

ELECTRONIC TUBE REFERENCE

16P12

Power - Triode electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION
CONSTRUCTION
TRIODE

Directly heated water-cooled triode with integral cooling for industrial induction-heating equipment, using a thoriated-tungsten filament suitable for direct switching.

GENERAL CHARACTERISTICS

BASE DESIGNATION	—	BASE PINS	—
NOMINAL HEATER	8 V / 26 A	PARALLEL HEATER	— / —
HEATING	Direct	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION1 Triode	
TRANSCONDUCTANCE	0.0075 S
AMPLIFICATION FACTOR	24
MAXIMUM PLATE VOLTAGE	8000 V
MAXIMUM PLATE DISSIPATION	3000 W
MAXIMUM GRID DISSIPATION	70 W
MAXIMUM CATHODE CURRENT	6 A
Published maximum ratings and characteristics audited; remaining values retained densely in parameter table.	

16P12 — Water-Cooled Industrial Power Triode

The **16P12** is a directly heated, water-cooled power triode designed primarily for use in industrial high-frequency induction heating equipment. Manufactured by Associated Electrical Industries (AEI) under the Ediswan brand and by Standard Telephones and Cables (STC), this robust triode features a thoriated

tungsten filament and an external anode with an integrated cooling coil. The design is optimized for high-power oscillator service, offering high efficiency and direct filament switching capability.

Construction and Cooling System

The 16P12 is constructed with an external anode surrounded by an integral water-cooling coil. This configuration represents a significant design advantage, as it completely obviates the need for a separate, bulky water jacket. The integrated coil provides highly efficient heat transfer directly from the anode structure while maintaining economy in water consumption.

The tube is part of a family of closely related industrial triodes, which includes the **16P13** and **16P14**. These three types share identical electrical characteristics and internal structures, differing solely in the physical positioning and types of their water connectors:

- **16P12** (also designated as **3R/167S**): Features a specific water inlet and outlet configuration aligned with its standard outline, utilizing a vertical cooling coil wound directly around the lower portion of the anode.
- **16P13** (also designated as **3R/167E**): Employs an alternative water jacket connection scheme, featuring union nipples (Enot's 1/4-inch diameter, reference number B17450) and union nuts (Enot's 1/4-inch BSP, reference number B17450) positioned at a 40-degree angle.
- **16P14** (also designated as **3R/167W**): Utilizes a distinct water connector arrangement with different spacing and physical offsets.

The envelope of the 16P12 consists of a heavy glass-to-metal seal structure. The tube is designed to be mounted exclusively in a **vertical position with the base upwards** to ensure proper water flow and filament alignment under operating conditions.

Filament and Base Connections

The 16P12 utilizes a directly heated **thoriated tungsten filament**. Thoriated tungsten provides high electron emission efficiency and mechanical stability at high temperatures. The filament is specifically rated for direct switching, meaning it can withstand the thermal and electrical stresses of being switched directly onto its nominal supply voltage without requiring complex step-start circuitry.

The physical base is a specialized industrial configuration with heavy-duty terminal pins to handle high currents. The physical dimensions and filament parameters are detailed below:

Physical Dimensions

- **Maximum Overall Length:** 211 mm (AEI specification) to 212.7 mm (STC specification)
- **Maximum Base Diameter:** 80.00 mm (3.150 inches)
- **Anode Coil Outer Diameter:** 52.4 mm (2.0625 inches) maximum
- **Terminal Pin Circle Diameter (P.C.D.):** 48.00 mm (1.890 inches)
- **Terminal Pin Diameter:** 7.94 mm (0.312 inches)

Filament Ratings

- **Nominal Filament Voltage (V_f):** 8.0 V (with an allowable variation of $\pm 5\%$)
- **Nominal Filament Current (I_f):** 26.0 A
- **Calculated Filament Power:** 208 W
- **Maximum Usable Emission (Peak Cathode Current):** 6.0 A

Electrical Characteristics

The electrical characteristics of the 16P12 are measured under specific static conditions ($V_a = 5.0$ kV, $I_a = 400$ mA). The tube exhibits a high amplification factor and robust transconductance, making it highly suitable for self-excited oscillator circuits:

- **Amplification Factor (μ):** 24
- **Mutual Conductance (g_m):** 7.5 mA/V
- **Calculated Internal Plate Resistance (r_p):** 3,200 Ω (derived from μ/g_m)

Interelectrode Capacitances

The direct interelectrode capacitances vary slightly depending on the manufacturer's measurement conditions and shielding configurations:

Capacitance Parameter	AEI Specification	STC Specification
Grid to Anode (C_{a-g})	11.5 pF	11.5 pF
Grid to Filament (C_{g-f})	14.5 pF	14.5 pF
Anode to Filament (C_{a-f})	0.8 pF	3.8 pF

The low anode-to-filament capacitance minimizes unwanted direct feedback, ensuring stable operation at high frequencies.

Maximum Ratings

To ensure reliable operation and prevent premature failure, the 16P12 must be operated within its absolute maximum ratings. These limits apply to continuous industrial service:

- **Maximum D.C. Anode Voltage ($V_{a(max)}$):** 8.0 kV (including peak value of direct voltage plus ripple)
- **Maximum Direct Grid Voltage ($V_{g(max)}$):** -1.0 kV
- **Maximum Anode Dissipation ($P_{a(max)}$):** 3.0 kW
- **Maximum Peak Cathode Current ($i_{k(pk) max}$):** 6.0 A
- **Maximum Operating Frequency (Limited by water connections):** 10 Mc/s
- **Maximum Operating Frequency (Limited by valve structure):** 40 Mc/s

The frequency limit of 10 Mc/s imposed by the water connections is due to RF heating effects in the water fittings and the cooling water itself, whereas the tube's internal structure is capable of operating up to 40 Mc/s under modified cooling or reduced power conditions.

Typical Class C Operating Conditions

The primary application of the 16P12 is as a Class C self-oscillator in industrial heating generators.

Typical operating conditions are calculated for two different anode voltage levels:

Parameter	5.0 kV Operation	6.0 kV Operation
Anode Voltage (V_a)	5.0 kV	6.0 kV
Mean Anode Current (I_a)	1.55 A	1.5 A
Mean Grid Current (I_g)	145 mA	135 mA
Grid Bias Voltage (V_g)	-250 V	-350 V
Grid Bias Resistor (R_g)	1.75 k Ω	2.6 k Ω
Peak Cathode Current ($i_{k(pk)}$)	6.0 A	6.0 A
Peak Anode Current ($i_{a(pk)}$)	5.0 A	5.0 A
Peak Grid Current ($i_{g(pk)}$)	1.0 A	1.0 A
Anode Dissipation (P_a)	2.5 kW	2.5 kW
Grid Dissipation (P_g)	70 W	65 W
Anode Efficiency	69%	72%
Power Output (Oscillator)	5.3 kW	6.3 kW
Power Output (at 85% transfer efficiency)	4.5 kW	5.35 kW

These operating points demonstrate that the 16P12 can deliver over 5 kW of high-frequency power with an anode efficiency exceeding 70%. When designing power supplies, care must be taken to account for mains variations and poor regulation, as high peak-to-mean ratios can cause the tube to exceed its absolute maximum ratings.

Cooling Requirements and Water Flow

Because the 16P12 dissipates up to 3.0 kW at the anode, maintaining adequate water flow through the integral cooling coil is critical. The relationship between anode dissipation, water flow rate, and the temperature rise of the cooling water is highly linear:

- **At 1.0 Litre/Minute Flow Rate:** An anode dissipation of 2.0 kW results in a temperature difference of approximately 29°C between the incoming and outgoing water. At 2.5 kW, the temperature difference rises to approximately 36°C.
- **At 1.5 Litres/Minute Flow Rate:** An anode dissipation of 3.0 kW (the absolute maximum rating) produces a temperature rise of approximately 29°C.
- **At 2.0 Litres/Minute Flow Rate:** An anode dissipation of 3.0 kW produces a temperature rise of approximately 21.5°C.

To prevent boiling and localized hot spots on the anode surface, the water flow must be initiated before applying filament or anode voltages and must be maintained for a short period after shutdown.

Characteristic Curves and Design Interpretation

The constant current characteristics (V_g versus V_a) of the 16P12 show a highly linear relationship across the normal operating region. The constant anode current lines run diagonally from the upper-left (high positive grid voltage, low anode voltage) to the lower-right (negative grid voltage, high anode voltage).

For example, to achieve a peak anode current of 5.0 A at an anode voltage of 1.0 kV, the grid must be driven to approximately +350 V. At an anode voltage of 6.0 kV, the same 5.0 A peak current is reached with a grid voltage of approximately +150 V.

The grid current curves show that grid current increases rapidly as the grid voltage becomes more positive than the anode voltage (the region where $V_g > V_a$). In typical Class C operation, the grid is driven positive to ensure low saturation voltage and high efficiency, but the drive power must be managed to keep grid dissipation below the maximum limits of 65 W to 70 W.



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1961 AEI Industrial Valves

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

1961 AEI INDUSTRIAL VALVES

Section 1 · Triode

OTHER

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum operating frequency	40 MHz	ValveLimit
Maximum operating frequency	10 MHz	WaterConnectionsLimit

CAPACITANCE

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode-grid capacitance	11.5 pF	—
Grid-filament capacitance	14.5 pF	—
Anode-filament capacitance	0.8 pF	—

CHARACTERISTIC

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Characteristic anode voltage	5 kV	—
Characteristic anode current	400 mA	—



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1961 Associated Electrical Industries

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

1961 ASSOCIATED ELECTRICAL INDUSTRIES

Section 1 · Triode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum operating frequency	40 MHz	ValveLimit
Maximum operating frequency	10 MHz	WaterConnectionsLimit

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode-grid capacitance	11.5 pF	—
Grid-filament capacitance	14.5 pF	—
Anode-filament capacitance	0.8 pF	—

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Characteristic anode voltage	5 kV	—
Characteristic anode current	400 mA	—



SOURCE DATA APPENDIX

SOURCE OPERATING CONDITIONS

SOURCE PDF

1962 ITT

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

1962 ITT

Section 1 · Triode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Filament voltage	80 V	Filament voltage 80 v
Filament current—nominal [1]	26 A	Filament current—nominal - 26:0 A
Filament current—nominal [2]	0 mA	Filament current—nominal - 26:0 A
Mutual conductance la = [1]	400 mA/V	Mutual conductance la = 400 mA 7-5 mA/V
Mutual conductance la = [2]	7 mA/V	Mutual conductance la = 400 mA 7-5 mA/V
Mutual conductance la = [3]	-5 mA/V	Mutual conductance la = 400 mA 7-5 mA/V
Grid to anode [1]	11	Grid to anode 11-5 pF
Grid to anode [2]	-5	Grid to anode 11-5 pF

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid to filament	145	Grid to filament 145 pF
Anode to filament [1]	3	Anode to filament 3-8 pF
Anode to filament [2]	-8	Anode to filament 3-8 pF
D.C. anode voltage (peak value of direct voltage plus ripple) [1]	8 kV	D.C. anode voltage (peak value of direct voltage plus ripple) 8-0 kv
D.C. anode voltage (peak value of direct voltage plus ripple) [2]	0 kV	D.C. anode voltage (peak value of direct voltage plus ripple) 8-0 kv
Direct grid voltage [1]	-1 kV	Direct grid voltage —1-0 kv
Direct grid voltage [2]	0 kV	Direct grid voltage —1-0 kv
Anode dissipation '	3 kW	Anode dissipation ' 3.0 kw
Anode voltage [1]	5 kV	Anode voltage 5-0 6-0 kV
Anode voltage [2]	0 kV	Anode voltage 5-0 6-0 kV
Anode voltage [3]	6 kV	Anode voltage 5-0 6-0 kV
Anode voltage [4]	0 kV	Anode voltage 5-0 6-0 kV
Mean anode current [1]	1 A	Mean anode current 1-55 1-5 A
Mean anode current [2]	-55 A	Mean anode current 1-55 1-5 A
Mean anode current [3]	1 A	Mean anode current 1-55 1-5 A
Mean anode current [4]	-5 A	Mean anode current 1-55 1-5 A
Mean grid current [1]	145 mA	Mean grid current 145 135 mA
Mean grid current [2]	135 mA	Mean grid current 145 135 mA
Bias voltage [1]	-250 V	Bias voltage —250 ~350 v
Bias voltage [2]	350 V	Bias voltage —250 ~350 v
Peak cathode current [1]	60 A	Peak cathode current 60 60 A
Peak cathode current [2]	60 A	Peak cathode current 60 60 A
Peak anode current [1]	50 A	Peak anode current 50 5-0 A
Peak anode current [2]	5 A	Peak anode current 50 5-0 A
Peak anode current [3]	0 mA	Peak anode current 50 5-0 A
Peak grid current i [1]	1 A	Peak grid current i 1-0 1-0 A
Peak grid current i [2]	0 mA	Peak grid current i 1-0 1-0 A
Peak grid current i [3]	1 A	Peak grid current i 1-0 1-0 A
Peak grid current i [4]	0 mA	Peak grid current i 1-0 1-0 A

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode dissipation [1]	2 kW	Anode dissipation 2-5 2-5 kw
Anode dissipation [2]	-5 kW	Anode dissipation 2-5 2-5 kw
Anode dissipation [3]	2 kW	Anode dissipation 2-5 2-5 kw
Anode dissipation [4]	-5 kW	Anode dissipation 2-5 2-5 kw
Grid dissipation [1]	70 W	Grid dissipation 70 65 w
Grid dissipation [2]	65 W	Grid dissipation 70 65 w
Anode efficiency [1]	69	Anode efficiency 69 72 %
Anode efficiency [2]	72	Anode efficiency 69 72 %
Power output—oscillator [1]	53 kW	Power output—oscillator 53 63 kw
Power output—oscillator [2]	63 kW	Power output—oscillator 53 63 kw
Power output (at [1]	859 kW	Power output (at 859, transfer efficiency) 4-5 5-35 kW
Power output (at [2]	4 kW	Power output (at 859, transfer efficiency) 4-5 5-35 kW
Power output (at [3]	-5 kW	Power output (at 859, transfer efficiency) 4-5 5-35 kW
Power output (at [4]	5 kW	Power output (at 859, transfer efficiency) 4-5 5-35 kW
Power output (at [5]	-35 kW	Power output (at 859, transfer efficiency) 4-5 5-35 kW
INPUT H [[1]	0	INPUT H [0:312 £ 0003 7,94 + 0,13
INPUT H [[2]	312	INPUT H [0:312 £ 0003 7,94 + 0,13
INPUT H [[3]	3	INPUT H [0:312 £ 0003 7,94 + 0,13
INPUT H [[4]	794	INPUT H [0:312 £ 0003 7,94 + 0,13
INPUT H [[5]	13	INPUT H [0:312 £ 0003 7,94 + 0,13