



ELECTRONIC TUBE REFERENCE

1A6

Voltage - Radio Detector Converter electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION
CONSTRUCTION
HEPTODE

Battery or receiving-tube frequency converter combining local-oscillator and mixer action for superheterodyne radio service. Its multi-grid structure provides frequency conversion while minimizing component count and, in battery types, filament power.

GENERAL CHARACTERISTICS

BASE DESIGNATION	6L	BASE PINS	6
NOMINAL HEATER	2 V / 60 mA	PARALLEL HEATER	– / –
HEATING	Direct	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION 1 Heptode	
PLATE RESISTANCE	500000 Ω
TRANSCONDUCTANCE	0.0003 S
MAXIMUM PLATE VOLTAGE	180 V
MAXIMUM SCREEN VOLTAGE	67.5 V
MAXIMUM CATHODE CURRENT	9 mA
<i>Pentagrid converter. Transconductance is conversion transconductance.</i>	

1A6 — Pentagrid Converter Vacuum Tube

A battery-operated, multi-electrode pentagrid converter designed to function simultaneously as an oscillator and mixer in superheterodyne receivers.

Overview

The **1A6** is a glass-envelope pentagrid converter (heptode) designed primarily for use in portable and battery-operated superheterodyne radio receivers. By combining the functions of a local oscillator and a mixer (first detector) within a single envelope, the 1A6 historically replaced the two separate tubes previously required for frequency conversion. This integration allowed for more compact receiver designs and reduced overall filament power consumption.

The tube features a coated filament designed for low-current 2.0-volt DC operation. It is optimized for standard broadcast frequencies, where it delivers reliable translation gain. For high-frequency or wide-band shortwave applications, its performance is somewhat limited by the low mutual conductance of its oscillator section, making related types with higher emission more suitable for those bands.

Physical Construction and Filament Ratings

The 1A6 is constructed with an ST-12 glass bulb (specifically designated as ST-12, ST-12C, or ST-12D in various technical records). It features a small metal top cap connected to the control grid (Grid No. 4) and is fitted with a small 6-pin base (UX base, 6L arrangement). For reliable operation, mounting the tube in a **vertical position** is recommended.

Physical Dimensions

- **Maximum Diameter:** 1-3/16 inches to 1-9/16 inches
- **Maximum Height to Shoulder:** 3-7/8 inches
- **Maximum Seated Height:** 3-22/32 inches
- **Maximum Overall Height:** 4-9/32 inches

Filament Power Supply

The filament is designed for direct-current (DC) operation, drawing a very low current to maximize battery life in portable equipment.

Filament Parameter	Value
Nominal Filament Voltage	2.0 V DC
Maximum Initial Voltage (from new air-cell)	2.15 V DC
Nominal Filament Current	0.060 A (60 mA)

To power the filament, several battery configurations are common:

1. **Dry-cells:** Used in conjunction with a series rheostat and a voltmeter to maintain the correct terminal voltage.
2. **2V Lead Storage-cell:** Connected directly without a series resistor.
3. **Air-cell Battery:** Operated with a fixed series resistor to drop the initial voltage.

4. **Series Operation:** Permissible in multi-tube series strings, provided shunt resistors are installed across the filament terminals to maintain exactly 2.0 V across the 1A6 filament.

Pinout and Electrode Connections

The 1A6 utilizes a small 6-pin base with a top cap. Because historical technical records contain conflicting pinout assignments for the 6L base configuration, designers and technicians must verify the specific wiring of their equipment. The primary documented pinout variations are detailed below:

Pinout Configuration A

This configuration is widely cited in standard receiving tube manuals:

- **Pin 1:** Filament Positive (F+)
- **Pin 2:** Plate (P)
- **Pin 3:** Grid No. 2 (Anode-Grid / Ga)
- **Pin 4:** Grids No. 3 & 5 (Screen / Gs)
- **Pin 5:** Grid No. 1 (Oscillator-Grid / Go)
- **Pin 6:** Filament Negative (F-)
- **Top Cap:** Grid No. 4 (Control-Grid / G)

Pinout Configuration B

An alternative configuration swaps the assignments of several pins:

- **Pin 1:** Filament Positive (F+)
- **Pin 2:** Oscillator Anode / Grid No. 2 (G2)
- **Pin 3:** Screen / Grids No. 3 & 5 (G3, G5)
- **Pin 4:** Oscillator Grid / Grid No. 1 (G1)
- **Pin 5:** Filament Negative (F-)
- **Pin 6:** Anode / Plate (A)
- **Top Cap:** Control Grid / Grid No. 4 (G4)

Pinout Configuration C

Another variation assigns the pins as follows:

- **Pin 1:** Filament (F)
- **Pin 2:** Plate (P)
- **Pin 3:** Anode Grid (Ga)
- **Pin 4:** Oscillator Grid (Go)
- **Pin 5:** Screen Grid (Gs)
- **Pin 6:** Filament (F)
- **Top Cap:** Control Grid (G)

Regardless of the pinout variation, Grid No. 4 always serves as the signal-input control grid via the top cap, while Grids No. 3 and 5 are internally tied together to act as the screen grid.

Electrical Characteristics and Operating Points

The 1A6 operates as a frequency converter by modulating the electron stream with both the local oscillator signal (generated via Grid No. 1 and Grid No. 2) and the incoming radio-frequency signal (applied to Grid No. 4). Typical operating conditions for converter service are documented at plate potentials of 135 V and 180 V:

Parameter	135 V Operating Point	180 V Operating Point
Plate Voltage	135 V	180 V
Screen Grid (G3 & G5) Voltage	67.5 V	67.5 V
Anode Grid (G2) Voltage	135 V	135 V
Anode Grid Supply Voltage	135 V	180 V*
Control Grid (G4) Bias	-3.0 V	-3.0 V
Oscillator Grid (G1) Resistor	50,000 Ω	50,000 Ω
Plate Current	1.2 to 1.8 mA	1.3 to 1.5 mA
Screen Grid Current	2.1 to 2.5 mA	2.0 to 2.4 mA
Anode Grid Current	2.0 to 2.3 mA	2.3 to 2.5 mA
Oscillator Grid Current	0.15 to 0.2 mA	0.2 mA
Total Cathode Current	6.0 to 6.2 mA	6.2 mA
Plate Resistance (Approx.)	0.4 M Ω	0.5 M Ω
Conversion Transconductance	275 μ mhos	300 μ mhos
Control Grid Bias (for 4 μmhos)	-22.5 V	-22.5 V

Oscillator Section Static Characteristics

When the oscillator section is evaluated under non-oscillating static conditions, its characteristics are as follows:

- **Plate Voltage:** 135 to 180 V
- **Screen Voltage:** 67.5 V
- **Anode Grid Voltage:** 135 V (without series dropping resistor)

- **Control Grid Bias:** -3 V
- **Oscillator Grid Voltage:** 0 V
- **Oscillator Transconductance (G1 to G2):** 425 μ mhos
- **Anode Grid Current:** 2.3 mA

Maximum Ratings

To ensure the longevity of the filament and prevent damage to the electrode structures, the following maximum ratings must be observed in converter service:

- **Maximum Plate Voltage:** 180 V
- **Maximum Screen (Grids No. 3 & 5) Voltage:** 67.5 V
- **Maximum Anode Grid (Grid No. 2) Voltage:** 135 V
- **Maximum Anode Grid Supply Voltage:** 180 V (must be applied through a 20,000-ohm series dropping resistor)
- **Minimum Control Grid (Grid No. 4) Bias:** -3 V
- **Maximum Total Cathode Current:** 9 mA

Circuit Design and Application Guidelines

Designing circuits around the 1A6 requires careful attention to electrode voltage relationships, shielding, and feedback mitigation:

1. **Voltage Relationships:** The plate voltage and the anode-grid voltage must always be maintained at a higher potential than the screen-grid voltage.
2. **Anode-Grid Supply:** The anode-grid (Grid No. 2) voltage must never exceed 135 V. If a 180 V supply is used, a 20,000-ohm series dropping resistor bypassed by a 0.1 μ F capacitor is mandatory to protect the grid.
3. **Oscillator Frequency Limit:** The oscillator section is suitable for frequencies up to approximately 10 MHz. At higher frequencies, the low mutual conductance of the oscillator section degrades performance.
4. **Degenerative Feedback Prevention:** A plate load condenser of at least 50 μ F must be connected to prevent degenerative radio-frequency feedback from the plate to the control grid (Grid No. 4).
5. **Gain Control:** The translation gain of the tube is typically around 40. The bias on Grid No. 4 controls this gain. With a screen voltage of 67.5 V, the control grid bias can be varied from -3 V down to the plate current cut-off point, which occurs at approximately -25 V. Lowering the screen voltage reduces this cut-off point.
6. **Shielding:** Complete shielding of the tube using a shield-can is generally necessary in receiver designs to prevent unwanted interstage coupling.

Interelectrode Capacitances

The direct interelectrode capacitances of the 1A6 are highly dependent on the presence of an external shield-can. Approximate values with a shield-can installed are:

Capacitance Parameter	Value
Control Grid (G4) to Plate	0.25 to 0.26 pF
Control Grid (G4) to Anode Grid (<u>G2</u>)	0.2 pF
Control Grid (G4) to Oscillator Grid (G1)	0.1 pF
Oscillator Grid (G1) to Anode Grid (<u>G2</u>)	0.8 pF (some records indicate up to 10.8 pF)
Control Grid (G4) to All Other Electrodes (RF Input)	10.5 pF
Oscillator Grid (G1) to All Other Electrodes (Osc. Input)	5.0 pF
Anode Grid (<u>G2</u>) to All Other Electrodes (Osc. Output)	6.0 pF
Plate to All Other Electrodes (Mixer Output)	9.0 pF

Related Designations and Alternatives

The 1A6 is closely related to several other battery-operated tubes of its era:

- **1D7G:** This tube is identical to the 1A6 in ratings and electrical characteristics, differing only in its physical capacitances.
- **1C6:** A similar pentagrid converter designed for wide-band shortwave coverage. It features a 120 mA filament (double the current of the 1A6) which provides higher electronic emission and higher mutual conductance, making it the preferred choice for high-frequency applications.
- **1C7G:** Shares identical application data with the 1A6, 1C6, and 1D7G when configured as a frequency converter.

Technical Summary

The **1A6** is a **2.0-volt, 60 mA battery-operated pentagrid converter** housed in an **ST-12 glass envelope** with a **small 6-pin base** and a **top cap**. Designed as a combined local oscillator and mixer for superheterodyne receivers, it provides a conversion transconductance of **275 to 300 μ mhos** and an internal plate resistance of **0.4 to 0.5 M Ω** under typical operating conditions.

With a maximum plate voltage rating of **180 V** and a maximum cathode current of **9 mA**, the 1A6 is highly optimized for low-power consumption in portable equipment. While highly effective at standard broadcast frequencies, its oscillator section's low transconductance of **425 μ mhos** limits its high-frequency utility, where the higher-emission **1C6** is preferred.

SOURCE OPERATING CONDITIONS

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1937 Raytheon Radio Receiving Tubes

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

1937 RAYTHEON RADIO RECEIVING TUBES

Section 1 · Heptode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum grid 2 voltage	135 V	—
Maximum grid 2 supply voltage	180 V	ThroughSeriesResistor
Minimum grid 4 bias	-3 V	—
Plate voltage	135 V	FrequencyConverter
Screen voltage	67.5 V	FrequencyConverter
Grid 2 voltage	135 V	FrequencyConverter
Grid 4 bias	-3 V	FrequencyConverter
Oscillator grid resistor	50000 ohm	FrequencyConverter
Plate current	1.2 mA	PlateVoltage=135V
Screen current	2.5 mA	PlateVoltage=135V
Grid 2 current	2.3 mA	PlateVoltage=135V
Oscillator grid current	0.2 mA	PlateVoltage=135V
Total cathode current	6.2 mA	PlateVoltage=135V
Plate voltage	180 V	FrequencyConverter
Plate current	1.3 mA	PlateVoltage=180V

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	0.4 MOhm	PlateVoltage=135V
Conversion transconductance	275 uS	PlateVoltage=135V
Conversion transconductance	300 uS	PlateVoltage=180V
Oscillator-section transconductance	425 uS	NotOscillating



SOURCE OPERATING CONDITIONS

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1940 RCA

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1940 RCA

Section 1 · Heptode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
HeaterVoltageNominal	2 V	Nominal
HeaterCurrentNominal	60 mA	Nominal
Maximum Plate Voltage	180 V	—
Maximum Screen Voltage	67.5 V	—
Maximum Cathode Current	6 mA	—

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Transconductance	425 μ S	Typical
Plate Resistance	600000 ohm	Typical
Oscillator Transconductance	425 μ S	Oscillator section not oscillating



SOURCE OPERATING CONDITIONS

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1948 Brimar Radio Valve Manual

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1948 BRIMAR RADIO VALVE MANUAL

Section 1 · Heptode

APPLICATION		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Service	Frequency changer	—



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1950 Sylvania

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1950 SYLVANIA

Section 1 · Heptode

CHARACTERISTICS

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Conversion transconductance	300 μ S	ConverterService



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195X General Electric Essential Characteristics

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195X GENERAL ELECTRIC ESSENTIAL CHARACTERISTICS

Section 1 · Heptode

OTHER

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	180 V	Converter
Screen voltage	67.5 V	Converter
Grid voltage	-3 V	Converter
Plate current	1.3 mA	Converter
Screen current	2.4 mA	Converter
Oscillator current	0.2 mA	Converter
Oscillator cathode resistor	50000 ohm	Converter
Oscillator plate voltage	180 V	Converter
Oscillator plate series resistor	20000 ohm	Converter

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Oscillator plate current	2.3 mA	Converter



SOURCE DATA APPENDIX

SOURCE OPERATING CONDITIONS

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1961 Tung Sol

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1961 TUNG SOL

Section 1 · Heptode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode-grid voltage	135 V	—

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Conversion conductance	300 μ S	ConverterService

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Control grid to plate	0.26 pF	—

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