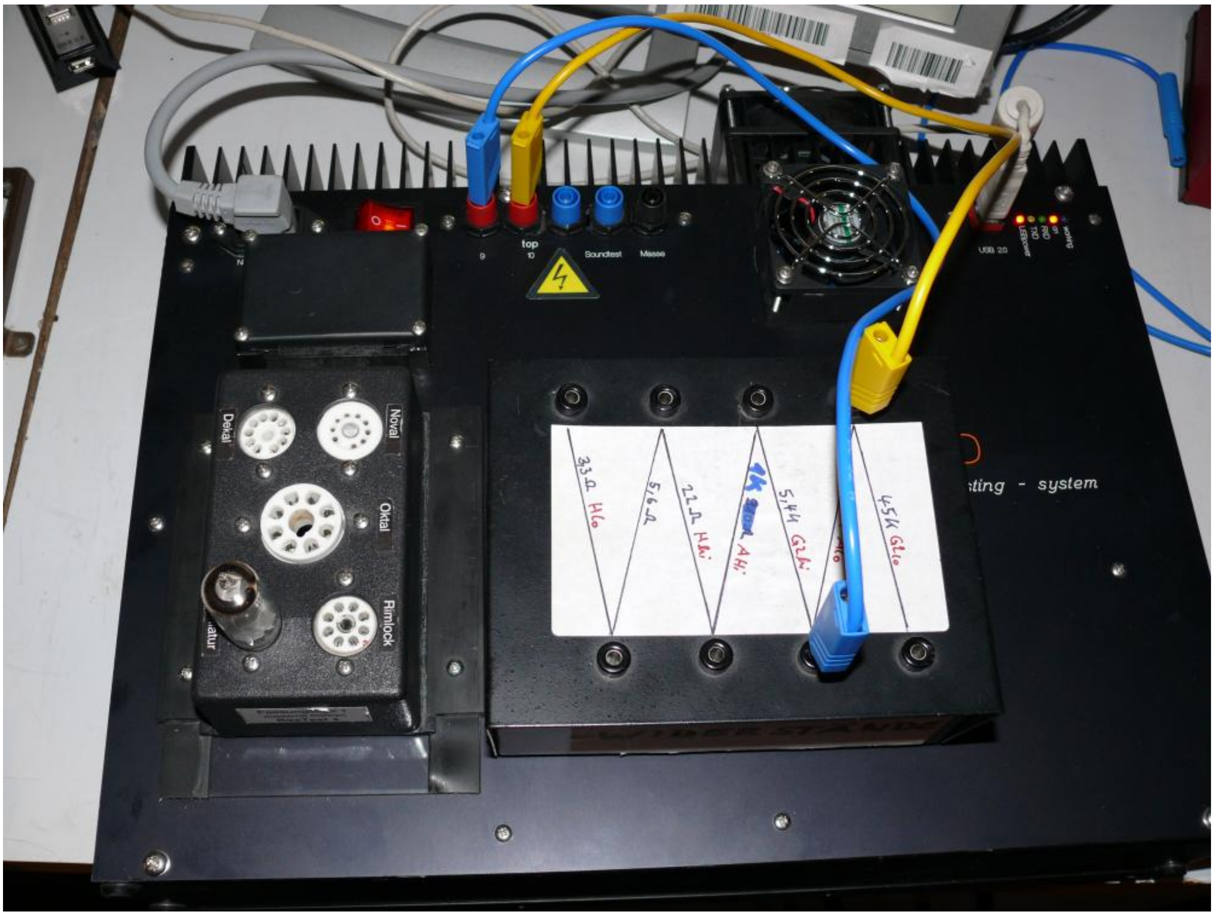
1. Heat up the tube, wait (with the PL21 at least 10 s)
2. Apply a negative control grid voltage (e.g. -10V for the PL21)
3. Apply the anode voltage, e.g. 250V
4. Reduce the negative grid voltage slowly until the thyratron ignites. This is the ignition voltage (Ug1_ignition)
5. Measure anode to cathode voltage at the thyratron. This is the running voltage (Ua_drop)
6. Slowly reduce the anode voltage. This gives the switch off voltage (Ua_off)

Starting with hardware version V9 there exists an automatic function to determine the above mentioned measuring values (with older hardware testing has to be done manually using the sliders).



Example PL21 (Tube type „Thyratron“):

Between jacks number 9 and 10 a series resistor is connected (e.g. 10KOhm/10W)



Thyratrons with large heater currents

In this case heating must be supplied from a separate power supply. The power supply must be floating, i.e. the power supply's outputs must not be connected to earth.

For the tube data the tube type „Thyratron externe H.“ is chosen. **This will connect F1 of the filament automatically to the RoeTest's ground**. F2 of the filament is not connected to the RoeTest.

The external heater voltage must be connected **directly at the tube socket** as follows:

Pin F1: Minus pole of external heater voltage

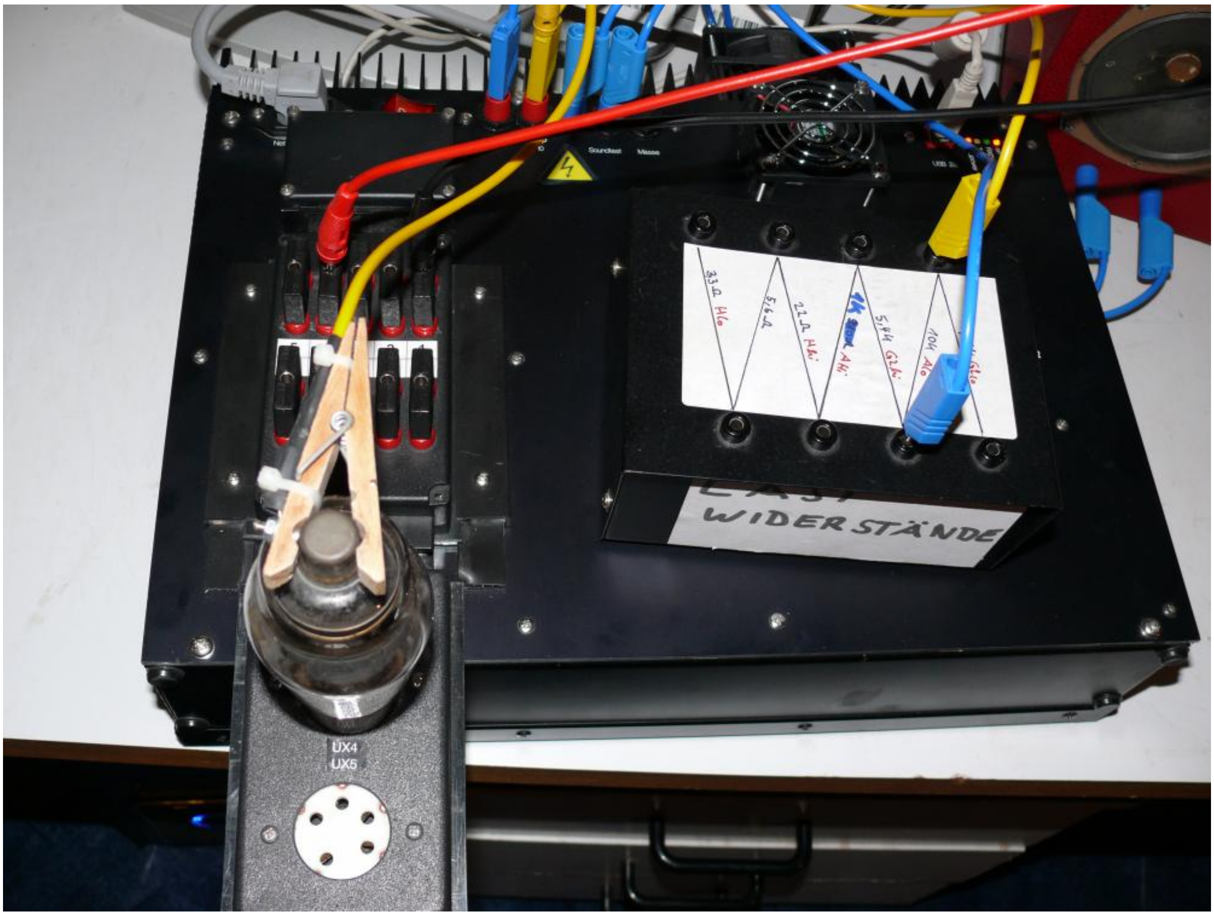
Pin F2: Plus pole of the external heater voltage

Due to the voltage drop across the feed lines the heater voltage should be checked at the tube socket.

Heating of the thyratron must be supplied for some time before measurements can be made (see data sheet of the respective thyratron). Especially with older thyratrons filled with mercury the mercury must first evaporate.

Example PL3C23A (Tube type „Thyratron externe H.“):

1. Connect a series resistor between jacks number 9 and 10 (10KOhm/10W)
2. Connect the top cap of the tube with jack number 10
3. Due to the large heater current of 7A an external heater supply is required. Pin1 (F1) is connected to the negative pole of the external power supply and Pin4 (F2) with the positive pole of the external power supply. NOTE: The external power supply must be floating (no connection of the outputs to ground/earth).



Warnings:

Be careful when dealing with mercury filled tubes. When a break of the tube occurs toxic mercury is set free.

Be careful with manual wiring – there are high and dangerous voltages present. Only use safe laboratory jacks and cables and mount the external resistor in a touch safe insulated package.