

L3-3 MANUAL

WARNING: Please perform these steps **EXACTLY** as described! Failing to do so may damage tester and burn certain components!

Vacuum tubes are powered instantly when you insert them, use gloves to prevent heat damage of skin! Remember, temperature of glass envelope is typically around 200 – 250 degree C.

Remove all pins from the tube parameter setup panel if any.

L1-3 and L3-3 have 2 parameter setup panels with 72 holes each. Further panels will be referred as "I" (top) and "II" (bottom, right above micro-ampermeter).

Put fuse into corresponding slot position (220V, 127V, etc.). Do NOT turn on yet.

Verify if scale is mechanically OK and is in position "0".

Potentiometers Uh ("ГРУБО" and "ПЛАВНО"), Ua, Ug1, Uc2 – left position (counterclockwise)

Rotary switch ИЗОЛЯЦИЯ – position "ПАР", switch "ПАРАМЕТРЫ" – 250.

Rocket switches "μA" and "S" – position "ИЗМЕР."

Open slide doors, turn on tester, and wait for 30 min.

Preliminary check of voltages

Rotary switch "ИЗОЛЯЦИЯ" – position "ПАР", rocket switches "μA" and "S" – position "ИЗМЕР."

Checking power line voltage. Push button "СЕТЬ" and rotary switch "СЕТЬ" to adjust scale to "120".

Take 4 pins and insert them into 1/I (Ug1 = -65V), 20/I (Uc2 = 300V), 26/I (Ua = 300V), 40/II and 52/II (2x450V)

Checking anode voltage. Rotary switch "ПАРАМЕТРЫ" – position "Ua". Push "ИЗМЕРЕНИЕ" and use potentiometer "Ua" to adjust scale to "120".

Checking 250V voltage (used for system blocks). Push "ИЗМЕРЕНИЕ" and use potentiometer "250V" on right side (under slide door) of tester to set scale to "120". Potentiometer is very tough and requires considerable force to turn. Use large screwdriver with insulated handle.

Checking grid #1 voltage. Rotary switch "ПАРАМЕТРЫ" – position "Ug1" ("СЕТКА" in Russian means "grid"). Push "ИЗМЕРЕНИЕ" and use potentiometer "Ug1 – 65V" to adjust scale to "65" (absolute value). Remove pin from 1/I and insert into 2/I. Push "ИЗМЕРЕНИЕ" and use potentiometer "Ug1 – 10V" to adjust scale to "10" (absolute value).

Checking grid #2 voltage. Rotary switch "ПАРАМЕТРЫ" – position "Uc2". Push "ИЗМЕРЕНИЕ" and use potentiometer "Uc2" to adjust scale to "120".

Translation from Russian: "ИЗОЛЯЦИЯ" – "Insulation", "ИЗМЕРЕНИЕ" or "ИЗМЕР." – measurement, "μA" – micro-ammeter, "ПАРАМЕТРЫ" or "ПАР" – parameters, "СЕТКА" – grid of vacuum tube, "СЕТЬ" – power line.

Checking filament voltage

Insert pins 69/II, 70/II (DC filament) and 66/II, 72/II. Then, one by one (one at time!), 21/I, 22/I, 23/I, 24/I, 19/II, 20/II, 21/II, 22/II. Filament voltage (shown on scale without pushing any additional buttons) should gradually drop.

Calibration (to be performed regularly)

First of all, take corresponding perforated card board of any triode, tetrode, or penthode and insert pins. Do not insert any tube!!!

Calibrate transconductance tester (КРУТИЗНОМЕТР). Rotary switch "ПАРАМЕТРЫ" – position "S", rocket switch "S" → "КАЛИБР." Push button "ИЗМЕРЕНИЕ" and adjust scale to "120" with potentiometer "S" – "КАЛИБР.". Then, put rocket switch "S" back into position "ИЗМЕР".

Set "0" of tube micro-ammeter and calibrate it.

Turn rotary switch "ПАРАМЕТРЫ" into position "Ic1". Rocket switch "μA" turn into "ИЗМЕР.", push button "ИЗМЕРЕНИЕ" and use potentiometer "μA" – "ИЗМЕР." to set scale to "0". If its not possible, use potentiometer "УСТ 0" on the left side next to the slide door. Potentiometer is very tough and requires considerable force to turn. Use large screwdriver with insulated handle.

Turn rocket switch "μA" into position "КАЛИБР.", push button "ИЗМЕРЕНИЕ" and use potentiometer "μA" – "КАЛИБР." to set scale in position 120.

IMPORTANT! Turn rocket switch "μA" into position "ИЗМЕР."

WARNING! *It is prohibited to turn rocket switch 'μA' in position "КАЛИБР." with installed vacuum tube for testing.*

Translation from Russian: "КАЛИБР." – calibration, "УСТ 0" – setup of "0" (zero point).

Managing Scale Values

Scale on L1-3 and L3-3 takes time to get used to.

Take any perforated cardboard, for example, 6H13C (6N13S)/6H5C (6N5S) – it corresponds to the USA/European 6080, 6AS7, ECC230, TE46, CV2984, 6520 family of twin triodes, and look closely. You will see 3 lines of parameters to be set or measured.

Top:

$U_h = 6.3V \sim$ – filament voltage

$U_{g1} = -30V (75)$ – grid #1 voltage

$U_a = 90V (150)$ – anode voltage

$U_{k-h} = 250V$ – voltage between filament and cathode (discrete setting with pins)

$R_k = 120\ \Omega$ (discrete setting with pins)

You need to adjust these variable values after inserting pins and installing vacuum tube for testing. Discrete values are set via pins on parameter setup panels I (top) or II (bottom).

Middle:

Для 6Н13С (for 6N13S)

$I_a = 48 \text{ :- } 80 \text{ :- } 112\text{ mA}$ (150) – anode current

$I_{k-h} \leq 100\text{ mA}$ (150) – leakage current between filament and cathode

$S = 3.9 \text{ :- } 5.5 \text{ :- } 7.1\text{ mA/V}$ (7.5) – transconductance

Bottom:

Для 6Н5С (for 6N5S)

$I_a = 25 \text{ :- } 60 \text{ :- } 95\text{ mA}$ (150) – anode current

$I_{k-h} \leq 100\text{ mA}$ (150) – leakage current between filament and cathode

$S = 3.3 \text{ :- } 4.75 \text{ :- } 6.2\text{ mA/V}$ (7.5) – transconductance

Do not overlook small numbers written next to the parameter setup values! This is max measured value which corresponds to the “150” mark on scale! If its 150, it is great, it means scale is absolute (value on scale = real value). If not, scale is relative and therefore, simple math required. For example, for transconductance scale value $150 = 7.5\text{ mA/V}$

Examples:

$U_h = 6.3V$ (15), real value = measured value * 15 / 150, e.g. 63 on scale = 6.3V

$U_{g1} = 250V$ (300), real value = measured value * 300 / 150, e.g. 125 on scale = 250V.

$S = 3.3 \text{ :- } 4.75 \text{ :- } 6.2\text{ mA/V}$ (7.5), real value = measured value * 7.5 / 150, e.g. 95 on scale = 4.75

Conclusion:

RV (Real Value) = SV (Scale Value) * K (coefficient from perforated card board) / 150

For quick tests, just to have scale values: $SV = RV * 150 / K$.

Testing Diodes

Take corresponding perforated card board and insert pins.

Install tube into corresponding socket (its number written on perforated card board in the middle right after word “ПАНЕЛЬ”) below tube model.

Setting filament voltage – use (without pushing buttons “ИЗМЕРЕНИЕ” and “СЕТЬ”) potentiometer “СЕТЬ” (on L1-3) or rotary switch “СЕТЬ” (on L3-3) to adjust voltage to required value – it corresponds to 120 value on scale.

Put rotary switch “ПАРАМЕТРЫ” in position “ИЗОЛ”, and rotary switch “ИЗОЛЯЦИЯ ” into position “КН”. Push button “ИЗМЕРЕНИЕ”. Read leakage value between cathode and filament (absolute value).

Put rotary switches “ИЗОЛЯЦИЯ” into position “ПАР”, and “ПАРАМЕТРЫ” in “I выпр.”. Push button “ИЗМЕРЕНИЕ”, and convert relative scale value into real current For example, for 5C4M scale value 78 will translate $78 \cdot 300 / 150 = 156$ mA, well above minimum.

If particular vacuum diode requires manual adjustment of U_a and I_a , please read below how to setup them (this procedure is identical to all tubes).

Translation from Russian: “КН” (кенотрон) – vacuum diode, “ПАНЕЛЬ ” – socket, “выпр.” – rectified.

Testing Voltage Stabilizers

Note: Scale is absolute in all measurements (value on scale = real value).

Take corresponding perforated card board and insert pins.

Put rotary switches “ИЗОЛЯЦИЯ” into position “ПАР”, and “ПАРАМЕТРЫ” in “ U_a ”, turn potentiometer “ U_a ” into left position (counterclockwise)..

Insert tube into corresponding socket (its number written on perforated card board in the middle right after word “ПАНЕЛЬ”) below tube model.

It should be turned off for the moment.

Rotate potentiometer “ U_a ” clockwise until voltage stabilizer turns on (ignites). Push button “ИЗМЕРЕНИЕ” and write down scale, e.g. 105V (absolute).

Put rotary switches “ПАРАМЕТРЫ” in “ I_a ”, push button “ИЗМЕРЕНИЕ”, and set “ I_a ” equal to min value (written on the perforated card board or in voltage stabilizer datasheet, e.g. 5mA). Switch back rotary switch “ПАРАМЕТРЫ” to “ U_a ”, push button “ИЗМЕРЕНИЕ”, and read voltage value (e.g. $U(I_a=\min) = 105V$).

Turn back rotary switch “ПАРАМЕТРЫ” in “ I_a ”, push button “ИЗМЕРЕНИЕ”, and set I_a to max value (e.g. 40mA) with potentiometer “ U_a ”. Switch back rotary switch “ПАРАМЕТРЫ” to “ U_a ”, push button “ИЗМЕРЕНИЕ”, and read voltage value (e.g. $U(I_a=\max) = 109V$).

Delta of stabilized voltage is calculated as $U_{\Delta} = U(I_a=\max) - U(I_a=\min) - 1$. 1V is a voltage drop of scale's shunt.

Rotate potentiometer "Ua" counterclockwise to the leftmost position and remove tube.

Testing Triodes, Tetrodes and Pentodes

Take corresponding perforated card board and insert pins

Rocket switches "μA" and "S" – position "ИЗМЕР."

Rotary switch "ИЗОЛЯЦИЯ" into position "ПАР".

"Ug1", "Uc2" must be switched in rightmost position (clockwise) to set maximum bias value in order to prevent overheating of tube in testing.

Use rotary switch "ПАРАМЕТРЫ" and potentiometers "Ua" (push button "ИЗМЕРЕНИЕ" on) to set anode voltage to the value specified on perforated cardboard.

Insert tube into corresponding socket (its number written on perforated card board in the middle right after word "ПАНЕЛЬ") below tube model. Without any buttons pushed, scale shows filament voltage (relative value).

Setting filament voltage

AC filament voltage (for power tubes): use (without pushing buttons "ИЗМЕРЕНИЕ" and "СЕТЬ") potentiometer "СЕТЬ" to adjust scale pointer to required value (usually, but not always, filament required voltage corresponds to 120 value on scale, look on particular perforated card board for more info) .

DC filament voltage (for small-signal tubes): Use (without pushing buttons "ИЗМЕРЕНИЕ" and "СЕТЬ") 2 potentiometers "НАКАЛ" → "ГРУБО" and "НАКАЛ" → "ПЛАВНО" to set exact filament voltage. (usually, but not always, filament voltage 12.6V corresponds to 126 value on scale, look on particular perforated card board for more info) .

Translation from Russian: "НАКАЛ" – filament, "ГРУБО" – roughly, "ПЛАВНО" – precisely.

Testing most obvious defects – leakage between filament, cathode and grid(s).

Leakage measurements: Of course, it's impossible to measure leakage current between grid #1 and grid #2 in case of testing triodes :-)

Set voltages "Ua", "Ug1", "Uc2" as written on perforated card board. Be sure to check if scale is absolute or relative in order to correctly interpret values!!!

Put rotary switches "ПАРАМЕТРЫ" into position "ИЗОЛЯЦИЯ" (leftmost counterclockwise). Turn rotary switch "ИЗОЛЯЦИЯ" in positions "КН", "КC1" and "C2C1" to measure required leakage currents (written on perforated cardboard, or may be taken from tube data sheet).

If leakage value is very low (zero or close to zero), hold down button “ИЗМЕРЕНИЕ” and remove pin 38/II ($U_{k-h} = 100V$) or 39/II ($U_{k-h} = 250V$). If scale value remains stationary, it means there are no short between cathode and filament.

Translation from Russian: “КН” (катод/нагреватель) – cathode/filament, “КC1” (катод/сетка #1) – cathode/grid #1, “C2C1” (сетка #1/сетка #2) – grid #1/grid #2 .

If leakage current is within allowed range, put rotary switch “ИЗОЛЯЦИЯ” into position “ПАР”, and then use rotary switch “ПАРАМЕТРЫ” to measure anode current “Ia” (emission test), and then perform transconductance “S” test. Do not forget to push button “ИЗМЕРЕНИЕ”!

Slight vibration of scale pointer during transconductance test is still OK, however, jumps at high range means tube is noisy.

Examples

Penthode **6П14П-ЕВ** (6P14P-EV), analog of 7189, EL84; tube socket #11, perforated card board “П-6” (P-6).

Top:

$U_h = 6.3V$ (15) – DC filament voltage, to be regulated with 2 potentiometers U_h (“ГРУБО” and “ПЛАВНО”).

$U_a = 250V$ (300) – anode voltage

$U_{c2} = 250V$ (300) – grid #2 voltage (grid#1 voltage fixed, discrete setting with pins)

$R_k = 120\ \Omega$ (discrete setting with pins)

Middle:

$I_{k-h} \leq 20\ \text{mA}$ – leakage current between filament and cathode, absolute scale, $U_{k-h} = 250V$ fixed.

Bottom:

$I_a = 40 \text{ :- } 48 \text{ :- } 56\ \text{mA}$ (75) – anode current

$I_{c1} \leq 1\ \text{mA}$ (3) – grid #1 current

$I_{c2} = n/a \text{ :- } 5 \text{ :- } 7\ \text{mA}$ (7.5) – grid #2 current (no min value)

$S = 9 \text{ :- } 11.3 \text{ :- } n/a\ \text{mA/V}$ (15) – transconductance (no max value)

Delta (triangle sign) printed on card means that min or max parameter is not specified and in fact can be any below (or above), depending upon range.

I will describe step by step setting for the first example, but skip these obvious matters in the future.

Rocket switches “μA” and “S” – position “ИЗМЕР.”.

Rotary switch “ИЗОЛЯЦИЯ” – position “ПАР”.

Put perforated card and insert pins into parameter setup panels.

Potentiometer Ua – left position (counterclockwise), minimum value.

Uc2 – right position (clockwise), maximum value.

Potentiometers Uh (“ГРУБО” and “ПЛАВНО”) left position (counterclockwise), minimum value.

Insert vacuum tube, and use potentiometers Uh (“ГРУБО” and “ПЛАВНО”) to set scale to 63 (6.3V DC filament); it should stabilize within 30 – 60 seconds or so.

Rotary switch “ПАРАМЕТРЫ” – position “Ua”; scale value should be 125 ($125 \cdot 300 / 150 = 250$).

Rotary switch “ПАРАМЕТРЫ” – position “Uc2”; scale value should be 125 ($125 \cdot 300 / 150 = 250$).

Rotary switch “ПАРАМЕТРЫ” – position “ИЗОЛЯЦИЯ”, rotary switch “ИЗОЛЯЦИЯ” – position “КН” (leakage current between cathode and filament); scale value 19, real value 19 mA, max allowed value 20 mA, test (almost) OK. If leakage value is very low (zero or close to zero), hold down button “ИЗМЕРЕНИЕ” and remove pin 38/II (located in the middle). If scale value remains stationary, it means there are no short between cathode and filament.

Rotary switch “ИЗОЛЯЦИЯ” – position “ПАР”, rotary switch “ПАРАМЕТРЫ” – position “Ic1”; scale value 29, real value $29 \cdot 3 / 150 = 0.58$ mA, max allowed value 1 mA, test OK.

Rotary switch “ИЗОЛЯЦИЯ” – position “ПАР”, rotary switch “ПАРАМЕТРЫ” – position “Ic2”; scale value 126, real value $126 \cdot 7.5 / 150 = 6.3$ mA, allowed range 5 -:- 7 mA, test OK.

Emission test. Rotary switch “ИЗОЛЯЦИЯ” – position “ПАР”, rotary switch “ПАРАМЕТРЫ” – position “Ia”; scale value 90, real value $90 \cdot 75 / 150 = 45$ mA, range is 40 (low), 45 (average), 48 (high), test value is OK.

Transconductance test. Rotary switch “ИЗОЛЯЦИЯ” – position “ПАР”, rotary switch “ПАРАМЕТРЫ” – position “S”; scale value 102, real value $102 \cdot 15 / 150 = 10.2$, test OK.

Scale values for quick emission & transconductance tests:

$$SV = RV \cdot 150 / K$$

$$SV f(Ia) = 80/96/112 \text{ (low/average/high)}$$

$$SV f(S) = 90/113 \text{ (min/max)}$$

Twin triode **6080**, analog of **6H13C** (6N13S), 6H5C (6N5S), 6AS7, ECC230, TE46, CV2984, 6520; tube socket #7, perforated card board “H-20” (N-20) for triode #1, “H-23” (N-23) for triode #2.

Top:

$U_h = 6.3V \sim$ – AC filament voltage, to be adjusted with potentiometer (on L1-3) or rotary switch (L3-3) labeled “CETb”, 6.3V will correspond to the “120” on scale..

$U_{g1} = -30V$ (75) – grid #1 voltage

$U_a = 90V$ (150) – anode voltage

$U_{k-h} = 250V$ – voltage between filament and cathode (discrete setting with pins)

$R_k = 120 \text{ ohm}$ (discrete setting with pins)

Middle:

Для 6Н13С (for 6N13S)

$I_a = 48 \text{ :- } 80 \text{ :- } 112 \text{ mA}$ (150) – anode current

$I_{k-h} \leq 100 \text{ mA}$ (150) – leakage current between filament and cathode

$S = 3.9 \text{ :- } 5.5 \text{ :- } 7.1 \text{ mA/V}$ (7.5) – transconductance

Bottom:

Для 6Н5С (for 6N5S)

$I_a = 25 \text{ :- } 60 \text{ :- } 95 \text{ mA}$ (150) – anode current

$I_{k-h} \leq 100 \text{ mA}$ (150) – leakage current between filament and cathode

$S = 3.3 \text{ :- } 4.75 \text{ :- } 6.2 \text{ mA/V}$ (7.5) – transconductance

Look at the perforated card board “H-23” (N-23) for triode #2. In the middle it lists 2 parameters: “ $S \geq 2.8 \text{ mA/V}$ ” and “ $I_a \geq 30 \text{ mA}$ ”, noted with asterisk “”. If your tube tests above these values, it means it still have long life expectancy before being worn out.*

We take values for Russian 6N13S, which is the same as 6080 but uses different glass envelope.

$U_a = 90V$ (absolute value)

$U_{g1} = 60 \cdot 75 / 150 = 30V$

$I_{k-h} = 50 \text{ mA}$ (absolute value) $\leq 100 \text{ mA}$, leakage current between cathode and filament test is OK.

$I_a = 85 \text{ mA}$ (absolute value), well above average, emission test is OK.

$S = 120 \cdot 7.5 / 150 = 6$, well above average, transconductance test is OK.

Scale values for quick emission & transconductance tests:

$SV = RV \cdot 150 / K$

SV f(Ia) = 26/60/98 (low/average/high)

SV f(S) = 70/100/130 (low/average/high)

WARNING: Some early runs of 6N5S have manufacturing defect – short between cathode and filament, so perform “KH” test ASAP after installing tube!

Beam high-frequency tetrode 6Ж3П (6J3P), analog of 6AG5, 6BC5, 6CE5, EF96, 6186

tube socket #10, perforated card board “Ж-19” (J-19), “Ж-20” (J-20), “Ж-21” (J-21).

Perforated card board J-20 (testing leakage, emission, transconductance, and grid #2 current)

Uh = 6.3V (15), Ua = 250V (300), Uc2 = 150V (300)

I_{k-h} ≤ 25 mA (U_{k-h} = 100V), *S ≥ 3.25 mA/V

I_a = 5.2 :- 7 :- 8.8 mA (15), I_{c2} = 1.3 :- 2 :- 2.7 mA (3), S = 4:- 5 :- 6 mA/V (7.5)

Scale Values for I_a = 52 :- 70 :- 88

Scale Values for I_{c2} = 65 :- 100 :- 135

Scale values for S = 80 :- 100 :- 120

Perforated card board J-20 (testing leakage and grid #1 current)

Uh = 6.3V (15), Ug1 = -2V (3), Ua = 250V (300), Uc2 = 150V (300)

I_{k-h} ≤ 25 mA (U_{k-h} = 100V)

I_{c1} ≤ 1 mA (3)

Scale value for Ug1 = 100

Scale value for I_{c1} ≤ 50

Perforated card board J-21 (I_{axb})

Uh = 6.3V (15), Ug1 = -9V (15), Ua = 250V (300), Uc2 = 150V (300)

I_{axb} ≤ 30 mA (30)

Scale value for Ug1 = 90

Scale value for I_{axb} ≤ 150

Penthode 6Ж4П (6J4P), analog of 6AU6, EF94, tube socket #10, perforated card board “Ж-25” (J-25), “Ж-26” (J-26),

Perforated card board J-25 (testing leakage, emission, transconductance and grid #2 current)

$U_h = 6.3V$ (15), $U_a = 250V$ (300), $U_{c2} = 150V$ (300)

$I_a = 7.7 \text{ :- } 11 \text{ :- } 14.3 \text{ mA}$ (15), $I_{c1} < 0.5 \text{ mA}$ (0.75), $I_{c2} = 2.8 \text{ :- } 4.5 \text{ :- } 6.2 \text{ mA}$ (7.5), $S = 4.8 \text{ :- } 5.7 \text{ :- } 7 \text{ mA/V}$ (7.5)

Perforated card board J-25 (testing leakage, emission, transconductance and grid #2 current)

$U_h = 6.3V$ (15), $U_a = 250V$ (300), $U_{g1} = -5V$ (7.5), $U_{c2} = 150V$ (300)

$I_a < 1 \text{ mA}$ (I_{axb}) (1.5)

Beam tetrode 6П1П (6P1P), analog of 6AQ5, EL90 and the 6V6, tube socket #11, perforated card board “П-7” (P-7).

$U_h = 6.3V$ (15), $U_a = 250V$ (300), $U_{g1} = -12.5V$ (15), $U_{c2} = 250V$ (300)

Voltage on both grids are regulated (no discrete values).

$I_{k-h} \leq 30 \text{ mA}$ (150), $U_{k-h} = 250V$ – voltage between filament and cathode (discrete setting with pins)

$I_{c2} \leq 7 \text{ mA}$ (7.5), $I_{c1} \leq 1 \text{ mA}$ (3)

$I_a = 33 \text{ :- } 44 \text{ :- } 55 \text{ mA}$ (75), $S = 3.8 \text{ :- } 4.9 \text{ :- } 6 \text{ mA/V}$ (7.5)

Scale value for $U_a = 125$

Scale value for $U_{g1} = 125$

Scale value for $U_{c2} = 125$

Scale value for $I_{c1} \leq 50$

Scale value for $I_{c1} \leq 140$

Scale values for $I_a = 66 \text{ :- } 88 \text{ :- } 110$

Scale values for $S = 76 \text{ :- } 98 \text{ :- } 120$