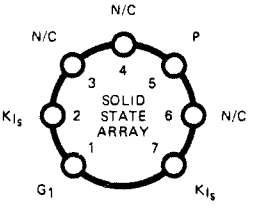
FETRON®
Solid State Vacuum Tube Replacement

TS6AK5 Series

Features

- ZERO WARM-UP
- NO MICROPHONICS
- REDUCED HEAT RADIATION
- MECHANICALLY RUGGED
- TRUE CUTOFF WHEN USED AS SWITCH
- NO SCREEN GRID POWER
- SEMICONDUCTOR RELIABILITY
- LOW NOISE/DISTORTION
- DIRECT REPLACEMENT
- NO HEATER OR SCREEN GRID POWER
- NO TRANSCONDUCTANCE
- DEGRADATION WITH TIME

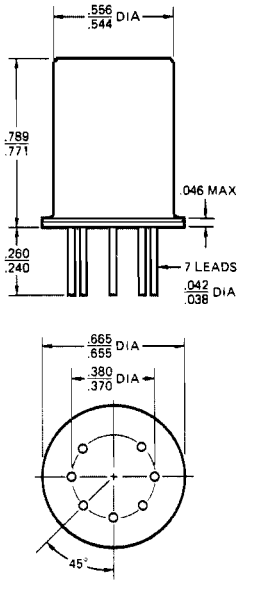
Connection Diagram



Description

The TS6AK5 Series is a 7-pin miniature pentode in a metal hermetic sealed package. It is designed for direct replacement of conventional glass vacuum tubes where greater reliability, stability, and performance are desired. It can be used in RF or IF amplifers/receivers, and in high-frequency wide-band applications up to 200 megahertz. It also excels in audio-frequency application exhibiting no microphonic noise and negligible 1/f noise. Low power consumption is ideal for mobile equipment tube replacement. Three types are available to meet differing applications.

Physical Dimensions



Maximum Ratings

Plate Voltage	180 V
Grid – No. 2 (Screen-Grid) Voltage	N/C
Grid – No. 1 (Control-Grid) Voltage, Positive-bias value	0 V
Plate Dissipation	3.0 W
Screen Grid Dissipation	0 (N/C)
Plate Current	30 mA
Heater-Cathode Voltage	N/C
Operating Temperature Range	−25°C to +125°C

SIMILAR TS6AK5 FAMILY REPLACEMENT TYPES

6AG5, 6AK5W, 403A, 403B. 408A, 5591, 5654, 6028, 6096, 6186, 6968, 7543.

Foreign:

6F32, 12F31, DP61, E95F, EF90F, EF94, EF95, EF96, EF905, HF93, HF94, PM05, M8100, M8180.

Other Available FETRONS

2D21, 6AL5, 6AM6, 6AU6, 6BC5, 6BH6, 6CB6, 6CE5, 6J6, 12AT7, 12AX7, 404A, 407A, 415A, 5590, 5670, 5847, 6688, 7721, E180F.

TELEDYNE SEMICONDUCTOR

General Characteristics

Heater Voltage	N/C (Open)
Heater Current	N/C
Grid No. 1 to Plate Capacitance	0.02 $\mu\mu$F
Grid No. 1 to Cathode Capacitance	4.0 $\mu\mu$F
Grid No. 2 and Grid No. 3 Capacitance	N/C

Recommended Applications by Type

TS6AK5/A1 – This FETRON is designed for general purpose applications at operating frequencies up to 30 MHz. Typical applications include telephone type carriers, FM IF strips operating at 10.7 MHz, Hi-Frequency receivers through the 10 meter band, and DC applications such as analog computers. It is not recommended for use an an FM Limiter.

TS6AK5/A2 – This FETRON should be used in those 6AK5 circuits heavily biased for low plate current operation and having high plate load resistances, typically above 5000 ohms.

TS6AK5/A3 – This FETRON is designed for VHF operation between 30 and 200 MHz. It duplicates 6AK5 vacuum type operating dynamic characteristics up to about 300 MHz. When use in RF Tuners is anticipated, the receiver AGC range should be compared with the TS6AK5/A3 cutoff characteristics to ensure proper operation.

Operating Conditions and Characteristics (At 25°C unless otherwise specified)

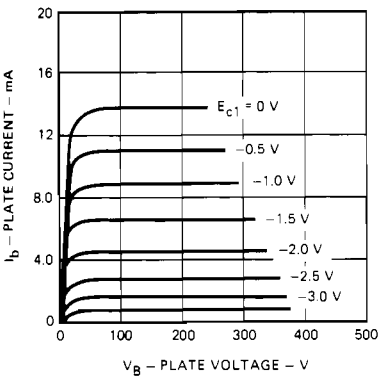
Characteristic	Condition	TS6AK5/A1 General Purpose			TS6AK5/A2 Low Current			TS6AK5/A3 Hi-Frequency			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Plate Supply Voltage			130	180		130	180		130	180	V
Grid No. 2 Supply Voltage			N/C			N/C			N/C		
Cathode Bias Resistor			200			200			200		Ω
Plate Resistance		0.5	5.0		0.5	5.0		0.5	5.0		MΩ
Transconductance @ 1 kHz	R_K = 200 Ω C_K = 4.0 μF	3500	4500	7500	2000	3500	7500	2800	3400	6000	μMHOS
Grid No. 1 Voltage	I_D = 10 μA		−5.0	−8.5		−2.5	−6.0	−3.5		−8.5	V
Plate Current	R_K = 200 Ω	4.0	7.0	10	1.5	3.0	4.5	2.8	4.0	8.0	mA
Grid No. 2 Current			N/A			N/A			N/A		
Useful Frequency Limit			30			30			100	200	MHz
Grid No. 1 Current	E_{c1} = −12 V		0.01	0.1		0.01	0.1		0.01	0.1	μA
Case Operating Temperature	P_p = 2.0 W		67			67			67		°C
Noise Figure	100 MHz									2.0	dB

NOTE: In series filament circuits, all tubes must be replaced by solid state replacements or appropriate resistor connected externally between pins 3 and 4. Some applications may require modified TS6AK5. Consult Teledyne Semiconductor for application information.

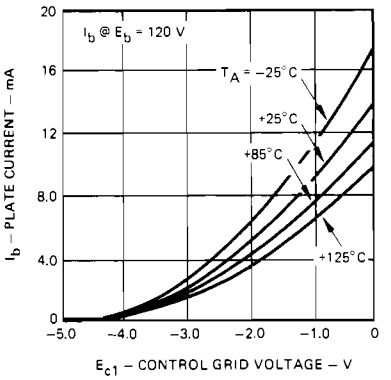
TS6AK5/A1

Typical Characteristics

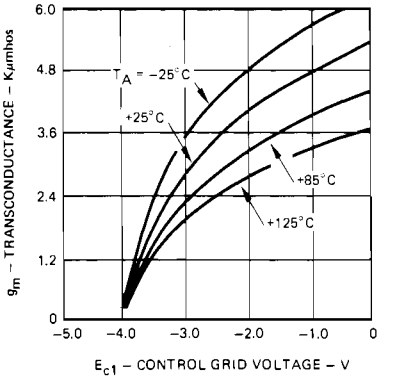
PLATE CHARACTERISTIC



TRANSFER CHARACTERISTIC



TRANSCONDUCTANCE CHARACTERISTIC



BY-PASSED PLATE CHARACTERISTIC

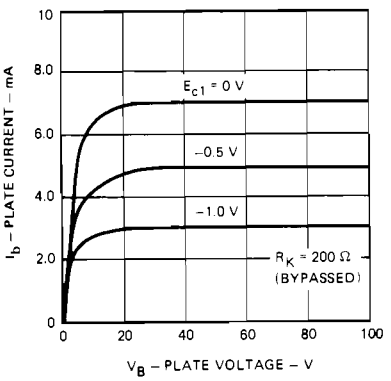
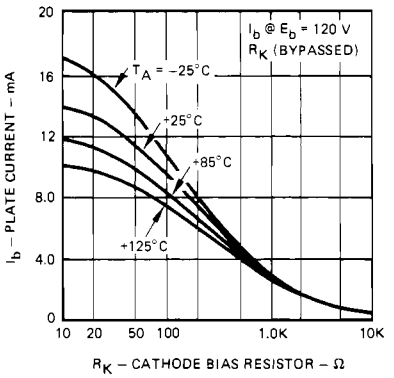
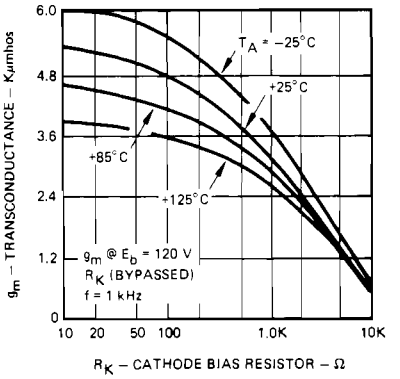


PLATE CURRENT VS. CATHODE BIAS



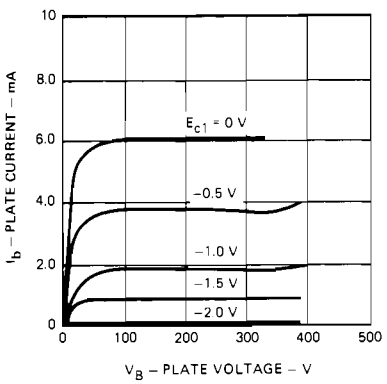
TRANSCONDUCTANCE VS. CATHODE BIAS



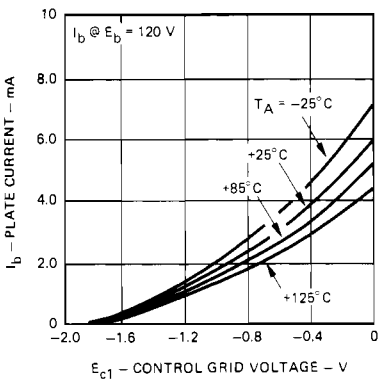
TS6AK5/A2 TS6AK5/A3

Typical Characteristics

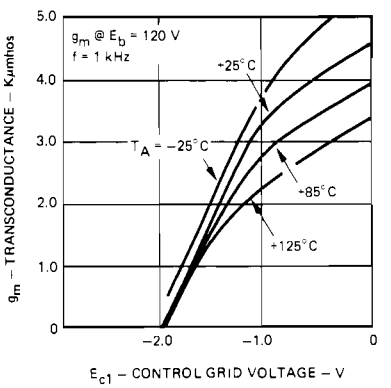
PLATE CHARACTERISTIC



TRANSFER CHARACTERISTIC



TRANSCONDUCTANCE CHARACTERISTIC



BY-PASSED PLATE CHARACTERISTIC

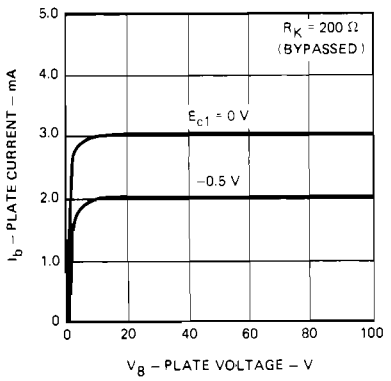
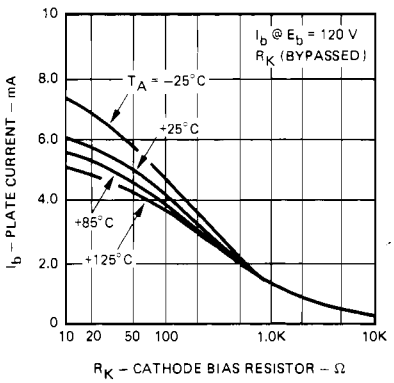
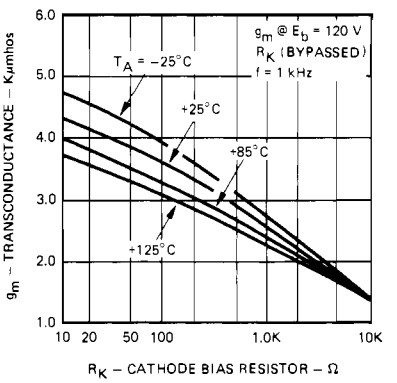


PLATE CURRENT VS. CATHODE BIAS



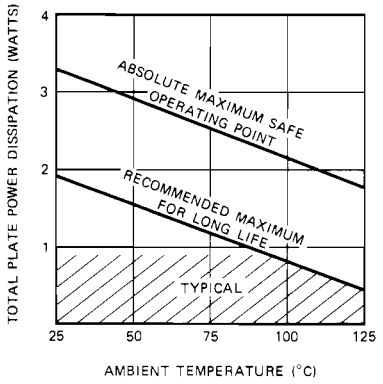
TRANSCONDUCTANCE VS. CATHODE BIAS



User's Guidelines

STEP 1

Determine the plate power dissipation from the circuit of the vacuum tube to be replaced. Use the highest ambient temperature in which the FETRON is expected to operate. Check the chart to ensure that the maximum safe operating point is not exceeded. The recommended maximum shown on the chart is established for a median lifetime of 300,000 hours (34 years).



STEP 2

In series filament circuits, short circuit the filament socket pins (Nos. 3 and 4) and place a 39 Ω, 2 W resistor in series at a convenient location in the filament string. (Special FETRONS with pins 3 and 4 internally short-circuited can be supplied. Consult factory representative).

STEP 3

Check the plate load resistance. If it exceeds 5000Ω select Fetron type TS6AK5/A2.

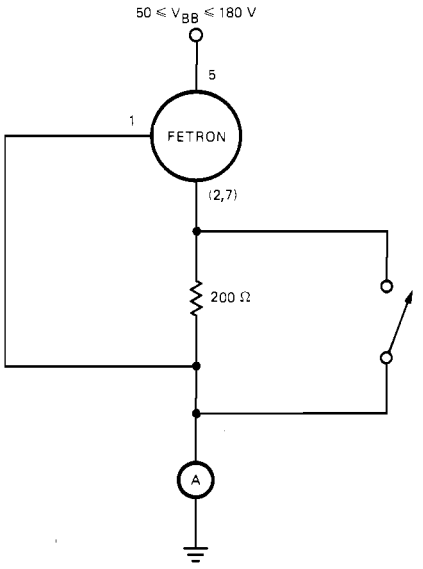
STEP 4

Check the grid circuit AGC and cathode bias resistor. The FETRON should not be used with positive grid-to-cathode bias or in class C operation wherein grid-to-cathode peak positive bias exceeds +1.0 volts. If AGC bias voltage developed in the receiver exceeds −5.0 volts, it is recommended that AGC bias be divided down to −5.0 volts maximum.

How to Test FETRONS

The recommended equipment for testing FETRONS is a vacuum tube or semiconductor curve tracer, such as the Tektronix Model 575. Some mutual-transconductance type tube testers, such as the Hickok Model 539C or 752A, may be used with caution for limited testing but **DO NOT TEST FOR SHORTS OR GASSY TUBES. DO NOT TEST A FETRON WITH AN EMISSION TYPE TUBE TESTER UNDER ANY CIRCUMSTANCES.** Factory warranties are void for all FETRONS tested in such manner.

If a suitable test method is not available, the simple circuit below may be used.



(A) Open the switch. Read cathode (plate) current, I_O. Interpret grid voltage from the formula: $V_G = I_O \cdot 200$.

(B) Close the switch and read cathode (plate) current, I_C.

(C) Interpret transconductance from the formula:

$$g_m = \frac{\Delta I_P}{\Delta V_G} \simeq \frac{I_C - I_O}{V_G} \simeq .005\left(\frac{I_C}{I_O} - 1\right), \text{ m Mhos}$$

TELEDYNE SEMICONDUCTOR

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Heathrow House, Bath Road, Cranford, Middlesex, England • Tel. (44) 01-897-2501 • Telex: UPQ 935008
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MARCH 1974

TELEDYNE SEMICONDUCTOR

TS6AM6*

*Note: Patent Pending

TS6AM6*
Solid State Vacuum Tube Replacement

Features

- ZERO WARM-UP
- NO MICROPHONICS
- REDUCED HEAT RADIATION
- MECHANICALLY RUGGED
- TRUE CUTOFF WHEN USED AS SWITCH
- 500 MHz PERFORMANCE
- NO SCREEN GRID POWER
- SEMICONDUCTOR RELIABILITY
- LOW NOISE/DISTORTION
- DIRECT REPLACEMENT
- NO HEATER POWER
- INTERNALLY RF SHIELDED
- NO TRANSCONDUCTANCE DEGRADATION WITH TIME

Description

The TS6AM6 is a 7-pin miniature pentode in a metal hermetic sealed package. It is designed for direct replacement of the conventional glass vacuum tubes where greater reliability, stability, and performance are desired. Application is primarily in Rf or If amplifiers/receivers especially in high-frequency wide-band applications up to 500 megahertz. It also excels in audio-frequency application exhibiting no microphonic noise and negligible 1/f noise. Low power consumption is ideal for mobile equipment tube replacement.

Maximum Ratings

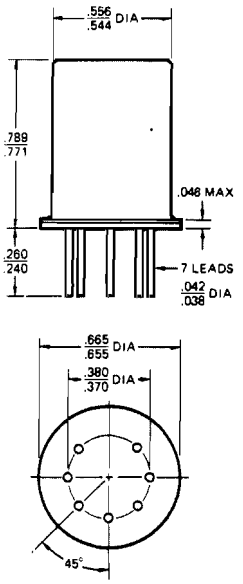
Plate Voltage	300 Volts
Grid – No. 2 (Screen-Grid) Voltage	N/C
Grid – No. 1 (Control-Grid) Voltage, Positive-bias value	0 Volts
Plate Dissipation	2.5 Watts
Screen Grid Dissipation	0 (N/C)
Heater-Cathode Voltage	N/C
Operating Temperature Range	–25°C to +125°C

SIMILAR TS6AM6 FAMILY REPLACEMENT TYPES

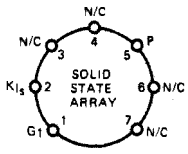
6AK5W, 5654, 6AG5, 6BC5, 6AU6, 12AU6, 7543, 6BH6, 6DT6-A, 12AW6, 3AU6, 3BC5, 3DT6, 4AU6, 4BC5, 408A, 403B, 415A, 6DC6, 403A, 6CE5, 1220, 5591, 6096, 6968, 6136, 6186, 6265, 6661, 7693, 6028.

Foreign:
6F32, DP61, E95F, EF905, EF96, EF94, 12F31, HF93, HF94, EF90F, EF95, M8100, M8180, PM05.

Physical Dimensions



Connection Diagram



TELEDYNE SEMICONDUCTOR 1300 Terra Bella Ave., Mountain View, Ca. 94040 Phone: 415/968-9241 TWX: 910/379-6494

March 1973

1973/Printed in U.S.A.

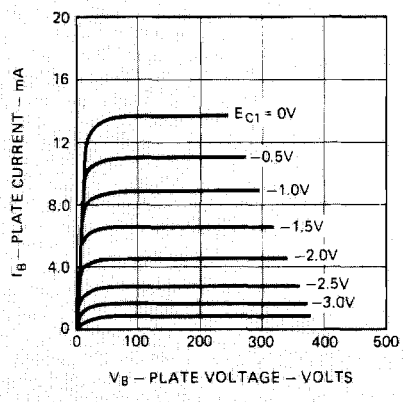
General Characteristics (Stated in conventional tube terminology)

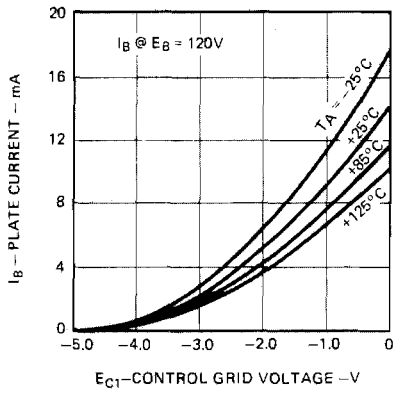
Heater Voltage	N/C (Open)
Heater Current	N/C
Grid No. 1 to Plate Capacitance	0.02μF
Grid No. 1 to Cathode Capacitance	8.0μF
Grid No. 2 and Grid No. 3 Capacitance	N/C

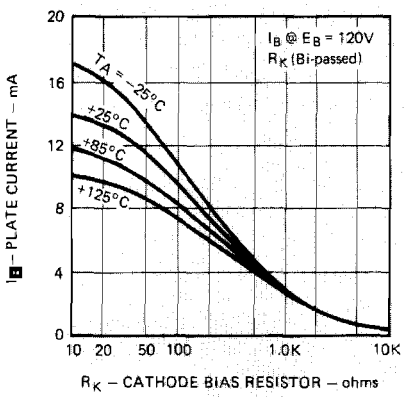
Operating Conditions and Characteristics (At 25°C unless otherwise specified)

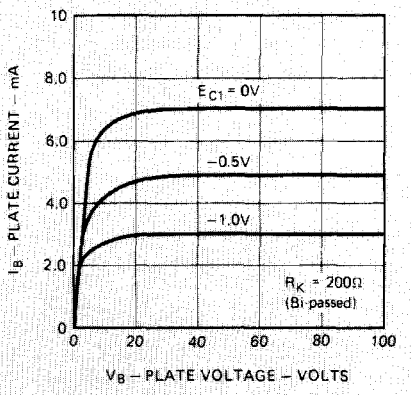
Characteristic	Symbol	Min.	Typ.	Max.	Units
Plate Supply Voltage	E_b		250	300	V
Grid No. 2 Supply Voltage	E_{C2}		N/C		
Grid No. 1 Voltage	E_{C1}		−2		V
Plate Resistance	r_p	0.5	3.0		MΩ
Transconductance	gm	4000	6500	9000	μmhos
Grid No. 1 Voltage for 10μA Plate Current	E_{C1}		− 6.0	−10.0	V
Plate Current	I_b	4.0	10	13	mA
Grid No. 2 Current	I_{C2}		N/C		
Amplification Factor	μ	2000	19500		
Grid Current	I_{C1}		0.5	100	nA

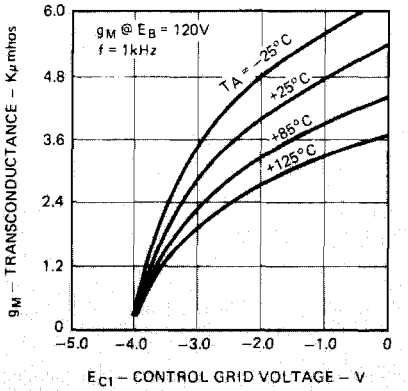
Average Plate Characteristics

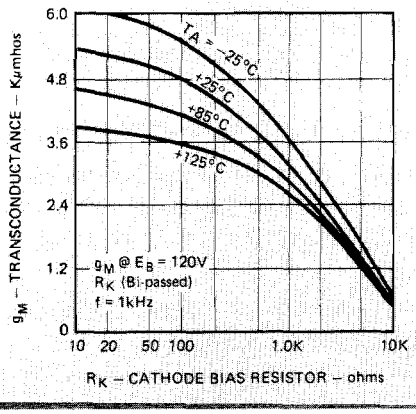












NOTE: In series filament circuits, all tubes must be replaced by solid state replacements or appropriate resistor connected externally between pins 3 and 4. Some applications may require modified TS6AM6. Consult Teledyne Semiconductor for application information.

TELEDYNE SEMICONDUCTOR

TS6CB6A*

*Note: Patent Pending

TS6CB6A*
Solid State Vacuum Tube Replacement

Features

- ZERO WARM-UP
- NO MICROPHONICS
- REDUCED HEAT RADIATION
- MECHANICALLY RUGGED
- TRUE CUTOFF WHEN USED AS SWITCH
- NO SCREEN GRID POWER
- SEMICONDUCTOR RELIABILITY
- LOW NOISE/DISTORTION
- DIRECT REPLACEMENT
- NO HEATER POWER
- INTERNALLY RF SHIELDED
- NO TRANSCONDUCTANCE DEGRADATION WITH TIME

Description

The TS6CB6A is a 7-pin miniature pentode in a metal hermetic sealed package. It is designed for direct replacement of the conventional glass vacuum tubes where greater reliability, stability, and performance are desired. Application is primarily in Rf or If amplifiers/receivers especially in high-frequency wide-band applications up to 175 megahertz. It also excels in audio-frequency application exhibiting no microphonic noise and negligible 1/f noise. Low power consumption is ideal for mobile equipment tube replacement.

Maximum Ratings

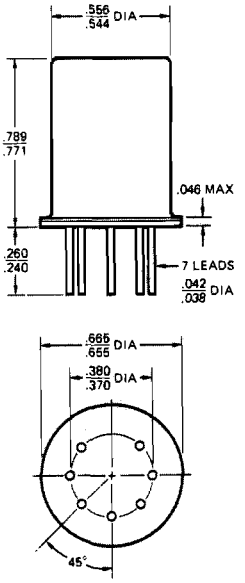
Plate Voltage	300 Volts
Grid – No. 2 (Screen-Grid) Voltage	N/C
Grid – No. 1 (Control-Grid) Voltage, Positive-bias value	0 Volts
Plate Dissipation	2.5 Watts
Screen Grid Dissipation	0 (N/C)
Heater-Cathode Voltage	N/C
Operating Temperature Range	–25°C to +125°C

SIMILAR TS6CB6A FAMILY REPLACEMENT TYPES

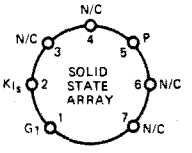
6AK5W, 5654, 6AG5, 6BC5, 6AU6, 12AU6, 7543, 6BH6, 6DT6-A, 12AW6, 3AU6, 3BC5, 3DT6, 4AU6, 4BC5, 408A, 403B, 415A, 6DC6, 403A, 6CE5, 1220, 5591, 6096, 6968, 6136, 6186, 6265, 6661, 7693, 6028, 6AM6.

Foreign:
6F32, DP61, E95F, EF905, EF96, EF94, 12F31, HF93, HF94, EF90F, EF95, M8100, M8180, PM05.

Physical Dimensions



Connection Diagram



TELEDYNE SEMICONDUCTOR 1300 Terra Bella Ave., Mountain View, Ca. 94040 Phone: 415/968-9241 TWX: 910/379-6494

March 1973

 FE-062-33/10M

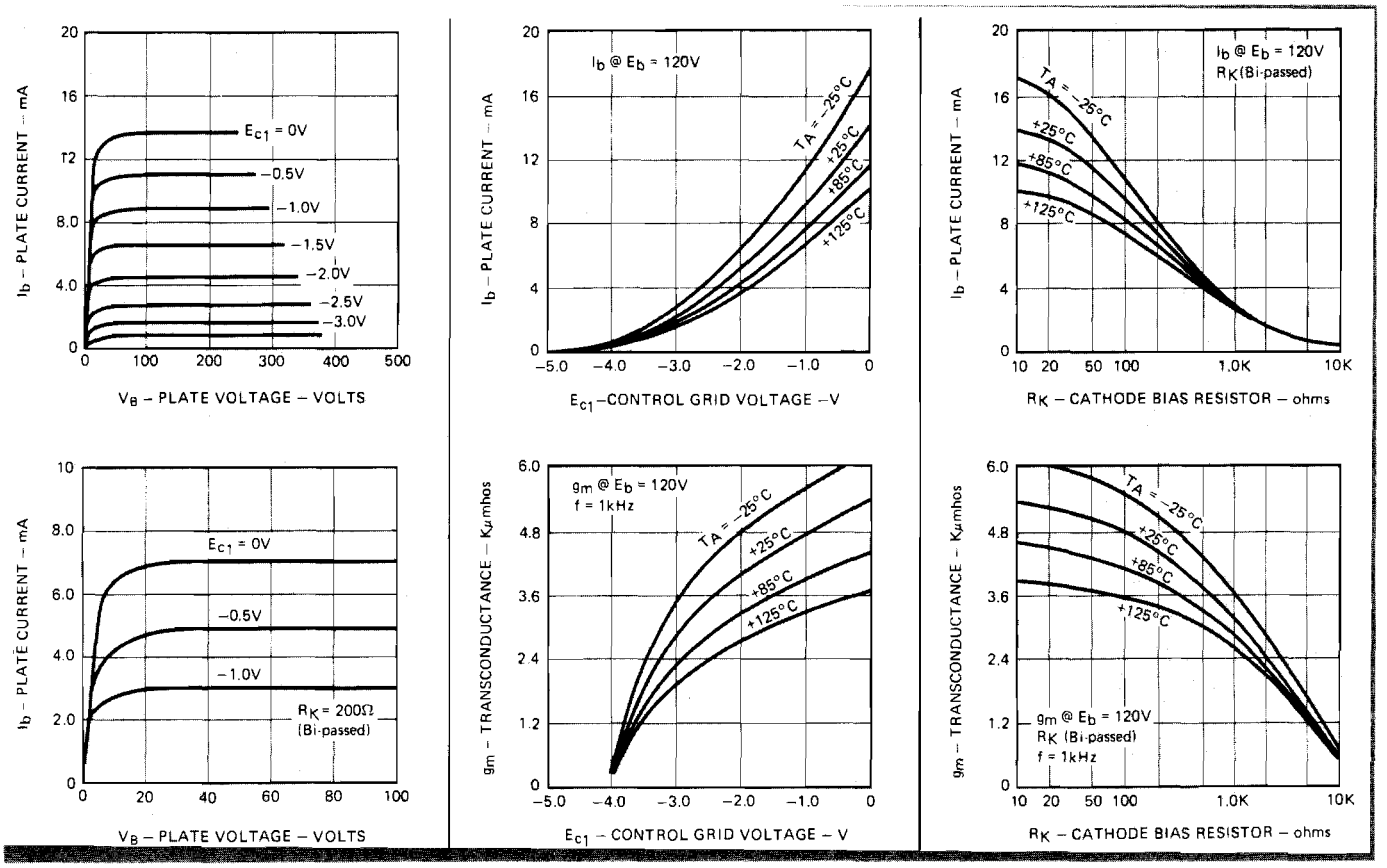
General Characteristics (Stated in conventional tube terminology)

Heater Voltage	N/C
Heater Current	N/C (Open)
Grid No. 1 to Plate Capacitance	0.02μμF
Grid No. 1 to Cathode Capacitance	8.0μμF
Grid No. 2 and Grid No. 3 Capacitance	N/C

Operating Conditions and Characteristics (At 25°C unless otherwise specified)

Characteristic	Symbol	Min.	Typ.	Max.	Units
Plate Supply Voltage	Eb		125	300	V
Grid No. 2 Supply Voltage	Ec_2			N/C	
Grid No. 1 Voltage	Ec_1		−3		V
Plate Resistance	rp	0.5	3.0		MΩ
Transconductance	gm	4000	7000	9000	μmhos
Grid No. 1 Voltage for 10μA Plate Current	Ec_1		−6.0	−10.0	V
Plate Current	Ib	4.0	10	13	mA
Grid No. 2 Current	Ic_2		N/C		
Amplification Factor	μ	2000	21000		
Grid Current	Ic_1		0.5	100	nA

Average Plate Characteristics



NOTE: In series filament circuits, all tubes must be replaced by solid state replacements or appropriate resistor connected externally between pins 3 and 4. Some applications may require modified TS6CB6A. Consult Teledyne Semiconductor for application information.

TELEDYNE SEMICONDUCTOR

TS12AT7*

*NOTE: Patent Pending.

TS12AT7*
Solid State Vacuum Tube Replacement

Features

- ZERO WARM-UP
- NO MICROPHONICS
- REDUCED HEAT RADIATION
- MECHANICALLY RUGGED
- TRUE CUTOFF WHEN USED AS SWITCH
- NO SCREEN GRID POWER
- SEMICONDUCTOR RELIABILITY
- LOW NOISE/DISTORTION
- DIRECT REPLACEMENT
- NO HEATER POWER
- INTERNALLY RF SHIELDED
- NO TRANSCONDUCTANCE DEGRADATION WITH TIME

Description

The TS12AT7 is a 9-pin miniature double triode in a metal hermetic sealed package. It is designed for direct replacement of the conventional glass vacuum tubes where greater reliability, stability, and performance are desired. It is used as push-pull cathode-drive amplifier or frequency converter in the FM range, multivibrators or oscillators in industrial control devices, phase inverters, clamp circuit, relay drivers, and other diversified applications. The low power consumption makes it ideal for mobile equipment tube replacement.

Maximum Ratings

Plate Voltage	250 Volts
Grid Voltage, Negative bias value	−50 Volts
Plate Dissipation	5.0 Watts
Peak Heater-Cathode Voltage	N/C
Maximum Grid Circuit Resistance	2.0 Megohms
Operating Temperature Range	−25°C to +125°C
Plate Current	30 mA

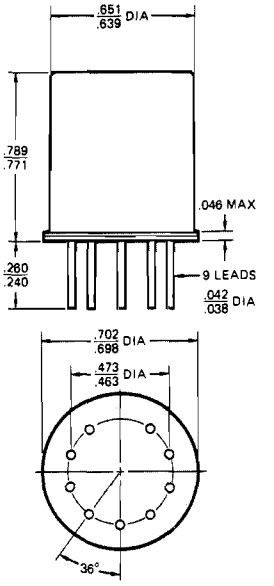
SIMILAR TS12AT7 FAMILY REPLACEMENT TYPES

12AU7, 6BC8, 6BQ7-A, 6CG7, 6J6, 7AU7, 9AU7, 8CG7, 12AV7, 6DT8, 6EV7, 12BZ7, 6201, 6679, 6189, 5814A, 6680, 6072, 396A, 407A, 407B, 12AX7, 12AZ7, 6BZ7, 6BZ8.

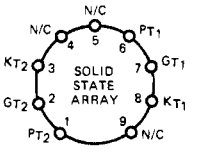
Foreign:

B152, B309, B739, ECC81, ECC82, E81CC, E82CC, ECC801, ECC801S, ECC802, ECC802S, ECC186, B329, B749, M8136, M8162, QB309, QA2406.

Physical Dimensions



Connection Diagram



TELEDYNE SEMICONDUCTOR 1300 Terra Bella Ave., Mountain View, Ca. 94040 Phone: 415/968-9241 TWX: 910/379-6494

March 1973

General Characteristics (Stated in conventional tube terminology)

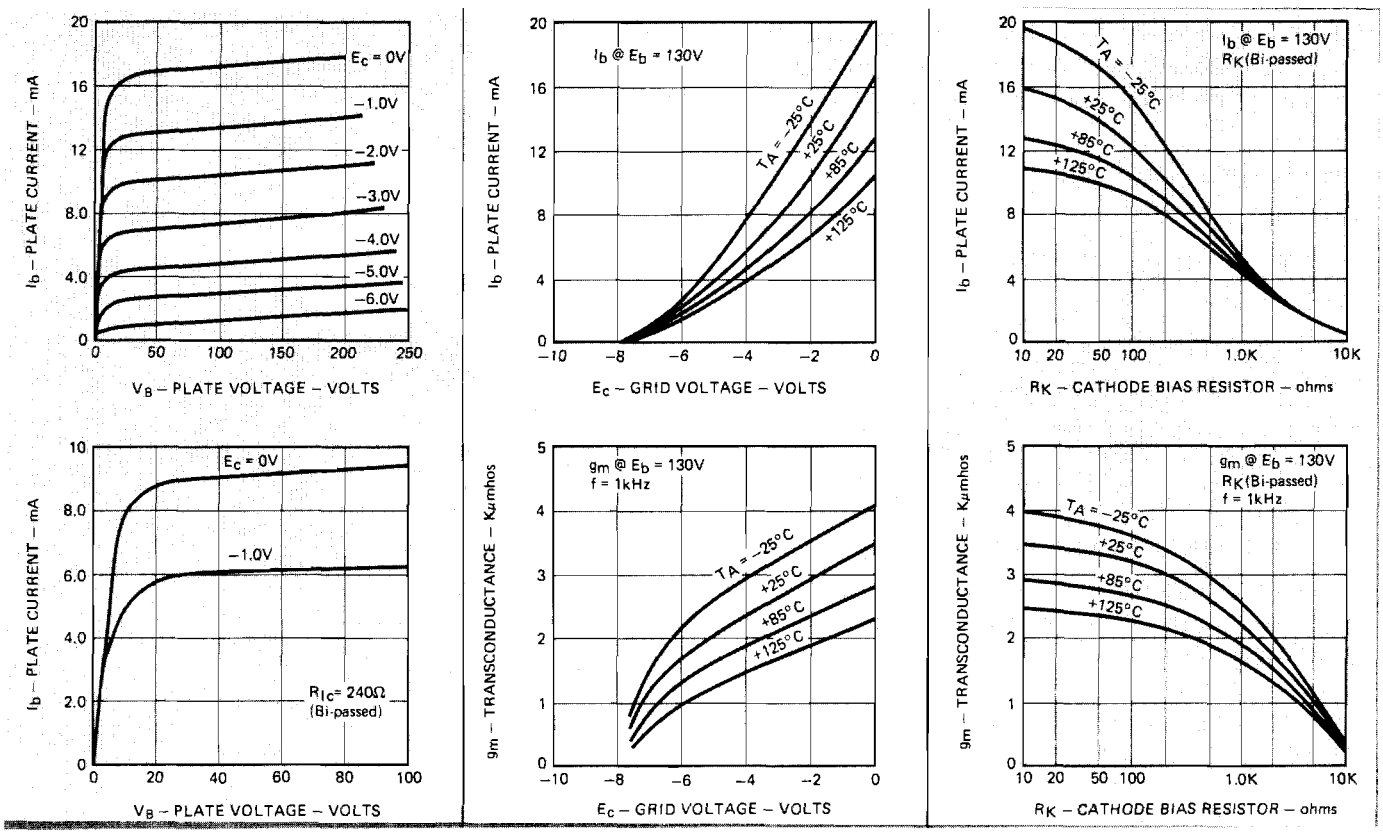
Heater Voltage	N/C (Open)
Heater Current	N/C
Grid-to-Plate Capacitance (Each unit)	3.5μμF
Grid-to-Cathode Capacitance (Each unit)	25μμF
Plate-to-Plate Capacitance	0.1μμF
Heater-to-Cathode Capacitance	N/C

Operating Conditions and Characteristics (At 25°C unless otherwise specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
Plate Supply Voltage	E_b		130	250	Volts
Cathode-Bias Resistor	R_K		240		ohms
Peak A-F Grid-to-Grid Voltage	E_{C1C2}			20	Volts
Plate Resistance	r_p	50	250		Kilohms
Transconductance	g_m	2000	3000	6000	Micromhos
Amplification Factor	μ	100	750		
Grid Voltage for Plate Current of 10μA			−7.0	−10	Volts
Peak Negative Grid Voltage	E_C	−150	−300		Volts
Plate Current	I_b	4.0	9.0	15	Milliamps
Grid Current	I_C		2.0	100	Nanoamps
Tube Operating Temperature	O_T	−55	+75	+125	°Centigrade

NOTE: In most cases, the more pentode type characteristics will enhance present circuit performance. In a few instances, the user might need a selected range.

Average Plate Characteristics (Each Unit)



NOTE: In series filament circuits, all tubes must be replaced by solid state replacements or appropriate resistor connected externally between pins 3 and 4. Some applications may require modified TS12AT7. Consult Teledyne Semiconductor for application information.

TELEDYNE SEMICONDUCTOR

TS12AX7*

*NOTE: Patent Pending.

TS12AX7*

Solid State Vacuum Tube Replacement

Features

- ZERO WARM-UP
- NO MICROPHONICS
- REDUCED HEAT RADIATION
- MECHANICALLY RUGGED
- TRUE CUTOFF WHEN USED AS SWITCH
- NO SCREEN GRID POWER
- SEMICONDUCTOR RELIABILITY
- LOW NOISE/DISTORTION
- DIRECT REPLACEMENT
- NO HEATER POWER
- NO TRANSCONDUCTANCE DEGRADATION WITH TIME

Description

The TS12AX7 is a 9-pin miniature twin triode in a metal hermetic sealed package. It is designed for direct replacement of the conventional glass vacuum tubes where greater reliability, stability, and performance are desired. It is used as multivibrators or oscillators in industrial control devices, phase inverters, clamp circuit, relay drivers, and other diversified applications. The low power consumption makes it ideal for mobile equipment tube replacement. Application is primarily intended for replacement in circuits requiring unusually low plate current operation, such as those employing the type 12AX7 vacuum tube. For other applications, refer to the **TS12AT7/A1** Fetron data sheet.

Maximum Ratings

Plate Voltage	250 Volts
Grid Voltage, Negative bias value	–50 Volts
Plate Dissipation	3.0 Watts
Peak Heater-Cathode Voltage	N/C
Maximum Grid Circuit Resistance	2.0 Megohms
Operating Temperature Range	–25°C to +125°C
Plate Current	5

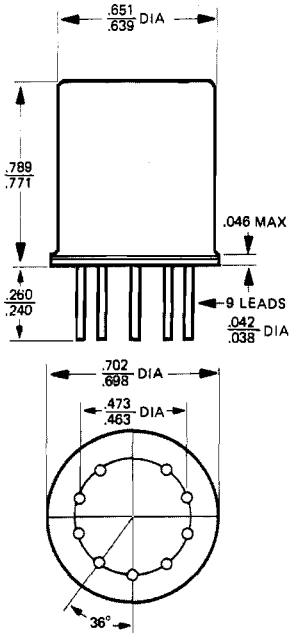
SIMILAR TS12AT7 FAMILY REPLACEMENT TYPES

12AU7, 6BC8, 6BQ7-A, 6CG7, 6J6, 7AU7, 9AU7, 8CG7, 12AV7, 6DT8, 6EV7, 12BZ7, 6201, 6679, 6189, 5814A, 6680, 6072, 396A, 407A, 407B, 12AT7, 12AZ7, 6BZ7, 6BZ8.

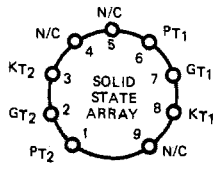
Foreign:

B152, B309, B739, ECC81, ECC82, E81CC, E82CC, ECC801, ECC801S, ECC802, ECC802S, ECC186, B329, B749, M8136, M8162, QB309, QA2406.

Physical Dimensions



Connection Diagram



TELEDYNE SEMICONDUCTOR 1300 Terra Bella Ave., Mountain View, Ca. 94040 Phone: (415) 968-9241 • TWX: (910) 379-6494

April 1973

General Characteristics (Stated in conventional tube terminology)

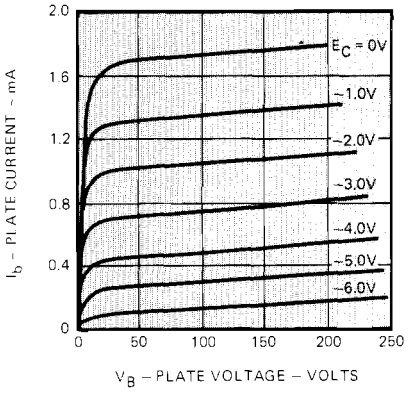
Heater Voltage	N/C (Open)
Heater Current	N/C
Grid-to-Plate Capacitance (Each unit)	3.5μμF
Grid-to-Cathode Capacitance (Each unit)	2μμF
Plate-to-Plate Capacitance	0.1μμF
Heater-to-Cathode Capacitance	N/C

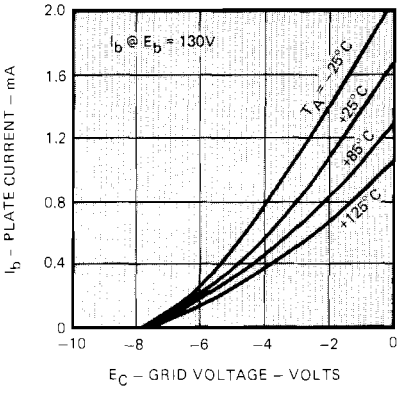
Operating Conditions and Characteristics (At 25°C unless otherwise specified)

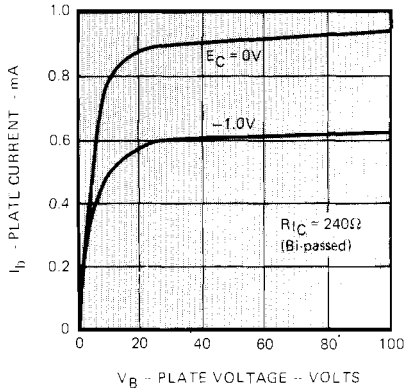
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS
Plate Supply Voltage	E_b		130	250	Volts
Grid No. 1 Voltage	E_{C1}	−0.3	−2.5	−2.7	Volts
Peak A-F Grid-to-Grid Voltage	E_{C1C2}			20	Volts
Plate Resistance	r_p	50	250		Kilohms
Transconductance	g_m	300	750	1000	Micromhos
Amplification Factor	μ	150	188		
Grid Voltage for Plate Current of 10μA			−7.0	−10	Volts
Peak Negative Grid Voltage	E_C	−150	−300		Volts
Plate Current	I_b	0.2	0.8	0.9	Milliamps
Grid Current	I_C		2.0	100	Nanoamps
Useful Frequency Limit	f_T		30		Megahertz
Tube Operating Temperature	O_T	−55	+75	+125	°Centigrade

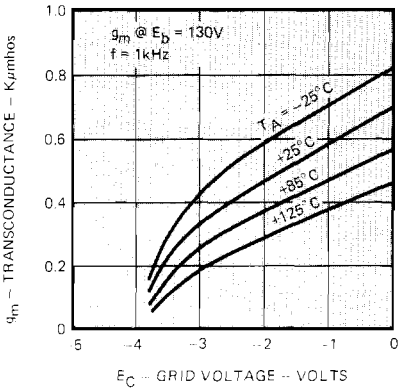
NOTE: In most cases, the more pentode type characteristics will enhance present circuit performance. In a few instances, the user might need a selected range.

Average Plate Characteristics (Each Unit)









NOTE: In series filament circuits, all tubes must be replaced by solid state replacements or appropriate resistor connected externally between pins 3 and 4. Some applications may require modified TS12AT7. Consult Teledyne Semiconductor for application information.