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6571

COMPUTER STORAGE TUBE

Single Beam	Primary-Current-Modulation Type	3"-Diameter Bulb
Electrostatic Focus	Redistribution Writing	11-1/2" Overall Length
Electrostatic Deflection	Capacitance-Discharge Reading	Duodecal 10-Pin Base

TENTATIVE DATA

RCA-6571 is a storage tube designed primarily for use in binary-digital computer systems. It is of the single-beam type, utilizes electrostatic focus and deflection, has its storage surface on the inner surface of the faceplate, and requires an external signal-output electrode shaped to conform to and placed in contact with the entire area of the faceplate. Redistribution writing and capacitance-discharge reading are employed.

Design features which make the 6571 particularly suitable for computer service include (1) a storage-surface having relatively uniform secondary emission to prevent "bad spots" on which information can not be stored, (2) a focused beam having an exceptionally small effective area including the fringe of low-density beam current and a well-defined boundary which is especially significant whenever a single storage element is addressed several times before neighboring elements are regenerated, and (3) separate external connection for the collector to serve as an effective shield to prevent cross-coupling between the electron gun and the external signal-output electrode.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3	volts
Current	0.6	amp
Direct Interelectrode Capacitances (Approx.):		
Grid No.1 to all other electrodes	6.5	μμf
Grid No.1 to deflecting electrode DJ_1	0.2	μμf
Grid No.1 to deflecting electrode DJ_2	0.2	μμf
Grid No.1 to deflecting electrode DJ_3	0.2	μμf
Grid No.1 to deflecting electrode DJ_4	0.2	μμf
Cathode to all other electrodes	5	μμf
DJ_1 to DJ_2	2.8	μμf
DJ_3 to DJ_4	2.6	μμf
DJ_1 to all other electrodes	9	μμf
DJ_2 to all other electrodes	9	μμf
DJ_3 to all other electrodes	8	μμf
DJ_4 to all other electrodes	7	μμf

Focusing Method . . . . Electrostatic
Deflection Method . . . . Electrostatic
Deflecting-Electrode Arrangement . . . . See *Dimensional Outline*
Storage Surface . . . . . . On inner surface of faceplate
Signal-Output Electrode . . Metal plate or 50-line (minimum) mesh covering external surface of faceplate and capacitively coupled to the storage surface. (This electrode is not supplied with tube).
Overall Length . . . . 11-1/2" ± 1/4"
Greatest Diameter of Bulb . . . . 3" ± 1/16"
Base . . Small-Shell Duodecal 10-Pin Base (JETEC No. B10-75)
Cap . . . . Recessed Small Cavity (JETEC No. J1-21)
Mounting Position . . . . . Center of tube face must be at same elevation as or at higher elevation than tube base

Maximum Ratings, *Design-Center Values*:

COLLECTOR VOLTAGE:		
Difference between collector voltage and ultor voltage	150 max.	volts
ULTOR● VOLTAGE	2500 max.	volts
GRID-No.3 VOLTAGE	1000 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	200 max.	volts
Positive bias value	0 max.	volts
Positive peak value	2 max.	volts
PEAK VOLTAGE BETWEEN ULTOR AND ANY DEFLECTING ELECTRODE	500 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	125 max.	volts

Equipment Design Ranges:

For any ultor voltage (E_{c_4}) between 1000 and 2500 volts

Collector Voltage	95% to 105% of E_{c_4}	volts
Grid-No.3 Voltage	20% to 28% of E_{c_4}	volts
Max. Grid-No.1 Voltage for Beam-Current Cutoff	2.4% of E_{c_4}	volts
Max. Grid-No.3 Current Range	-15 to +10	μamp
Deflection Factors:		
DJ_1 & DJ_2	39 to 53	v dc/in./kv of E_{c_4}
DJ_3 & DJ_4	35.5 to 48.5	v dc/in./kv of E_{c_4}
Focused-Beam Position	●●	

Examples of Use of Design Ranges:

For ultor voltage of	*1000*	*2500*	*volts*
Collector Voltage	950 to 1050	2375 to 2625	volts
Grid-No.3 Voltage	200 to 280	500 to 700	volts
Max. Grid-No.1 Voltage for Beam-Current Cutoff	-24	-60	volts

Examples of Use of Design Ranges (Cont'd):

For ultor voltage of	*1000*	*2500*	*volts*
Deflection Factors:			
DJ_1 & DJ_2	39 to 53	97.5 to 133	volts dc/in.
DJ_3 & DJ_4	35.5 to 48.5	89 to 122	volts dc/in.

Storage Characteristics for Ultor Voltage of 2500 Volts:

Storage-Surface Boundary (in terms of deflection voltage):		
In the $DJ_1 - DJ_2$ direction from position of undeflected focused beam . .	±109	volts
In the $DJ_3 - DJ_4$ direction from position of undeflected focused beam . .	±100	volts
Blemish Factor*, for storage surface within indicated boundary	0.5 max.	
Spill (Determined for Double-Dot Pattern):**		
Under conditions involving 255 references to "spill" element and 1 reference to "test" element		
Separation Between Storage Elements, in either the $DJ_1 - DJ_2$ or $DJ_3 - DJ_4$ direction in terms of deflection voltage:		
At center of storage surface. . . .	8 max.	volts
At midpoint on each side of storage-surface boundary.	10 max.	volts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance.	1.5 max.	megohms
Resistance in Any Deflecting-Electrode Circuit■	1.0 max.	megohm

● The "ultor" in a storage tube is the electrode to which is applied the highest dc voltage for accelerating the electrons in the beam prior to its deflection. In the 6571, the ultor function is performed by grid No.4. Since grid No.4 and grid No.2 are connected together within the 6571, they are collectively referred to simply as "ultor" for convenience in presenting data and curves.

The center of the undeflected focused beam will fall within a circle having a 7.5-mm radius concentric with the center of the tube face.

* Blemish factor is defined as the factor by which the normal positive signal is reduced by the blemish.

** Spill is indicative of the amount of binary information that can be stored by the tube. The storage capability is determined by the separation between two storage elements at which the signal from one element is changed by no more than a specified amount after repeated references to the other element. For the 6571, the separation is measured, in terms of deflection voltage, when the amplitude of the negative signal of the "test" element has decreased to 50% of its maximum negative amplitude. The maximum negative amplitude is determined by separating the two elements far enough to eliminate the effects of secondary electron redistribution from the "spill" element.

■ It is recommended that the deflecting-electrode-circuit resistances be approximately equal.

OPERATING CONSIDERATIONS

Handling. The 6571 should always be handled and transported with the face up in order to prevent possible damage to the storage surface caused by any loose particles striking the storage surface and adhering to it.

The *maximum ratings* in the tabulated data for the 6571 are working design-center maximums established according to the standard design-center system of rating electron tubes. Tubes so rated will give satisfactory performance in equipment designed so that these maximum ratings will not be exceeded when the equipment is operated from ac or dc power-line supplies whose normal voltage including normal variations falls within ±10 per cent of line-center voltage value of 117 volts.

Support for the tube should be provided by a padded mechanism about the neck and by a cushioned ring or saddle arrangement near the large end of the tube. The tube should not be supported by the socket nor by a clamping arrangement on the base.

Shielding. In typical computer applications, the 6571 is mounted in a compartment having effective magnetic and electrostatic shielding. It is recommended that the bulb be provided with a tight-fitting electrostatic shield extending from the base to the collector coating (see *Dimensional Outline*). This external shield supplements the shielding action of the collector in preventing cross-coupling between the electron gun and the external signal electrode.

The *heater* is designed to be operated at 6.3 volts. The transformer winding supplying the heater power should be designed to operate the heater at the rated voltage under average line-voltage conditions. If the circuit design is such as to cause a high voltage between heater winding and ground, the heater transformer should be adequately insulated to withstand the high voltage.

Although maximum values of peak heater-cathode voltage are specified in the tabulated data, it is recommended that the mid-tap or one side of the heater winding be connected directly to the cathode to minimize the possibility of damage to the tube produced by arcing between heater and cathode when a possible momentary internal arc causes the voltage between heater and cathode to exceed the maximum heater-cathode ratings. When, in some circuit designs, the heater is not connected directly to the cathode, precautions must be taken to hold the peak heater-cathode voltage to the maximum values shown in the tabulated data.

Grid No.2, connected within the tube to grid No.4 and operated at grid-No.4 potential, is incorporated in the electron-gun design so that the beam current and grid-No.1 cutoff voltage will not be affected by focusing adjustment. Because of the effect of grid No.2, and the negligible current taken by grid No.3, the beam can be sharply focused on the storage surface and remains sharp when beam current is varied over a wide range.

Grid No.3, the focusing electrode, is so designed that it takes negligible current. This feature makes possible the use of a low-current voltage-divider system. Focusing of the beam is controlled by adjustment of the ratio of grid-No.3 voltage to grid-No.4 voltage. Ordinarily, the ratio is adjusted by variation of grid-No.3 voltage. For this purpose, a potentiometer adequately insulated is required in the voltage-divider circuit; the necessary range of adjustment is indicated under *Equipment Design Ranges* and *Examples* in the tabulated data.

The *collector* connection should be made by a flexible lead to the recessed small cavity cap on the side of the bulb. The separate connection to the collector permits operation of the collector at a voltage slightly different from that of the ultor and enables the collector to serve as an effective shield to prevent cross-coupling between the electron gun and the external signal electrode. Normally, the collector is connected to the common ground of the system.

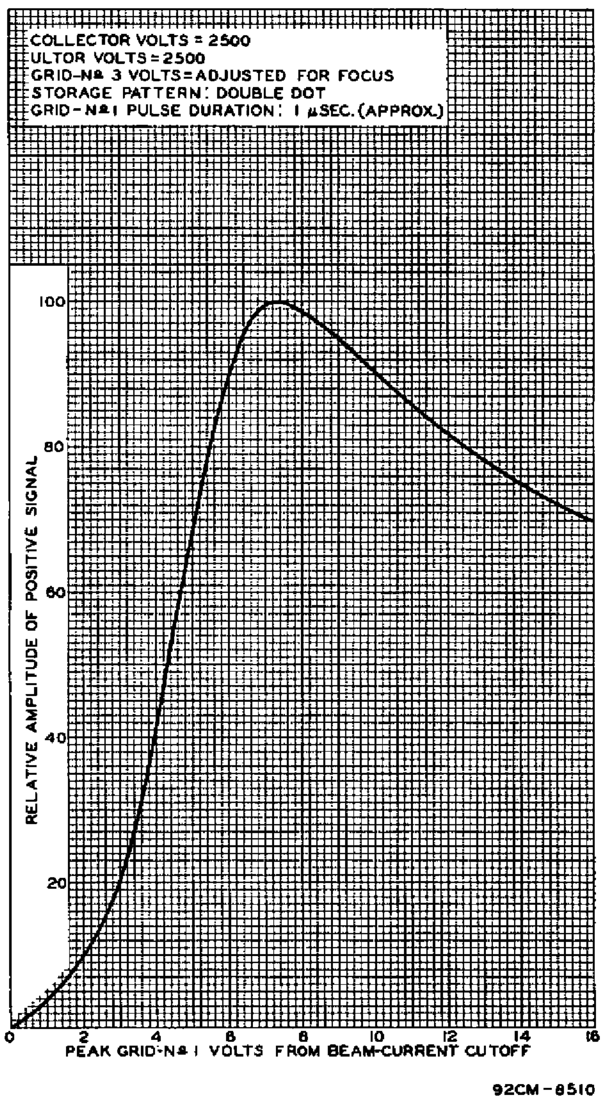


Fig. 1 - Average Characteristic of Type 6571.

Two pairs of *electrostatic deflecting electrodes*, producing fields approximately at right-angles to each other, are located within the bulb neck to provide for deflection of the electron beam in the directions of the respective fields.

Each pair of deflecting electrodes is normally operated at an average potential the same as that of grid No.4. The grid-No.4 voltage may be adjusted with respect to the average deflecting-electrode potential to provide control of astigmatism. Each electrode of each pair should be connected through a resistor of not more than 1 megohm to the grid-No.4 socket terminal.

A *signal-output electrode* shaped to conform with the external contour of the faceplate and placed in contact with the entire area of the faceplate, is required. The signal-output electrode is connected to a low-noise, video amplifier having sufficient gain to amplify signals from a fraction of a millivolt to the desired level.

The *dc voltages* for grid No.1, grid No.3, and ultor should be obtained from an extremely well-regulated power supply essentially free of ripple.

In most applications, it is recommended that the ultor (grids No.2 and No.4) be grounded in order that the deflecting electrodes may be operated at essentially ground potential. With this method, the cathode and heater are at high negative potential with respect to ground.

The high voltages at which this tube is operated may be very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. Safety precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is desired. In most applications, it is recommended that the ultor terminal be grounded rather than the cathode terminal. With this method, which places the heater and cathode at high negative potential with respect to ground, the dangerous voltages can more easily be made inaccessible.

In the use of high-voltage tubes, it should always be remembered that high voltages may appear at normally low-potential points in the circuit as a result of capacitor breakdown or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off, and both terminals of any capacitors grounded.

The *undeflected focused beam* is normally close to the geometric center of the tube face. However, to compensate for variation from tube to tube, designers should provide an adjustable and reversible supply of at least 12 volts dc per kilovolt of ultor voltage (balanced to ultor) for application between the two deflecting electrodes of each pair. By adjustment of this dc voltage on each pair of the deflecting electrodes, the beam may be centered.

The *amount of information that can be stored by the 6571* is dependent on the manner in which it is operated, and is affected by the stability of the deflecting system, freedom from noise in the associated output circuit, the number of regenerations compared with the number of addresses, and the effectiveness of the electrostatic and magnetic shielding.

In general, the number of storage elements is proportional to the operating ultor voltage. For the greatest number of storage elements, the 6571 should be operated at the rated maximum ultor voltage and so that the peak grid-No.1 drive is less than that required for the maximum positive amplitude but high enough to provide a satisfactory output signal.

It is recommended that the beam current be limited to the minimum value which provides satisfactory signal amplitude. As shown by the curve in Fig.1, an increase in beam current or grid-No.1 drive beyond the peak of the curve (i.e., saturation of the positive signal) does not increase the amplitude of the positive signal.

The *storage characteristics* in the tabulated data and the curve in Fig.1 are based on the use of a double-dot pattern. In this method of storage, the positive signal is produced by adjusting the beam current and the distance between two dot storage elements so that the optimum positive signal is produced when the "test" element is addressed. Other methods of storage such as superimposed focused and defocused spots or dots and dashes may be used equally well with the 6571.

REFERENCES

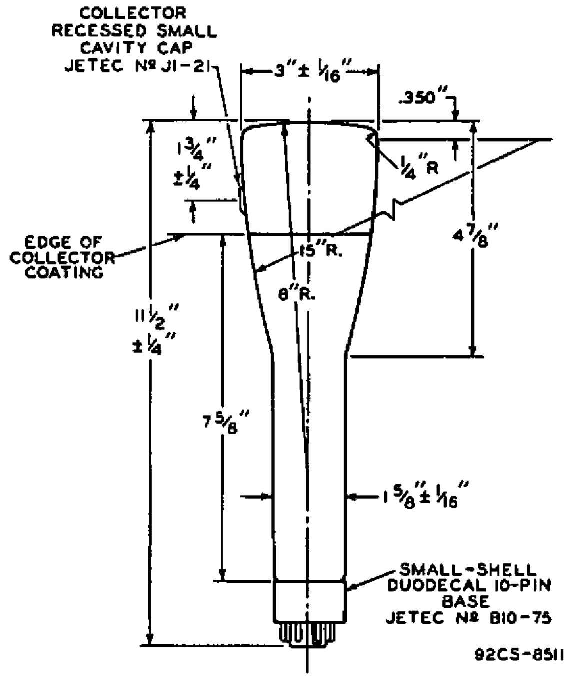
F. C. Williams and T. Kilburn, *"A Storage System for Use with Binary-Digital Computing Machines,"* Proc. Inst. Elec. Eng. (London), Vol.96, Part *II*, pp.183-202, and Part *III*, pp.77-100, 1949; and Vol. 97, Part *IV*, pp. 453-454, 1950.

J. P. Eckert, Jr., H. Lukoff, and G. Smoliar, *"A Dynamically Regenerated Memory Tube,"* Proc. I.R.E., Vol. 38, pp.498-510, 1950.

R. Thorensen, *"An Improved Cathode-Ray Tube Storage System"*. National Bureau of Standards, Report No.2275, 1953.

M. Knoll and B. Kazan, *"Storage Tubes and Their Basic Principles"*. John Wiley & Sons, Inc., New York (1952).

DIMENSIONAL OUTLINE



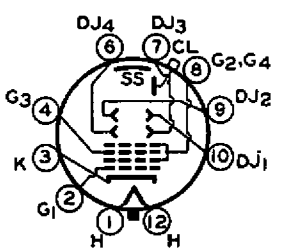
CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM PERPENDICULAR ERECTED AT CENTER OF BOTTOM OF BASE.

DJ_1 AND DJ_2 ARE NEARER THE STORAGE SURFACE: DJ_3 AND DJ_4 ARE NEARER THE BASE. WITH DJ_1 POSITIVE WITH RESPECT TO DJ_2, THE BEAM WILL BE DEFLECTED TOWARD PIN 2; LIKEWISE, WITH DJ_3 POSITIVE WITH RESPECT TO DJ_4, THE BEAM WILL BE DEFLECTED TOWARD VACANT PIN POSITION 11.

THE PLANE THROUGH TUBE AXIS AND EACH OF THE FOLLOWING ITEMS MAY VARY FROM THE DEFLECTION PATH PRODUCED BY DJ_1 AND DJ_2 BY THE FOLLOWING ANGULAR TOLERANCES (MEASURED ABOUT THE TUBE AXIS): PIN 2, 10°; SIDE TERMINAL (ON SAME SIDE AS PIN 8), 10°. ANGLE BETWEEN DJ_1-DJ_2 DEFLECTION PATH AND DJ_3-DJ_4 DEFLECTION PATH IS 90° ± 3°.

SOCKET CONNECTIONS
Bottom View

PIN 1: HEATER
PIN 2: GRID NO.1
PIN 3: CATHODE
PIN 4: GRID NO.3
PIN 6: DEFLECTING ELECTRODE DJ_4
PIN 7: DEFLECTING ELECTRODE DJ_3
PIN 8: ULTOR (GRIDS NO.2 & NO.4)



PIN 9: DEFLECTING ELECTRODE DJ_2
PIN 10: DEFLECTING ELECTRODE DJ_1
PIN 12: HEATER
CAP: COLLECTOR (CL)
SS: STORAGE SURFACE TO WHICH EXTERNAL SIGNAL-OUTPUT ELECTRODE IS CAPACITIVELY COUPLED (SEE DATA)