engineering data for CBS®

BULLETIN T-1013

MEDIUM-MU TWIN TRIODE

7728

CBS Type 7728 is a miniature medium-mu twin triode which is especially designed and tested for use in measurement test equipment, instrumentation, and other applications where extreme reliability, stable characteristics, and long life are required. The 7728 is a replacement for type 12AT7 and superior performance is assured because of its improved construction, special tests, and tight minimum-maximum limits.

This electron tube has a continuous-wound coil heater which is superior to ordinary heaters both electrically and mechanically. Burn-outs are virtually eliminated, heater-cathode leakage is lower, and hum is lower. Further insurance of quality is provided by heater cycle testing.

Stable characteristics throughout life and resistance against the formation of interface impedance are a result of meticulous processing and selection of cathode sleeve material. Also each tube is subjected to a 48 hour burn-in period to obtain a more uniform level of performance when they are put into operational service.

An elaborate testing procedure is carried out on these tubes for confidence in their ultimate operation. There is a 100-hour early life assurance test, a special 1000-hour life test, and a 5000-hour informational life test.

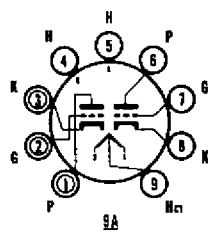
Additional mechanical features offered by CBS type 7728 include: gold plated base pins which prevent oxidation and improve base pin contact; precisely made and fitted parts in stronger structures for lower noise and microphonism; and electrical features include: initial plate current balance, life tested plate current balance, grid current test, and reverse grid current test.

MECHANICAL DATA

Cathode, coated unipotential	
Bulb	T-6 1/2
Outline	JEDEC 6-2
Base	Miniature 9-pin (E9-1)
Basing	9A
Mounting position	Any

PIN CONNECTIONS

Pin 1: Plate (Section 2)
Pin 2: Grid 1 (Section 2)
Pin 3: Cathode (Section 2)
Pin 4: Heater
Pin 5: Heater
Pin 6: Plate (Section 1)
Pin 7: Grid (Section 1)
Pin 8: Cathode (Section 1)
Pin 9: Heater Center Tap



ELECTRICAL DATA

HEATER CHARACTERISTICS

	Series	Parallel	
Voltage, a-c or d-c	12.6±10%	6.3±10%	volts
Current	150	300	ma
Peak heater-cathode voltage, max.			
Heater negative to cathode	200	200	volts
Heater positive to cathode*	200	200	volts

*D-c component must not exceed 100 volts

DIRECT INTERELECTRODE CAPACITANCES

	Section 1	Section 2	
Grid to plate: g to p	1.5	1.5	uuf
Input: g to k+h	2.2	2.2	uuf
Output: p to k+h	0.5	0.4	uuf
Heater to cathode	2.4	2.4	uuf
Coupling			
Grid (Section 1) to grid (Section 2)		.005	uuf
Plate (Section 1) to plate (Section 2)		0.4	uuf

MAXIMUM RATINGS (Design maximum values)

Each Section

Plate voltage	330	volts
Plate dissipation	2.8	watts
Bulb temperature	165	C

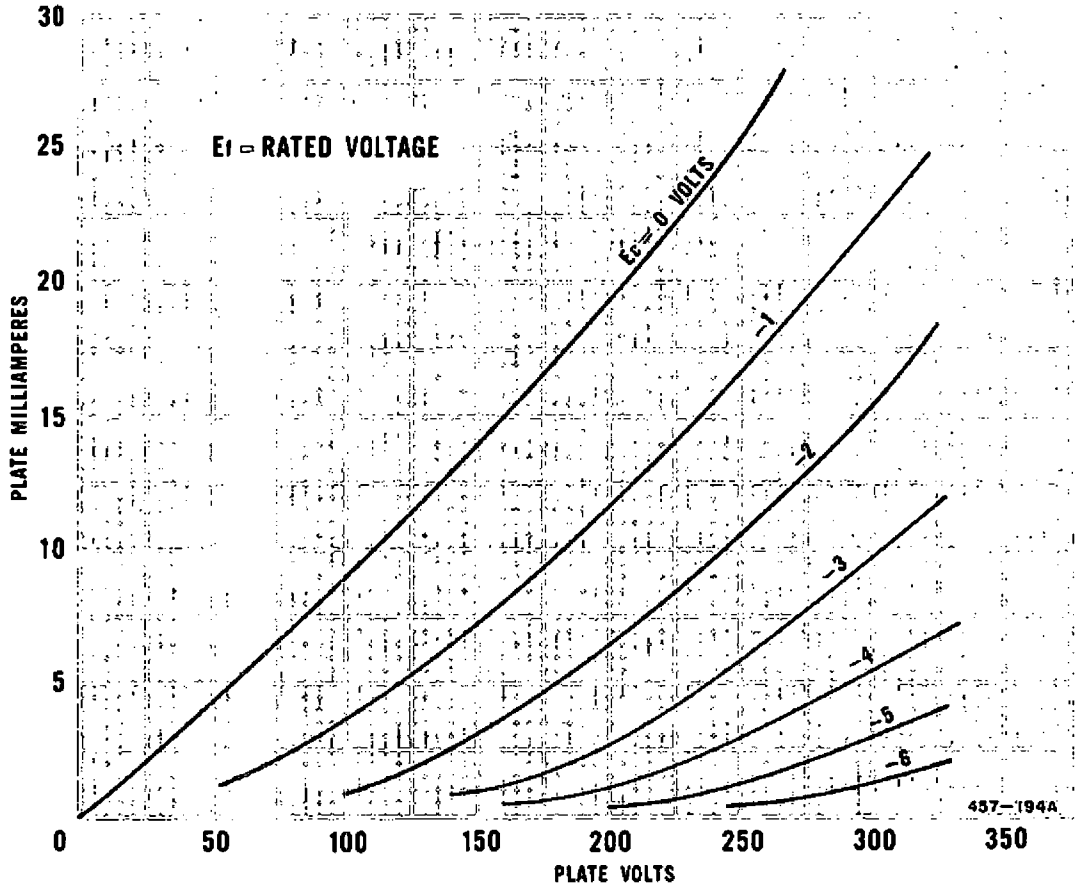
CHARACTERISTICS AND TYPICAL OPERATION

Class A Amplifier - Each Section

Plate voltage	100	250	volts
Control grid voltage	-1.0	-2.0	volts
Cathode bias resistor	270	200	ohms
Plate resistance (approx.)	15000	10900	ohms
Transconductance	4000	5500	umhos
Amplification factor	60	60	
Plate current	3.7	10.0	ma
Control grid voltage (approx.)			
for Ib = 10 uA	-5	-12	volts

from JEDEC release #2870, July 4, 1960

AVERAGE PLATE CHARACTERISTICS



Test Conditions

12.6 series connection or 6.3 parallel connection — Eb = 250 Vdc; Ec = -2 Vdc

Reference Note 2	AQL Note 1	Test	Conditions	Sym.	Min.	Max.	Unit
4.7.5	0.4	Continuity & Short		---	---	---	---
4.10.8	2.5*	Heater Current	Ef = 12.6	If	138	162	mA
			Ef = 6.3	If	275	325	mA
4.10.15	1.0	Heater Cathode Leakage	Ehk = +200 Vdc	Ihk	0	5.0	uAdc
			Ehk = -200 Vdc	Ihk	0	5.0	uAdc
4.10.6.1	1.0	Grid Current (1)	Rg = 0.5 meg; Note 4	Ic(1)	---	-0.5	uAdc
---	2.5 [redacted]	Grid Block (2)	Eb = 120 Vdc; Ec = 0; Note 6, 3	E_1C_1	0	-1.5	Vdc
4.10.4.1	2.5 [redacted]	Plate Current (1)	Ec = -15 Vdc, Note 3	Ib(1)	---	50	uAdc
4.10.4.1	1.0	Plate Current (2)	Note 3	Ib(2)	7.0	14.0	mAdc
4.10.4.1	1.0	Plate Current Differential	Notes 3, 12	Δ Ib(3)	---	15	%
4.10.9	2.5	Transconductance (1)	Note 3	Sm(1)	4500	6700	umhos
4.10.9	2.5	Transconductance (2)	Ef=5.7 or 11.4; Note 3	Δ Sm	---	15	%
---	1.0	Pulse Emission	Eb=250 Vdc, Ec= -30 Vdc; Rk=1.0 ohm; Notes 3, 5	Isp	200		mA
4.10.3.4	2.5	Noise & Microphonics	Ebb=300Vdc, Rk=200 Ω; Rp=10K, Ck=1000uf, Rg=250K; Ecal=100mVac; Notes 4, 13	M	---	---	---
---	2.5	Contact Potential	Eb=150Vdc, Ec_1=0, Rg/g=2.2meg; Notes 3, 11	Ecp	0	-1.0	Vdc
4.8	2.5	Insulation of Electrodes	E(g_1-all)=100Vdc, g_1 Negative	R(g-all)	1000	---	meg
			E(p-all)=300Vdc, p Negative; Note 3	R(p-all)	1000	---	meg
4.10.14	2.5*	Capacitance	Without Shield; Note 3	Cgp	1.3	1.9	uuf
				Cin	2.0	3.0	uuf
				Cout(1)	0.2	0.7	uuf
				Cout(2)	0.16	0.6	uuf
				[redacted] Cpp	0.15	0.33	uuf
LIFE TESTS							
---	1.0 Code K	Early Life Assurance Test	Ef=6.3V or 12.6V; Eb=250 Vdc; Rk=200 Ω; Ehk= -200 Vdc, Note 7	---	---	---	---

Reference	AQL	Test	Conditions	Sym.	Min.	Max.	Unit
---	---	Early Life Assurance Test End Points	Shorts and Continuity	---	---	---	---
			Change in Plate Current (2) of Individual tubes	$\Delta \frac{Ib}{t}$	---	20	%
			Plate Current (3) Differential Note 12	Δ Ib(3)		20	%
4.11.5	---	Intermittent Life Test (1) 1000 Hours	Early Life Assurance Test Conditions, Note 8	---	---	---	---
4.11.4	---	Intermittent Life Test (1) End Points 1000 Hours	Inoperatives	---	---	---	---
			Grid Current(1)	Ic(1)	0	-1.0	uAdc
			Change in Plate Current (2) of Individual Tubes	$\Delta \frac{Ib}{t}$	---	20	%
			Plate Current (3) Differential Note 12	Δ Ib(3)		25	%
			Heater Cathode Leakage				
			Ehk= +200 Vdc	Ihk	---	20	uAdc
			Ehk= -200 Vdc	Ihk	---	20	uAdc
			Insulation of Electrodes				
			E(g-all)	Rg-all	1000	---	meg
			E(p-all)	Rp-all	1000	---	meg
4.11.5	---	Intermittent Life Test(2) 1000 Hours	Ef=6.3V or 12.6V Eb = 250 Vdc Ec= -50Vdc, Note 9	---	---	---	---
4.11.4	---	Intermittent Life Test (2) End Points 1000 Hours	Interface Resistance Note 10	Ri	---	100	ohms
4.11.7	---	Heater Cycling Life Test	Ef=7.0 or 13.8V Ehk= -200 Vdc Cycle 1.0 min. on 4.0 min. off	---	---	48	hours
4.11.4	---	Heater Cycling Life Test End Points	Shorts and Continuity	---	---	---	---
			Heater Cathode Leakage				
			Ehk = +200 Vdc	Ihk	---	15	uAdc
			Ehk = -200 Vdc	Ihk	---	15	uAdc

TEST NOTES

Note 1: Lots of CBS Electronics tubes may be sampled using MIL-STD-105A sampling tables for the specified AQL. All characteristics having similar AQL's shall be combined for sampling purposes with the exception of control test. Control tests are indicated by an asterisk (*). The term AQL, as used on the specification, is defined in MIL-STD-105A, paragraph 4.1.

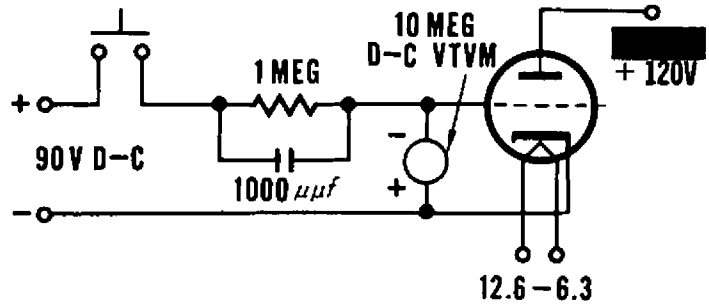
Note 2: References are paragraphs in MIL-E-1D specification, dated 31 March 1958.

Note 3: Test each section separately. The section not under test shall be grounded.

Note 4: Connect both sections in parallel.

Note 5: The grid is driven with a pulse voltage as follows: egk = +30V; Prr = 1000; Tp = 10 us; Tr < 1 us; Tf = < 1 us (egk shall be defined as the instantaneous peak voltage between the grid and the negative end of the cathode resistor). Peak cathode current shall be measured by means of a high impedance oscilloscope, or equivalent, device connected across a cathode resistor of 1.0 ohm. Preheat for 5 minutes at rated heater voltage; no other voltages applied.

Note 6: The grid blocking test shall be performed using circuit shown below or equivalent.



Apply 90 Vdc to grid momentarily. Upon removal of voltage VTVM shall not go positive nor shall it go more negative than -1.5 volts.

Note 7: Early Life Assurance Test

a. Life test samples shall be selected from a lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing tubes which are outside the initial specification limits for the relevant life test endpoint characteristics, such tubes shall be replaced by randomly selected acceptable tubes.

b. Serially mark all tubes of the sample.

c. Record reference characteristic measurements on the entire sample after a maximum operation of 15 minutes under specified voltage and current conditions.

d. The Early Life Assurance Test sample shall be operated at specified conditions or equivalent for 100 hours (± 4 hours) with the intermediate down period reading point at 20 hours (± 4 hours) and 2 hours (± 30 minutes). Intermittent or continuous operation may be employed.

e. A defective shall be defined as a tube having failed the shorts and continuity test or a tube hav ing a change in referenced characteristic greater than that specified.

Note 8: 1000 Hour Intermittent Life Test

a. The sample size shall be 10 tubes and shall be selected from the first 10 lowest number tubes which have successfully passed the Early Life Assurance Test and meet the initial test end point characteristic.

b. Record the reference characteristic.

c. Place the sample on life test with the specified operating conditions for 1000 hours with the intermediate down period reading points at 250 ± 24 hours, 500 ± 24 hours and 750 ± 24 hours. The 100 hours of Early Life Assurance Test shall be part of the 1000 hours.

d. Acceptance criteria - The sample is acceptable if it has earned a total of 9000 tube hours. The total number of tube hours is the sum of the successful operating hours of each tube.

e. Quarterly, the life test sample shall be continued to 5000 hours with interim reading points at each 1000 hours. This test will be run to determine long life capabilities.

Note 9: Intermittent Life Test (2)

a. Life test samples shall be selected from a lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing tubes which are outside the initial specification limits for the relevant life test end point characteristics, such tubes shall be replaced by randomly selected acceptable tubes.

b. Sample size shall be 10 tubes.

c. Record the reference characteristics.

d. Place the sample on life test with the specified operating conditions for 1000 hours with the intermediate down period reading points at 250 ± 24 hours, 500 ± 24 hours and 750 ± 24 hours.

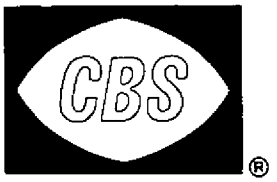
e. Acceptance criteria - The sample is acceptable if it has earned a total of 9000 tube hours. The total number of tube hours is the sum of the successful operating hours of each tube.

Note 10: Ri (Interface Resistance) shall be measured using the equivalent diode resistance 2 frequency method.

Note 11: Use 10 megohm input resistance DC VTVM. Read voltage developed across Rg.

Note 12: Difference in Plate Current (Ib3) between each section.

Note 13: The rejection level shall be set at the VU meter reading obtained during calibration.



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