ELECTRONIC TUBE REFERENCE

18040

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

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

PENTODE

> Special-quality long-life Philips pentode for telephone equipment, usable as either preamplifier or output valve.

General characteristics

BASE DESIGNATION	–	**BASE PINS**	8
NOMINAL HEATER	18 V / 200 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	37
MAXIMUM PLATE VOLTAGE	250 V
MAXIMUM SCREEN VOLTAGE	250 V
MAXIMUM PLATE DISSIPATION	4.5 W
MAXIMUM SCREEN DISSIPATION	1.2 W
MAXIMUM CATHODE CURRENT	30 mA

Special-quality Philips telephone pentode for series or parallel heater supply, usable as preamplifier or output valve.

18040 — Special Quality Pentode

The **18040** (also designated as the **SQ 18040**) is a Special Quality (SQ) pentode designed primarily for high-reliability telephone equipment. Engineered for long life and stable performance, the tube is highly versatile, serving as either a voltage pre-amplifier or a power output valve in telecommunication systems. It features an indirectly heated cathode, a loctal base, and robust electrical characteristics tailored for demanding professional applications.

Mechanical Design and Pinout

The 18040 is constructed with a glass envelope and a standard eight-pin loctal base. The physical dimensions of the tube are tightly controlled to ensure compatibility and mechanical stability:

- **Maximum overall height**: 85 mm
- **Maximum envelope height (excluding pins/base sleeve)**: 70 mm
- **Maximum diameter**: 33 mm

The loctal base configuration provides secure retention and reliable electrical contact. The pin connections, viewed from the bottom of the base, are assigned as follows:

Pin Number	Electrode Connection
Pin 1	Heater (f)
Pin 2	Anode (a)
Pin 3	Screen grid ($g2$)
Pin 4	Suppressor grid and internal shield ($g3, s1$)
Pin 5	External shield ($s2$)
Pin 6	Control grid ($g1$)
Pin 7	Cathode (k)
Pin 8	Heater (f)

Heater and Power Supply Requirements

The 18040 utilizes an indirectly heated, coated unipotential cathode. The heater is designed to operate from either an AC or DC supply and can be integrated into series or parallel heater strings. The nominal heater ratings and strict operational tolerances are:

- **Nominal heater voltage (Vf)**: 18 V
- **Nominal heater current (If)**: 0.2 A
- **Maximum current deviation**: ± 0.01 A at $Vf = 18$ V

To maintain the "Special Quality" reliability standards, the power supply must adhere to the following absolute limits:

- **Parallel Supply**: The maximum permissible variation of the heater voltage (V_f) is restricted to $\pm 5\%$.
- **Series Supply**: The maximum permissible deviation of the heater current (I_f) due to supply voltage fluctuations and component tolerances is restricted to $\pm 1.5\%$.

Electrical Characteristics and Capacitances

Under typical operating conditions, the 18040 exhibits high transconductance and moderate internal plate resistance. The standard test conditions and typical parameters are defined below:

Typical Operating Conditions

- **Anode voltage (V_a)**: 210 V
- **Suppressor grid voltage (V_{g3})**: 0 V
- **Screen grid voltage ($V_{[g2](/tubes/G2)}$)**: 210 V
- **Cathode bias resistor (R_k)**: 120 Ω

Typical Parameters

- **Anode current (I_a)**: 20 ± 3.5 mA
- **Screen grid current ($I_{[g2](/tubes/G2)}$)**: 5.3 ± 1.5 mA
- **Mutual conductance (S)**: 11 ± 2.0 mA/V
- **Amplification factor (screen to control grid, μ_{g2g1})**: 37
- **Internal resistance (R_i)**: 0.3 MΩ (minimum 0.2 MΩ)
- **Equivalent noise resistance (R_{eq})**:
  - High Frequency (H.F.): Maximum 1.2 kΩ
  - Audio/Low Frequency (A.F. / B.F. / N.F.): Maximum 12 kΩ

Interelectrode Capacitances

The tube's internal shielding minimizes parasitic capacitances, which is critical for high-frequency and pre-amplifier stability. The capacitances are measured as:

- **Anode capacitance (C_a)**: 7.5 ± 1.0 pF
- **Control grid capacitance (C_{g1})**: 14.5 ± 1.0 pF
- **Anode to control grid capacitance (C_{ag1})**: < 0.02 pF
- **Control grid to heater capacitance (C_{g1f})**: < 0.02 pF
- **Cathode to heater capacitance (C_{kf})**: 4.5 ± 1.5 pF
- **Control grid capacitance in operating state** (measured at $I_k = 25.3$ mA): 18.5 pF

Circuit-Specific Operating Examples

The 18040 is optimized for two distinct operating modes within telephone and line transmission equipment: as a voltage pre-amplifier and as a power output stage.

Pre-Amplifier Service

When configured as a pre-amplifier, the tube is biased for lower current consumption and higher input impedance:

- **Anode voltage (V_a)**: 210 V
- **Suppressor grid voltage (V_{g3})**: 0 V
- **Screen grid voltage ($V_{[g2](/tubes/G2)}$)**: 210 V
- **Cathode resistor (R_k)**: 185 Ω
- **Anode load resistor (R_a)**: 20 kΩ
- **Anode current (I_a)**: 15 mA
- **Screen grid current ($I_{[g2](/tubes/G2)}$)**: 4 mA
- **Mutual conductance (S)**: 10 mA/V
- **Internal resistance (R_i)**: 0.4 MΩ
- **Voltage gain (g)**: 5.15 N (Nepers)

Output Valve Service

In output stage configurations, the tube is biased to maximize power transfer into the load while maintaining acceptable distortion levels:

- **Anode voltage (V_a)**: 210 V
- **Suppressor grid voltage (V_{g3})**: 0 V
- **Screen grid voltage ($V_{[g2](/tubes/G2)}$)**: 210 V
- **Cathode resistor (R_k)**: 120 Ω
- **Anode load resistor (R_a)**: 15 kΩ
- **Anode current (I_a)**: 20 mA
- **Screen grid current ($I_{[g2](/tubes/G2)}$)**: 5.3 mA
- **Mutual conductance (S)**: 11 mA/V
- **Internal resistance (R_i)**: 0.3 MΩ
- **Output power (W_o)**: 1.0 W
- **Total distortion (d_{tot})**: 5%

Absolute Maximum Ratings

To ensure the long-term reliability and survival of the device, the following absolute maximum limits must not be exceeded under any operating conditions:

Parameter	Absolute Maximum Limit
Anode cold voltage (V_{ao})	500 V
Anode voltage (V_a)	250 V
Anode dissipation (W_a)	4.5 W
Screen grid cold voltage (V_{g2o})	400 V
Screen grid voltage ($V_{[g2](/tubes/G2)}$)	250 V
Screen grid dissipation ($W_{[g2](/tubes/G2)}$)	1.2 W
Cathode current (I_k)	30 mA
Control grid voltage (V_{g1} at $I_{g1} = +0.3\ \mu\text{A}$)	-1.3 V
Voltage between cathode and heater (V_{kf})	50 V
External resistance between cathode and heater (R_{kf})	20 kΩ

Maximum Control Grid Resistor (R_{g1}) Limits

The maximum allowable resistance in the control grid circuit depends on the application and the biasing method:

- **Pre-amplifier, automatic bias**: 1 MΩ
- **Pre-amplifier, fixed bias**: 0.5 MΩ
- **Output tube, automatic bias**: 0.3 MΩ
- **Output tube, fixed bias**: 0.15 MΩ

Dynamic Behavior and Curve Interpretation

Analysis of the tube's characteristic curves reveals several key aspects of its dynamic performance:

- **Transfer Characteristics**: At a constant anode and screen grid voltage of 210 V, the mutual conductance (S) rises almost linearly from near zero at a control grid bias of -7 V up to 15 mA/V as the bias approaches 0 V. Concurrently, the anode current (I_a) curves upward sharply, reaching approximately 55 to 60 mA at $V_{g1} = 0$ V.
- **Anode Characteristics**: The family of I_a versus V_a curves displays classic pentode knee behavior, with the knee occurring below $V_a = 50$ V. The safe operating region at higher anode voltages is strictly bounded by the $W_a = 4.5$ W anode dissipation curve.
- **Distortion and Power Output**: In output configuration ($R_a = 15$ kΩ, $R_k = 120\ \Omega$), total harmonic distortion rises progressively with output power. The distortion is 5% at 1.0 W of output power,

reaching approximately 10% at 1.7 W, and rising to 20% to 22% near the maximum output power of 2.2 W.

- **Output Power vs. Load Resistance**: The output power peaks for various distortion limits (1%, 2.5%, 5%, and 10%) across a range of load resistances from 0.1 kΩ to 100 kΩ. The optimal load resistance for maximizing power output while minimizing distortion lies in the range of 10 kΩ to 15 kΩ.
- **Input Capacitance Variation**: The change in input capacitance (ΔC_i) is highly non-linear with respect to control grid bias. It decreases from approximately 5.2 pF at $V_{g1} = -2$ V down to a baseline of 0.5 to 0.7 pF at $V_{g1} = -8$ V.

End of Life Criteria

For maintenance and performance monitoring in telephone systems, the 18040 is considered to have reached its end of life when its parameters degrade below the following thresholds:

- **Anode current (I_a)**: < 13 mA (under typical operating conditions)
- **Screen grid current ($I_{[g2](/tubes/G2)}$)**: < 3 mA
- **Mutual conductance (S)**: < 7.5 mA/V

Technical Summary

The **18040** is a high-reliability, Special Quality loctal pentode designed for telephone pre-amplifier and output stage applications. Operating with an 18 V, 0.2 A heater, it provides a mutual conductance of 11 mA/V, an amplification factor (μ_{g2g1}) of 37, and an anode dissipation rating of 4.5 W. Its robust mechanical construction, strict heater tolerances, and well-defined end-of-life criteria make it an exemplary choice for professional telecommunications equipment requiring long-term operational stability.

SOURCE OPERATING CONDITIONS

1957 Philips Receiving and Amplifying Tubes

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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 DATA APPENDIX

SOURCE OPERATING CONDITIONS

1963 Philips Electron Tubes Handbook V1

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1963 PHILIPS ELECTRON TUBES HANDBOOK V1

Section 1 · Pentode

OTHER		
PARAMETER	**PUBLISHED VALUE**	**CONDITION / NOTE**
Plate voltage	**210 V**	—
Screen voltage	**210 V**	—
Plate current	**20 mA**	—
Screen current	**5.3 mA**	—
Output power	**1 W**	OutputValve

CHARACTERISTIC		
PARAMETER	**PUBLISHED VALUE**	**CONDITION / NOTE**
Transconductance	**11000 uS**	—
Plate resistance	**0.3 MOhm**	—

CAPACITANCE		
PARAMETER	**PUBLISHED VALUE**	**CONDITION / NOTE**
Anode capacitance	**7.5 pF**	—
Control-grid capacitance	**14.5 pF**	—
Anode-to-control-grid capacitance	**—0.02 pF**	Maximum
Cathode-to-heater capacitance	**4.5 pF**	—

SOURCE OPERATING CONDITIONS

SOURCE PDF

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

OTHER		
PARAMETER	**PUBLISHED VALUE**	**CONDITION / NOTE**
Plate voltage	**210 V**	TelephonePreamplifier
Screen voltage	**210 V**	TelephonePreamplifier
Cathode resistor	**185 Ω**	TelephonePreamplifier
Plate current	**15 mA**	TelephonePreamplifier
Screen current	**4 mA**	TelephonePreamplifier
Plate voltage	**210 V**	OutputStage
Plate current	**20 mA**	OutputStage
Screen current	**5.3 mA**	OutputStage
Load resistance	**15000 Ω**	OutputStage
Power output	**1 W**	OutputStage

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Total distortion	**5 %**	OutputStage

CHARACTERISTIC

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Transconductance	**10000 µS**	TelephonePreamplifier
Plate resistance	**400000 Ω**	TelephonePreamplifier
End-of-life plate current minimum	**13 mA**	LifeTest
End-of-life screen current minimum	**3 mA**	LifeTest
End-of-life transconductance minimum	**7500 µS**	LifeTest

CAPACITANCE

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate capacitance	**7.5 pF**	Section1
Grid capacitance	**14.5 pF**	Section1
Grid-to-plate capacitance maximum	**0.02 pF**	Section1

SOURCE OPERATING CONDITIONS

1999 Philips 0-D

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1999 PHILIPS 0-D

Section 1 · Pentode

OTHER

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	**18 V**	Nominal

TUBE TINKER
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