

Tentative Technical Information

Hughes Products
Hughes Aircraft Company

TONOTRON* (ELECTROSTATIC) JETEC 7222

5-inch Direct-Display Half-tone Storage Tube

A. DESCRIPTION

The Tonotron is a direct-display, cathode-ray storage tube featuring: (1) storage of half-tones, (2) sufficient brightness for use in high ambient-light levels, (3) controllable persistence, (4) minimum over-all length. Black**, white, and intermediate shades of grey can be stored for periods of the order of a minute. Erasure can be either "instantaneous" or a gradual fading. The physical dimensions of the electrostatic Tonotron are given in the accompanying outline drawing.

There are two guns, a writing gun and a flood gun. The flood gun sprays the entire storage surface with a uniform spray of well-collimated, low-energy, electrons. The relative brightness at the viewing screen depends upon the surface potentials of the insulating storage layer on the gun side of the metal storage mesh. Starting with a uniform potential about 5 volts negative with respect to the flood-gun cathode, the storage surface is unwritten, or black. The writing gun can then apply a charge pattern on the screen, raising this potential through the half-tone scale towards the flood-gun cathode potential (full brightness). Since the storage surface is always negative, it can control the flood-electron transmission, but no flood electrons can strike it. Except for ion currents, then, the stored pattern could exist indefinitely. Under good vacuum conditions, ion currents limit the storage time to the order of a minute. Instantaneous erasure can be effected by application of a single positive voltage pulse to the storage grid. This pulse carries the potentials of the storage area positive with respect to the flood-gun cathode, and the flood electrons landing on the insulator surface restore its potential to the flood-gun cathode potential. When the pulse is removed, the insulator surface potential becomes so negative with respect to the flood-gun cathode potential that flood electrons are everywhere prevented from reaching the viewing screen. For gradual erasure, the single pulse is replaced by a train of very much shorter pulses; the time of erasure (persistence time) is controlled by adjusting the duty cycle of this pulse train.

*Trademark of the Hughes Aircraft Company

**The use of "black" and "white" refer to the unwritten and the fully written states.

4/29/59

from JEDEC release #2489, June 15, 1959

PROPOSED INDIVIDUAL MILITARY SPECIFICATION SHEET

Electron Tube, Cathode Ray Storage, Electrostatic Deflection
Electrostatic Focus, 7222

This specification sheet follows the format of the Military Specification (MIL-E-1).

<u>Ratings:</u> (Note 1)	E_f V-AC or DC	E_{vs} Vdc	P_{vs} W	E_{sm} Vdc	E_{cm} Vdc	E_{B3} Vdc
Absolute Maximum:	6.3 \pm 10%	+11,000	10	+200	+300	+300
Minimum:	----	+3,000	----	-25	0	----
Test Cond: (Note 2)	6.3	+4,000	----	+5	+120	Adjust

<u>Ratings:</u>	E_{B4} Vdc	E_{B2} Vdc	E_{1b1} Vdc	E_{1k} Vdc	E_{1c1} Vdc	E_{2K} Vdc
Absolute Maximum:	+200	+200	0	-3000	0	0
Minimum:	----	----	----	-2000	-125	0
Test Cond:	Adjust	100	Adjust	-2500	Adjust	0

<u>Ratings:</u>	E_{hk} V	E_{2c1} Vdc	E_{dp} (av.) Vdc
Absolute Maximum:	+180	0	+200
Minimum:	----	-125	+50
Test Cond:	----	Adjust	+100

Tube must be operated in suitable magnetic shield.

4/29/59

Base Connections

Small shell, Diheptal 14-pin. (JETEC No. B14-38)

Pin No. 1 Heater, writing gun
Pin No. 2 Cathode, writing gun
Pin No. 3 Control Grid, writing gun
Pin No. 4 Deflecting Electrode, D1
Pin No. 5 Deflecting Electrode, D3
Pin No. 6 Control Grid, Flood Gun
Pin No. 7 Heater, flood gun
Pin No. 8 Heater, Flood gun
Pin No. 9 Cathode, flood gun
Pin No.10 Second Anode
Pin No.11 Deflecting electrode D4
Pin No.12 Deflecting electrode D2
Pin No.13 First anode, focus, writing gun
Pin No.14 Heater, writing gun

Bulb Terminal Connections

Recessed, small ball cap (JETEC No. J1-22)

Cap No. 1 View screen
Cap No. 2 Internal Connection to A3
Cap No. 3 Collector electrode
Cap No. 4 Fourth Anode
Cap No. 5 Third Anode, collimator
Cap No. 6 Storage Electrode
Cap No. 7 Internal Connection to A3

<u>Ref.</u>	<u>Test</u>	<u>Condition</u>	<u>Min.</u>	<u>Max.</u>
3.1	Qualification Approval:	Required for JAN marking		
4.9.2.1	Dimensions:	Per Figure 1		
4.6.1	Preheating:			
4.5	Holding period:			
4.9.18.1.2	Carton Drop	Package Group 4 Carton Size E		
4.10.8	*Heater current (1) write gun:	I_{1f}	540	660 ma
	*Heater current (2) flood gun:	I_{2f}	540	660 ma
4.12.1.2	*Voltage breakdown:			
4.12.1.3	*Voltage breakdown:			
4.12.2.2	*Gas Ratio:		----	0.25
	Alignment	Note 3		
4.12.5.1	Blemishes:			
4.12.7.2	Spot Position:			0.75 in.
4.12.9	Grid Cutoff Voltage (1) Write Gun	E_{1cl}	-30	-70 Vdc
4.12.10.1	Focussing Voltage at Cutoff:	E_{1bl}	350	750 Vdc
4.12.8	Cathode Emission (1) write gun:			
4.12.8	Cathode Emission (2) flood gun:			
4.12.9	Grid cutoff voltage (2) Flood gun:	E_{2cl}	-60	-125 Vdc
-----	*Heater Cathode Leakage:	Note 4	I_{hk}	----- 50µa dc
4.12.13.2	Grid No. 1 leakage (1) Write gun	I_{1cl}	-----	12µAdc
4.12.13.2	Grid No. 1 leakage (2) Flood gun	I_{2cl}	-----	50µAdc
4.12.13.4	Anode No. 1 leakage (1) Write gun	I_{1bl}	-----	15µAdc
4.12.13.5	Anode No. 2 leakage (both guns)	I_{b2}	-----	30µAdc

<u>Ref.</u>	<u>Test</u>	<u>Condition</u>	<u>Min.</u>	<u>Max.</u>
----	Brightness:	Note 5 Light	200	FtL.
----	Differential Cutoff:	Note 6	----	1.2 Vdc
----	Persistence:	Note 7 t	15	--- sec.
----	Erase Time:	Note 8 E.T.	----	250 m sec.
----	Writing speed:	Note 9 W.S.	30,000	--- in/sec.
4.12.5.3	Modulation:	Note 10 E _{1c1}	----	25 Vdc
----	*Screen Color:	P20 Aluminized		
----	Stored Line Width A	Note 11	----	.020 in.
----	Stored Line Width B	Note 11	----	.020 in.
4.9.11	**Pressure:	45 PSIA		
4.9.19.8	**Vibration:		Lw	5.0 mm
4.10.14	**Capacitance (1) writing gun			
		Ck to all	----	10 μ fd
		C _{G1} to all	----	14 μ fd
		C _{D1} to all	----	13 μ fd
		C _{D2} to all	----	12 μ fd
		C _{D3} to all	----	13 μ fd
		C _{D4} to all	----	13 μ fd
		C _{D1} to D2	----	6 μ fd
		C _{D3} to D4	----	6 μ fd
4.11.6	Service Life Guarantee		400	---hrs.
4.9.15.1	**Low temperature operation:	Note 12		
4.9.15.2	**High temperature operation:	Note 13		
4.12.11	Deflection factor	D1-02 Axis	23	39 Vdc/in/KV
4.12.11	Deflection factor	D3-D4 Axis	23	39 Vdc/in/KV
4.12.12	Deflection factor uniformity		----	5 percent

Note 1: All voltages are given with respect to flood gun cathode potential except E1b1 and E1c1 which are referenced to Elk. The following element identification is used in this specification sheet:

Evs	View Screen Voltage
Pvs	Power Dissipation of viewing screen
Esm	Storage mesh voltage
Ecm	Collector mesh voltage
Eb3	Collimating electrode voltage
Eb4	Fourth Anode voltage
Eb2	Second anode voltage, both electron guns
E1b1	Focus electrode voltage, writing gun
Elk	Cathode voltage, writing gun
E1c1	Control grid voltage, writing gun
E2k	Cathode voltage, flood gun
E2c1	Control grid voltage, flood gun

Note 2: The specified test condition voltages are applied to the tube except when different voltages are specified for a particular test. Writing gun should always be biased to cutoff whenever flood gun beam is cut off unless collector mesh is lowered to storage mesh potential to prevent runaway charging in the absence of the flood beam. No storage mesh pulses shall be applied unless specified for the particular test. The test raster shall be produced by supplying a sine wave voltage to the D1 D2 plates and a sawtooth waveform voltage to the D3 D4 plates synchronized with the sine wave. To obtain proper collimation the flood gun bias, E2C1, should be reduced to the point where full coverage of the target is obtained. The target is then erased to a low half tone level with either one long pulse of sufficient amplitude or with a multiple pulse train. When the low halftone level is obtained, the third anode potential, Eb3, is adjusted in the range 30 to 50 volts to obtain uniformity over a four inch diameter circle. Further improvement in collimation may be possible by adjusting the second anode potential, E_{B4}, in the range 0 to 20 volts.

Note 3: The angle between a vertical trace through the center of the tube face and a line through the center of the tube face and a point on the tube face periphery corresponding to the location of the view screen button must not exceed $\pm 10^\circ$.

Note 4: One hundred eighty volts dc in series with a microammeter shall be applied between one heater leg and cathode. The current shall be determined for both negative and positive polarities between heater and cathode. The absolute value of the leakage current measured shall not exceed the limit specified. A resistor, in series with the current meter, of not more than

1,000 ohms per volt of heater-cathode potential, shall be used in this measurement.

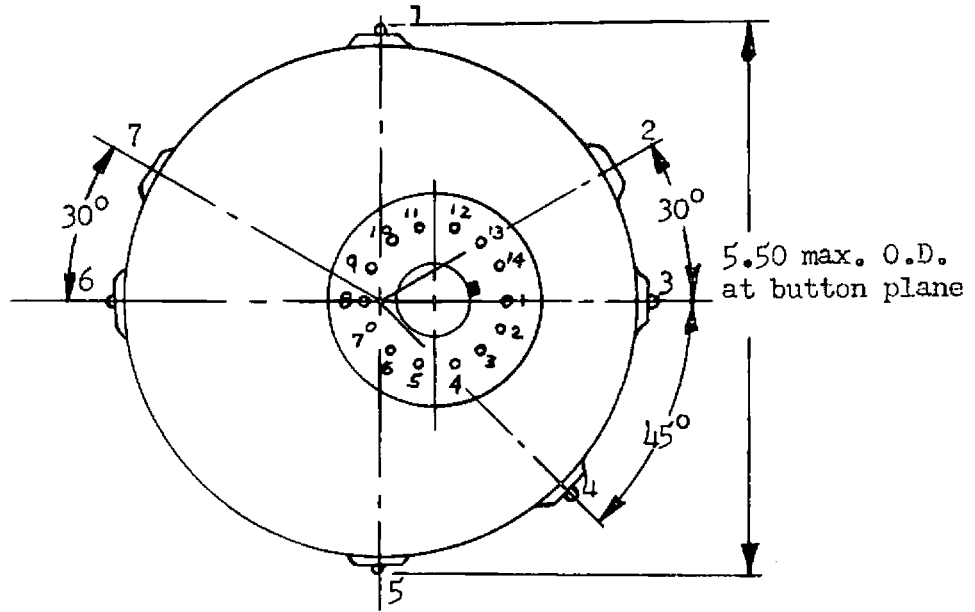
- Note 5: When the collimation has been properly adjusted as described in Note 2, the entire screen is allowed to attain full brightness by scanning with the writing beam. No erase pulses are applied to the storage electrode. Light output is measured at 4 KV view screen potential using a photocell corrected for the spectral response of the human eye placed in contact with the tube face.
- Note 6: Starting with the screen in full bright condition, positive-going, rectangular erase pulses of one second duration and successively greater amplitude are applied to the storage mesh electrode until some spot of the area inside a four inch diameter collimated circle has become completely black. Record this pulse amplitude. Continue to increase the pulse amplitude until the entire collimated area has become completely black. The differential cutoff is the value of pulse amplitude required to produce a completely black screen minus the value of pulse amplitude recorded above.
- Note 7: The target cutoff voltage, defined as the value of erase pulse amplitude required to cause the center of the target area to become completely black (generally the same as the amplitude found in the last section) is found as described under "Differential Cutoff". Then starting with the screen in full bright condition, a one second erase pulse of target cutoff plus one volt amplitude is applied to the storage mesh electrode. Measure time from the end of this pulse to the first appearance of the flood beam at the center of the target. This time must be at least 15 seconds.
- Note 8: Starting with the screen in a full bright condition and using an erase pulse of amplitude equal to target cutoff plus one volt, find the narrowest pulse width which will completely cut off the target at the center with a single pulse starting from full brightness. Pulse width must be at most 250 milliseconds.
- Note 9: Starting with the screen in a full bright condition, find the pulse amplitude of a one second duration erase pulse which will reduce the light output to 80 percent of its full bright value. Subtract this value of pulse amplitude from the target cutoff. This is known as the range. Apply a one second erase pulse to the storage mesh electrode of amplitude equal to the target cutoff plus the range. Trigger one 3" wide test raster of 10 - 30 lines and 10 μ a beam current or maximum beam current if 10 μ a is unobtainable and observe the central portion of raster for completeness. Repeat pulse and triggering and vary horizontal frequency until the highest frequency is found for which the central portion of the raster is just barely visible. Writing speed is the product of 3 π (frequency) and must be at least 30,000 inches/second.
- Note 10: With the tube properly collimated as outlined in Note 2, apply a single erase pulse of amplitude equal to target cutoff plus one volt as determined above. Next apply a single 3" x 3: raster, centrally located using a spot writing speed of 30,000 inches/second by gating the writing gun grid to zero bias for the required time interval. Measure the brightness of the

raster immediately after triggering by holding a photocell corrected for the response of the human eye against the face. Then while alternately erasing and writing, increase the writing gun control grid bias level to the point that the light level starts to decrease. Record this voltage. Then, continue increasing the control grid bias level until the raster lines are just barely visible at the center of the display. Subtract this voltage from the former voltage to determine ΔE_{1C1} .

- Note 11: Writing beam current is metered by measuring the current collected by the collector electrode, storage electrode, view screen and third anode all connected together at +250V. E_{1C1} is adjusted for $10\mu a$ of beam current or maximum beam current if $10\mu a$ is unobtainable. E_{1B1} is adjusted for minimum spot size. Apply a pulse voltage to the control grid such that correct E_{1C1} exists with pulse off and beam is cut off when pulse is on. Then, return all other elements to normal operating values. Using an erase pulse amplitude equal to target cutoff and raster conditions described in Note 9, trigger one raster by applying a grid pulse of proper duration. While alternately writing and erasing, decrease the raster height until the lines of the stored raster are just barely distinguishable. Line width is defined as raster height divided by number of lines.
- Note 12: The tube shall meet the brightness, persistence, erase time and writing speed requirements at the specified ambient operating temperature.
- Note 13: The tube shall meet the persistence, erase time, and writing speed requirements at the specified ambient operating temperature.

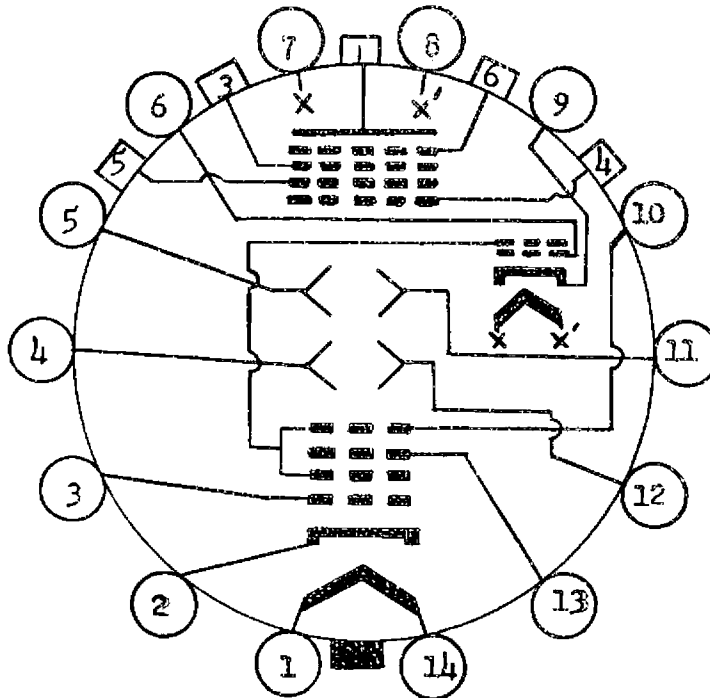
K. R. Hesse
29 April 1959

KRH:gm



Bottom View

7222 OUTLINE
 5 inch, 1- Gun
 Electrostatic Tomicon



BASING DIAGRAM

<u>Bulb Contact</u>	<u>Connection</u>	<u>Pin No.</u>	<u>Connection</u>
1.	JETEC J1-22 Viewing Screen	1	Heater (writing gun)
2.	Internal Connection to A3	2	Cathode (writing gun)
3.	JETEC J1-22 Collector Electrode	3	Control grid (writing gun)
4.	JETEC J1-22 Fourth Anode	4	Deflection Plate, D1
5.	JETEC J1-22 Collimator, A3	5	Deflection Plate, D3
6.	JETEC J1-22 Storage Electrode	6	Control Grid (flood gun)
7.	Internal Connection to A3	7	Heater (flood gun)
		8	Heater (flood gun)
		9	Cathode (flood gun)
		10	Second Anode (Both guns)
		11	Deflection Plate, D4
		12	Deflection Plate, D2
		13	Focus (writing gun) A1
		14	Heater (writing gun)