



ELECTRONIC TUBE REFERENCE

18045

Power - Pentode Single (NOT beam) (under 10W) electronic tube

CONSOLIDATED TECHNICAL
DATA

1 SECTION
CONSTRUCTION
PENTODE

Long-life Philips output pentode for telephone and communications equipment, documented for service exceeding 10,000 hours.

GENERAL CHARACTERISTICS

BASE DESIGNATION	—	BASE PINS	9
NOMINAL HEATER	18 V / 130 mA	PARALLEL HEATER	— / —
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION1 Pentode	
TRANSCONDUCTANCE	0.011 S
AMPLIFICATION FACTOR	36
MAXIMUM PLATE VOLTAGE	210 V
MAXIMUM SCREEN VOLTAGE	210 V
MAXIMUM PLATE DISSIPATION	4.5 W
MAXIMUM SCREEN DISSIPATION	1.2 W
MAXIMUM CATHODE CURRENT	30 mA
<i>Special-quality long-life output pentode for telephone equipment with specified service life exceeding 10,000 hours.</i>	

18045 — Special Quality Output Pentode

An indirectly heated, high-reliability pentode designed for long-life telephone equipment applications, offering versatile operation as a pre-amplifier or Class A output stage.

Overview

The **18045** is a Special Quality (SQ) output pentode engineered primarily for use in telephone equipment. Designed for high reliability and an exceptionally long operating life exceeding 10,000 hours, this tube features an indirectly heated cathode, a Noval (9-pin) base, and a compact glass envelope. It is capable of operating as both a high-gain pre-amplifier and a Class A output stage, delivering robust performance with controlled distortion and stable electrical parameters over its service life.

Construction, Mechanical Data, and Pinout

The 18045 is housed in a glass envelope with a maximum diameter of 22 mm, a maximum height of 61 mm (excluding pins), and a maximum total height of 67 mm. It utilizes a standard 9-pin Noval base. The tube includes internal shielding to minimize noise and unwanted coupling.

Depending on the specific production configuration, the pinout assignments for Pin 1 and Pin 2 may be swapped. The two documented configurations are:

- **Configuration A:**
 - Pin 1: Internal shield/screen (s)
 - Pin 2: Control Grid (g1)
- **Configuration B:**
 - Pin 1: Control Grid (g1)
 - Pin 2: Internal shield/screen (s)

The remaining pins are consistently assigned as follows:

- Pin 3: Cathode (k)
- Pin 4: Heater (f)
- Pin 5: Heater (f)
- Pin 6: Internal shield/screen (s)
- Pin 7: Anode (a)
- Pin 8: Screen Grid (g2)
- Pin 9: Suppressor Grid (g3)

Heater/Filament Ratings and Supply Tolerances

The 18045 features an indirectly heated cathode designed for either AC or DC operation, supporting both parallel and series supply configurations.

- **Heater Voltage (Vf):** 18 V

- **Heater Current (If):** 0.130 A nominal (with an initial spread of 123 to 137 mA, and a maximum deviation of ± 0.007 A at $V_f = 18$ V). Some specifications list the nominal current as 0.135 A.

To guarantee the minimum 10,000-hour service life, strict supply tolerances must be maintained:

- **Parallel Supply:** The maximum variation of the heater voltage (V_f) must be restricted to less than $\pm 5\%$ (absolute limits).
- **Series Supply:** The maximum variation of the heater current (I_f) due to voltage fluctuations and component tolerances must be restricted to less than $\pm 1.5\%$ (absolute limits).

The cathode heating time is typically 16 seconds (with a maximum of 22 seconds), while the cooling time is typically 15 seconds (with a minimum of 7 seconds).

Interelectrode Capacitances

The interelectrode capacitances of the 18045 are tightly controlled. The values under cold and active conditions are:

- **Anode Capacitance (Ca or Ca/g2g3kfs):** 6.5 $\pm$ 0.7 pF (with an initial spread of 5.8 to 7.2 pF; some specifications list 6.5 $\pm$ 0.6 pF).
- **Grid 1 Capacitance (Cg1 or Cg1/g2g3kfs):** 11.2 $\pm$ 1.2 pF cold (with an initial spread of 10 to 12.4 pF; some specifications list 11.5 $\pm$ 0.8 pF).
- **Active Grid 1 Capacitance (Cg1 at $I_k = 25$ mA):** Increases to 14.3 pF due to space charge effects.
- **Anode to Grid 1 Capacitance (Cag1):** < 0.02 pF.
- **Grid 1 to Heater Capacitance (Cg1f):** < 0.2 pF.
- **Cathode to Heater Capacitance (Ckf):** 4.2 pF.

Additionally, radiation capacitances measured to a surrounding test box (with an inner diameter of 52 mm and a height of 98 mm, with other electrodes earthed) are:

- **Anode Radiation Capacitance (Cra):** < 0.06 pF.
- **Grid 1 Radiation Capacitance (Crg1):** < 0.12 pF.

Typical Electrical Characteristics and End of Life Criteria

Under standard test conditions ($V_a = 210$ V, $V_{g3} = 0$ V, $V_{g2} = 210$ V, and $R_k = 120$ Ohm), the typical characteristics of a new tube are:

- **Anode Current (Ia):** 20 mA nominal (initial spread of 17 to 23 mA).
- **Screen Grid Current (Ig2):** 5.3 mA nominal (initial spread of 4.1 to 6.5 mA).
- **Mutual Conductance (S):** 11 mA/V nominal (initial spread of 9.5 to 12.5 mA/V).
- **Internal Resistance (Ri):** 0.3 MOhm nominal (minimum 0.2 MOhm).
- **Amplification Factor (ug2g1):** 36.
- **Equivalent Noise Resistance (Req H.F.):** 1.2 kOhm.
- **Grid 1 Cutoff Voltage (-Vg1 at $I_a = 0.5$ mA):** Maximum 8.5 V.

- **Negative Grid Current (-Ig1 at Rg1 = 0.1 MOhm):** Maximum 0.5 uA.
- **Hum Voltage (at Rg1 = 0.5 MOhm, heater center earthed):** Maximum 0.2 mV RMS.
- **Insulation Resistance:** Minimum 100 MOhm between any two arbitrary electrodes.
- **Cathode-Heater Insulation (Vkf = 120 V):** Minimum 5 MOhm (with a maximum leakage current Ikf of 24 uA).

The tube is considered to have reached its **End of Life** when any of the following performance limits are met:

- **Anode Current (Ia):** ≤ 13.5 mA.
- **Screen Grid Current (Ig2):** ≤ 3.1 mA.
- **Mutual Conductance (S):** ≤ 7.8 mA/V.
- **Grid Current (-Ig1 at Rg1 = 0.1 MOhm):** ≥ 1.0 uA.

Circuit-Specific Operating Examples

The 18045 can be configured for two primary operating modes:

As a Pre-Amplifier

In pre-amplifier service, the tube operates with a higher cathode resistance to reduce current consumption and optimize voltage gain:

- **Anode Voltage (Va):** 210 V
- **Suppressor Grid Voltage (Vg3):** 0 V
- **Screen Grid Voltage (Vg2):** 210 V
- **Cathode Resistor (Rk):** 180 Ohm
- **Anode Load Resistance (Ra~):** 20 kOhm
- **Anode Current (Ia):** 15 mA
- **Screen Grid Current (Ig2):** 4 mA
- **Mutual Conductance (S):** 10 mA/V
- **Internal Resistance (Ri):** 0.4 MOhm
- **Voltage Gain (g):** 5.15 Nepers (N)

As an Output Tube (Class A)

When configured as a power output stage, the tube is biased for higher current to maximize output power:

- **Anode Voltage (Va):** 210 V
- **Suppressor Grid Voltage (Vg3):** 0 V
- **Screen Grid Voltage (Vg2):** 210 V
- **Cathode Resistor (Rk):** 120 Ohm
- **Anode Load Resistance (Ra~):** 15 kOhm
- **Anode Current (Ia):** 20 mA

- **Screen Grid Current (I_{g2}):** 5.3 mA
- **Mutual Conductance (S):** 11 mA/V
- **Internal Resistance (R_i):** 0.3 MOhm
- **Input Voltage (V_i):** 0.95 V_{RMS}
- **Output Power (W_o):** 1.0 W nominal (minimum 0.7 W) at 5% total distortion (dtot).
- **Low-Power Distortion:** At $W_o = 0.1$ W, the total distortion (dtot) is typically 1.2% (maximum 2.0%).

Absolute Maximum Ratings

The following limiting values are based on the Absolute Maximum Rating System (or Design Centre Rating System where specified) and must not be exceeded under any operating conditions:

- **Anode Voltage, Cold (V_{ao}):** Maximum 550 V
- **Anode Voltage (V_a):** Maximum 210 V
- **Anode Dissipation (W_a):** Maximum 4.5 W
- **Screen Grid Voltage, Cold (V_{g2o}):** Maximum 550 V
- **Screen Grid Voltage (V_{g2}):** Maximum 210 V
- **Screen Grid Dissipation (W_{g2}):** Maximum 1.2 W
- **Cathode Current (I_k):** Maximum 30 mA
- **Grid 1 Voltage (V_{g1} at $I_{g1} = +0.3$ uA):** Maximum -1.1 V
- **Grid 1 Resistor (R_{g1}):**
 - Maximum 0.5 MOhm with automatic grid bias
 - Maximum 0.25 MOhm with fixed grid bias
- **Voltage between Cathode and Heater (V_{kf}):** Maximum 120 V
- **Cathode-Heater Circuit Resistance (R_{kf}):** Maximum 20 kOhm (restricting this value to < 20 kOhm is advised for stable operation)
- **Bulb Temperature:** Maximum 170 °C

Analysis of Characteristic Curves

The behavior of the 18045 is characterized by several key relationships:

- **Transfer Characteristics:** At $V_a = V_{g2} = 210$ V and $V_{g3} = 0$ V, the mutual conductance (S) rises continuously from near zero at $V_{g1} = -8$ V (or -7 V) to approximately 15 mA/V at $V_{g1} = 0$ V. At this zero-bias point, the anode current (I_a) reaches approximately 58 mA.
- **Anode Characteristics:** The I_a versus V_a curves (for grid steps from 0 V down to -6 V) exhibit typical pentode knee behavior, with the knee occurring at low anode voltages below 50 V. A hyperbolic boundary line representing the maximum anode dissipation limit ($W_a = 4.5$ W) restricts the safe operating region at higher voltage and current combinations.
- **Output Power and Distortion:** Under a 15 kOhm load, total distortion (dtot) remains low (below 2%) for output powers up to 0.5 W. Beyond this point, distortion rises progressively, reaching 5% at 1.0 W and approximately 10% near 2.0 W. Above 1.2 W, distortion rises sharply.

- **Load Resistance vs. Output Power:** Plotting output power against load resistance (R_a) from 1 k Ω to 100 k Ω shows that peak power output is centered around a load of 10 k Ω to 15 k Ω , depending on the acceptable distortion limit (1% to 10%) and the grid current start boundary ($I_{g1} = +0.3 \mu A$).
- **Capacitance Variation:** The change in grid 1 capacitance (ΔC_{g1}) increases non-linearly with cathode current (I_k). It rises from 0 pF at $I_k = 0$ mA to approximately 2.7 pF to 3.1 pF at $I_k = 25$ mA, reflecting the expansion of the space charge.

Technical Summary

The **18045** is a high-reliability, Special Quality (SQ) output pentode designed for telephone equipment with a lifetime rating exceeding 10,000 hours. Featuring a 9-pin Noval base and an 18 V, 130 mA heater, it is optimized for stable, long-term operation under strict supply tolerances. With a nominal mutual conductance of 11 mA/V, an internal resistance of 0.3 M Ω , and an anode dissipation limit of 4.5 W, the 18045 serves effectively as a pre-amplifier (yielding a gain of 5.15 Nepers) or as a Class A output stage delivering 1.0 W of power into a 15 k Ω load.

SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1957 Philips Receiving and Amplifying Tubes

Published test conditions and operating points. Values on this page are preserved as reported by this source.

1957 PHILIPS RECEIVING AND AMPLIFYING TUBES

Section 1 · Pentode

CHARACTERISTICS		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode Voltage	210 V	—
Screen Voltage	210 V	—
Anode Current	20 mA	—
Screen Current	5.3 mA	—

SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1963 Philips Electron Tubes Handbook V1

Published test conditions and operating points. Values on this page are preserved as reported by this source.

1963 PHILIPS ELECTRON TUBES HANDBOOK V1

Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	210 V	—
Screen voltage	210 V	—
Cathode resistor	120 ohm	—
Plate current	20 mA	—
Screen current	5.3 mA	—

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Output power	1 W	OutputValve
Distortion	5 %	AtOutputPower=1W

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Transconductance	11000 μ S	—
Plate resistance	0.3 M Ω m	—

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode capacitance	6.5 pF	—
Control-grid capacitance	11.2 pF	—
Cathode-to-heater capacitance	4.2 pF	—



SOURCE OPERATING CONDITIONS

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1963 Philips Electron Tubes Handbook V3

Published test conditions and operating points. Values on this page are preserved as reported by this source.

1963 PHILIPS ELECTRON TUBES HANDBOOK V3

Section 1 · Pentode

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	210 V	Section1
Screen voltage	210 V	Section1
Cathode resistor	120 Ω	Section1
Plate current	20 mA	Section1
Screen current	5.3 mA	Section1
Transconductance	11000 μ S	Section1
Plate resistance	300000 Ω	Section1
Amplification factor	36	Section1

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Minimum power output at end of life	0.7 W	LifeTest

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Power output	1 W	OutputStage
Plate voltage	210 V	TelephonePreamplifier
Plate current	15 mA	TelephonePreamplifier
Screen current	4 mA	TelephonePreamplifier
Load resistance	20000 Ω	TelephonePreamplifier
Plate voltage	210 V	OutputStage
Plate current	20 mA	OutputStage
Load resistance	15000 Ω	OutputStage
Total distortion	5 %	OutputStage

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate capacitance	6.5 pF	Section1
Grid capacitance	11.2 pF	Section1



SOURCE DATA APPENDIX

SOURCE OPERATING CONDITIONS

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1999 Philips 0-D

Published test conditions and operating points. Values on this page are preserved as reported by this source.

1999 PHILIPS 0-D

Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	18 V	Nominal
Heater current	130 mA	Nominal
Maximum plate voltage	550 V	Maximum
Maximum screen voltage	550 V	Maximum

CHARACTERISTICS		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Transconductance	11000 μS	Typical
Anode current	20 mA	Published datasheet table
Anode current	0.5 mA	Published datasheet table
Anode current	15 mA	Published datasheet table
Grid No.2 current	3.1 mA	Published datasheet table
Grid No.2 current	5.3 mA	Published datasheet table
Anode voltage	210 V	Published datasheet table
Grid No.2 voltage	210 V	Published datasheet table
Grid No.2 voltage	550 V	Published datasheet table

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