from JEDEC release #4636, March 16, 1964

RCA-8521

VIDICON

Magnetic Focus
Magnetic Deflection

1-1/2" Diameter,
High-Resolution, High-Sensitivity
Type for Industrial TV Pickup Service

1.5" - Diameter
7.75" - Length

RCA-8521 is a 1-1/2"-diameter vidicon type of camera tube featuring high sensitivity and high resolution capability. It is designed especially for black-and-white television pickup in industrial closed-circuit TV systems where a limiting resolution of more than 1200 TV lines is required. The sensitivity of the photoconductive surface employed in this tube is sufficient to produce high-quality pictures under normal room-lighting conditions or under the lighting conditions normally encountered in industrial areas.

The 8521 incorporates in its design precision construction, a mesh electrode with separate external connection, and a photoconductive surface having uniform thickness. The electrically isolated mesh electrode permits operation of the 8521 with high values of beam current without excessive loss in resolution and simplifies operational and set-up procedures. With proper adjustment of the mesh and grid-No.3 voltages, the 8521 will provide a uniform signal output from the entire scanned area with a minimum of "porthole" and geometric distortion.

Other design features of the 8521 are non-magnetic materials in the front end, and an extremely flat faceplate free from optical distortion.

DATA

General:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current at 6.3 volts	0.6	amp
Direct Interelectrode Capacitance:[a]		
Target to all other electrodes	8.0	pf
Spectral Response	See *Fig.5*	
Photoconductive Layer:		
Maximum useful diagonal of rectangular image (4 x 3 aspect ratio)	1.0	inch

Orientation of quality rectangle—Proper orientation is obtained when the horizontal scan is essentially parallel to the plane passing through the axis and short index pin. The masking is for orientation only and does not define the proper scanned area of the photoconductive layer. Final orientation should be such that the image also fits inside of any internal mask of the mesh assembly.

Focusing Method	Magnetic
Deflection Method	Magnetic
Overall Length	7.75" ± 0.25"
Greatest Diameter	1.59" ± 0.01"
Bulb Diameter	1.50" ± 0.01"
Bulb	T12
Base	Small-Button Super-Ditetrar 8-Pin (JEDEC No.E8-78)
Socket	Alden[b] No.208-SBSDC, or equivalent
Focusing-Alignment Assembly	Cleveland Electronics[c] No.15-VFA-259, or equivalent
Deflecting Yoke[d]	Cleveland Electronics[c] No.15-VY-258, or equivalent
Operating Position	Any
Weight (Approx.)	5.25 oz

Maximum Ratings, *Absolute-Maximum Values:*[e]

For scanned area of 0.6" x 0.8"

Grid-No.4 Voltage	1500 max.	volts
Grid-No.3 Voltage	1500 max.	volts
Grid-No.2 Voltage	550 max.	volts
Grid-No.1 Voltage:		
Negative bias value	300 max.	volts
Positive bias value	0 max.	volts
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode	125 max.	volts
Heater positive with respect to cathode	10 max.	volts
Target Voltage	100 max.	volts
Dark Current	0.25 max.	μa
Peak Target Current[f]	0.60 max.	μa
Faceplate:		
Illumination	1000 max.	fc
Temperature	71 max.	°C

Typical Operation and Performance Data:

For scanned area of 0.6" x 0.8"
Faceplate temperature of 28° to 34° C

Grid-No.4 (Decelerator) Voltage[g]	1400	volts
Grid-No.3 (Beam-Focus Electrode[h]) Voltage	800 to 1000	volts
Grid-No.2 (Accelerator) Voltage	300	volts
Grid-No.1 Voltage for Picture Cutoff[j]	-45 to -100	volts
Average "Gamma" of Transfer Characteristic for Signal-Output Current between 0.02 and 0.6 μa	0.65	

Minimum Peak-to-Peak Blanking Voltage:		
When applied to grid No.1 . . .	75	volts
When applied to cathode	20	volts
Lag—Per Cent of Initial Value of Signal-Output Current 1/20 Second after Illumination is Removed:[k]		
Maximum value	45	%
Typical value	30	%
Limiting Resolution:		
At center of picture—		
Typical value	1500	TV lines
Minimum value	1200	TV lines
At corners of picture—		
Typical value	900	TV lines
Amplitude Response to a 400 TV Line Square-Wave Test Pattern at Center of Picture:		
Minimum value	60	%
Field Strength at Center of Focusing Coil (Approx.)	46	gauss
Field Strength of Adjustable Alignment Coil[m]	0 to 4	gauss
Peak Deflecting-Coil Current for Specified Deflecting Yoke:		
Horizontal.	240	ma
Vertical.	50	ma
Maximum-Sensitivity Operation — 0.1 Footcandle on Faceplate		
Faceplate Illumination (Highlight)	0.1	fc
Target Voltage[np].	30 to 60	volts
Dark Current[q]	0.1	μa
Signal-Output Current:[r]		
Typical	0.2	μa
Average-Sensitivity Operation — 1.0 Footcandle on Faceplate		
Faceplate Illumination (Highlight)	1.0	fc
Target Voltage[np].	17 to 35	volts
Dark Current[q]	0.02	μa
Signal-Output Current:[r]		
Typical	0.20	μa
Minimum	0.15	μa
High-Light Level Operation — 10 Footcandles on Faceplate		
Faceplate Illumination (Highlight)	10	fc
Target Voltage[np].	10 to 20	volts
Dark Current[q]	0.005	μa
Signal-Output Current:[r]		
Typical	0.3	μa

[a] This capacitance, which effectively is the output impedance of the 8521, is increased when the tube is mounted in the deflecting yoke and focusing-alignment assembly. The resistive component of the output impedance is in order of 100 megohms.

[b] Made by Alden Products Co., 9140 North Main Street, Brockton 64, Mass.

[c] Made by Cleveland Electronics Inc., 1974 East 61st Street, Cleveland, Ohio.

[d] For minimum geometric distortion, the deflecting yoke should be located in its proper axial position 3/4-inch from the face of the tube.

[e] The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

[f] Video amplifiers must be designed properly to handle target currents of this magnitude to avoid amplifier overload or picture distortion.

[g] Grid-No.4 voltage must always be greater than grid-No.3 voltage. For minimum "porthole" effect, grid-No.4 voltage should be adjusted to approximately 1.6 times the grid-No.3 voltage value, and the focusing-alignment assembly and deflecting yoke positioned as shown in Fig.1.

[h] Beam focus is obtained by the combined effect of grid-No.3 voltage, which should be adjustable over indicated range, and a focusing coil having an average field strength of 46 gauss.

[j] With no blanking voltage on grid No.1.

[k] For initial signal-output current of 0.2 μa and a dark current of 0.02 μa.

[m] The alignment coil should be located on the tube so that its center is at a distance of 6 inches from the face of the tube, and be positioned so that its axis is coincident with the axis of the tube, the deflecting yoke, and the focusing coil.

[n] Indicated range for each type of service serves only to illustrate the operating target-voltage range normally encountered.

[p] The target voltage for each 8521 must be adjusted to that value which gives the desired operating dark current.

[q] The deflecting circuits must provide extremely linear scanning for good black-level reproduction. Dark-current signal is proportional to the scanning velocity. Any change in scanning velocity produces a black-level error in direct proportion to the change in scanning velocity.

[r] Defined as the component of the highlight target current after the dark-current component has been subtracted.

REFERENCE

Otto H. Schade, *"A New System of Measuring and Specifying Image Definition"*, National Bureau of Standards Circular 526, April 29, 1954.

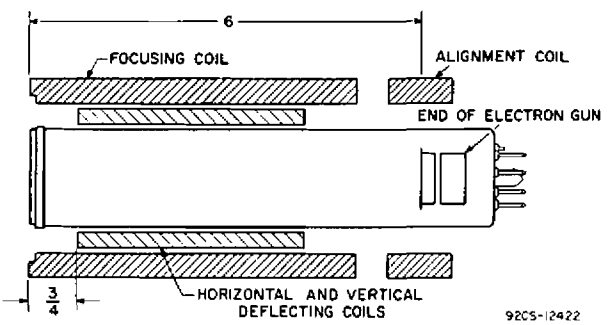
OPERATING CONSIDERATIONS

The *target connection* may be made by a suitable spring-finger contact bearing against the edge of the metal ring at the face end of the tube.

The *front end of the deflecting yoke* should be positioned 3/4-inch to the rear of the tube faceplate as shown in Fig.1. Positioning the yoke further to the rear of the tube faceplate increases deflection sensitivity but impairs corner focus.

Provisions should be made in the camera installation to hold the faceplate temperature of the 8521 at a steady value within the recommended range. Dark current increases with increasing temperature. It is highly desirable to operate the 8521 at a steady temperature to maintain dark current at a preselected value. This mode of operation ensures both optimum and stable day-to-day performance. If such provisions cannot be made, changes in target voltage may be required from time to time to maintain the desired picture quality.

COMPONENT LOCATIONS



DIMENSIONS IN INCHES

Fig.1

As *target voltage* is increased, dark current also increases. The range of target voltage for various dark current levels of different 8521's is shown in Fig.2. The exact value of target

RANGE OF DARK CURRENT

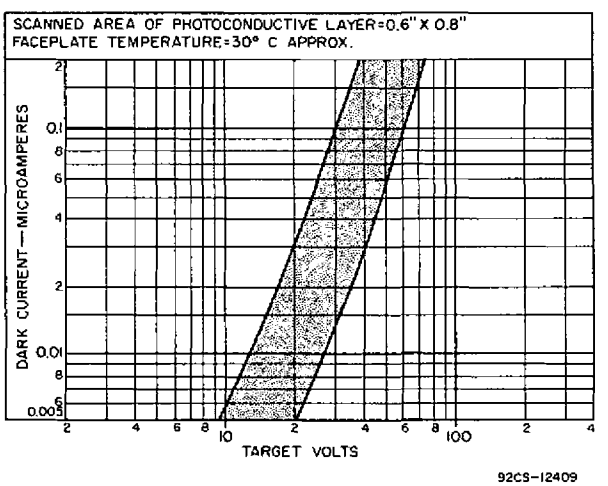


Fig.2

voltage to give the required dark current will depend on the individual tube and on the temperature at which its faceplate is operated. It is important that the tube be allowed to reach a stable operating temperature before the operating dark current is determined; otherwise, the dark current will change as the temperature of the tube changes. It should be noted that individual 8521's will *have substantially the same transfer characteristics (Fig.4) when operated with the same value of dark current.* For proper adjustment of the target voltage to obtain the desired operating characteristics for each 8521 see **SET-UP PROCEDURE** on page 5.

The *temperature of the faceplate* should not exceed 71° C (160° F), either during operation or storage of the 8521. Operation with a faceplate temperature in the range from about 28° to 34° C (82° to 93° F) is recommended. The temperature of the faceplate is determined by ambient temperature and the combined heating effects of the incident illumination on the faceplate, the associated components, and the tube itself. To reduce these heating effects and permit operation in the preferred temperature range, under conditions of extremely high light levels, the use of

TYPICAL PERSISTENCE CHARACTERISTICS

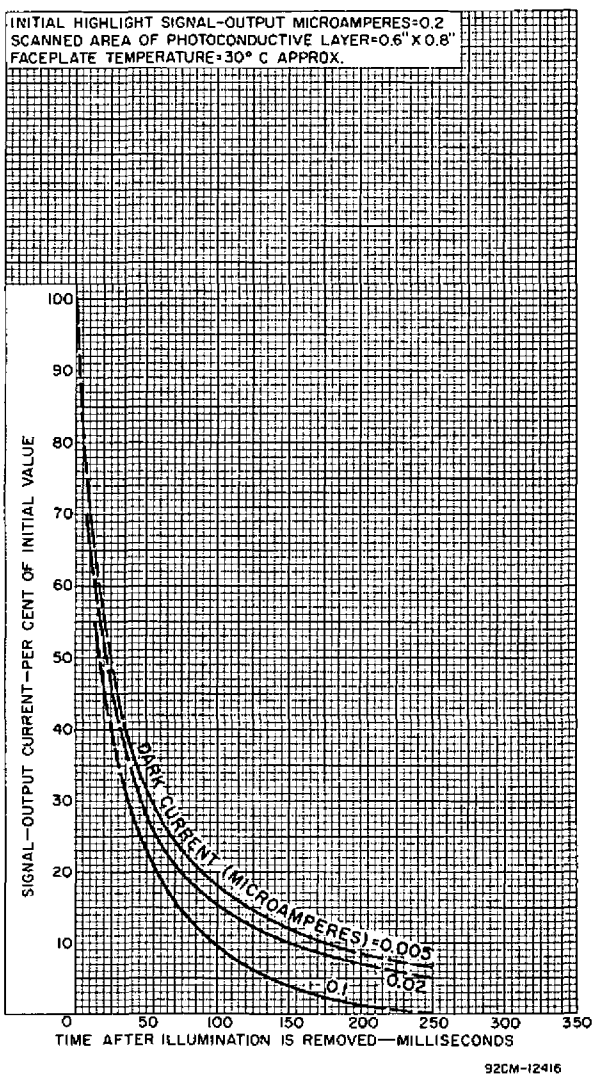


Fig.3

an infrared filter between the object and the camera lens is recommended.

Persistence or lag of the photoconductive layer is given in Fig.3 for several values of dark current. Each curve shows the decay in signal-output current from an initial value of 0.2 microampere after the illumination is cut off.

Signal Output and Light Transfer Characteristics. Typical signal output as a function of uniform 2870° K tungsten illumination on the photoconductive layer for different values of

dark current is shown in Fig.4. For an illumination level of 1 footcandle on the faceplate, operation at a dark current of 0.02 microampere will usually provide a satisfactory signal level. If an illumination of 10 footcandles on the faceplate is available, the dark current level may be reduced to 0.005 μa or less, and at lower light levels—less than 50 footcandles on the scene—higher values of dark current and higher target voltages can usually be employed.

Proper-size scanning of the photoconductive target area should always be used. Both overscanning and underscanning impair performance. Overscanning, which produces a smaller-than-normal picture on the monitor, adversely effects corner resolution, signal uniformity, and geometrical accuracy. Underscanning, which produces a larger-than-normal picture on the monitor, should never be permitted as it may cause a permanent change in sensitivity and dark current of the underscanned area with a resulting loss in resolution and sensitivity. An underscanned area showing such a change will be visible when proper-size scanning is restored.

LIGHT TRANSFER CHARACTERISTICS

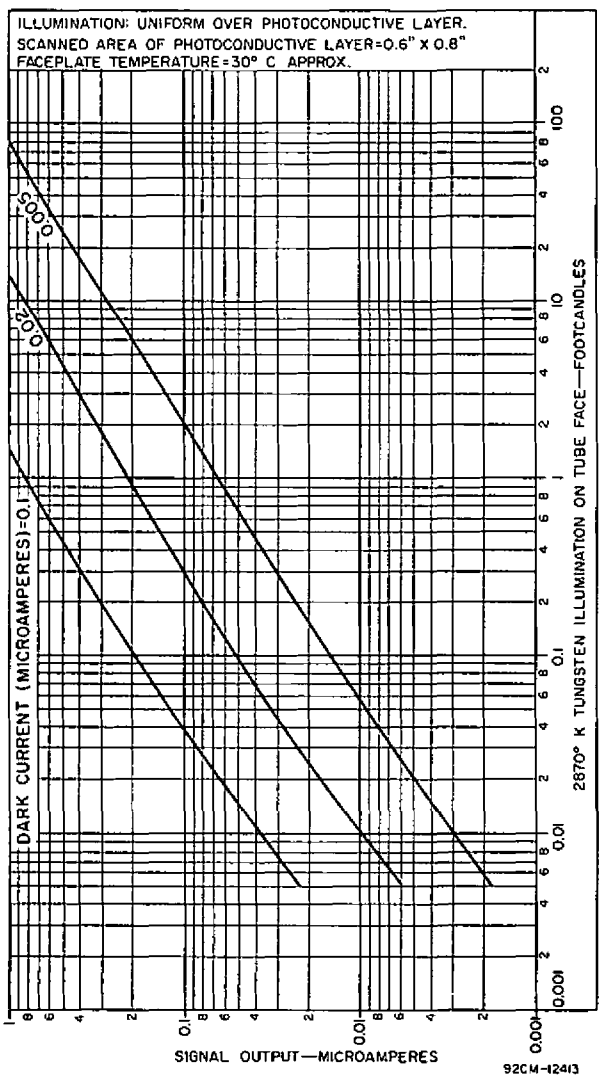


Fig.4

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTIC

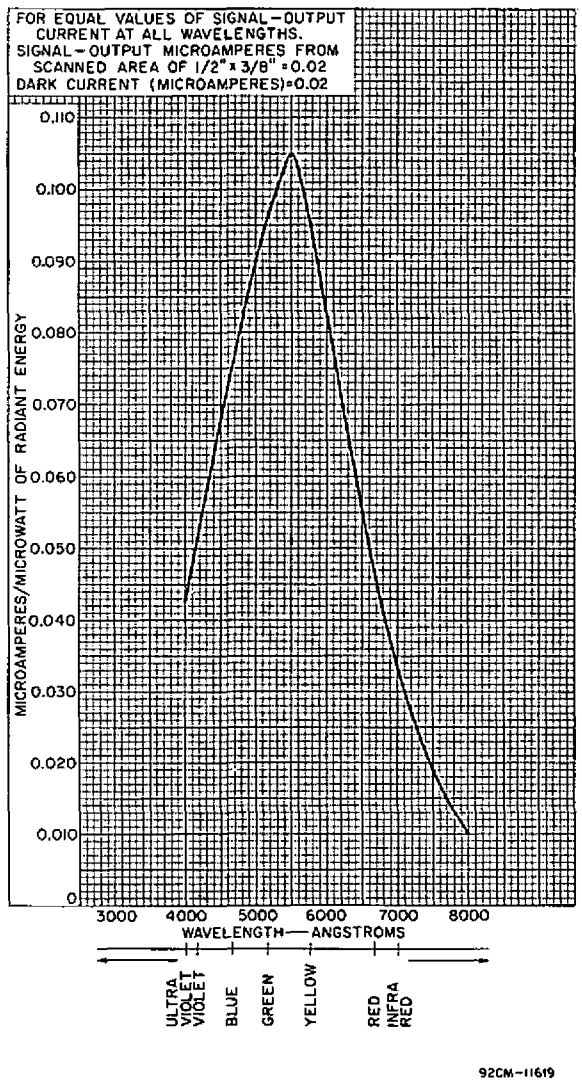


Fig.5

The average "gamma", or slope, of the light transfer characteristic curves shown in Fig.4 is approximately 0.65. This value is relatively constant and is applicable for the light levels required to obtain signal currents in the 0.02 μa to 0.6 μa range at dark current values of 0.005 μa to 0.02 μa. Because its transfer characteristic is approximately the complement of the transfer characteristic of a picture tube, the 8521 can produce a picture having proper tone rendition.

The *spectral response* of the 8521 is shown in Fig.5.

Failure of scanning even for a few seconds may permanently damage the photoconductive layer. The damaged area shows up as a spot or line in the picture during subsequent operation. To avoid damaging the 8521 during scanning failure, it is necessary to prevent the scanning beam from reaching the layer.

The scanning beam can conveniently be prevented from reaching the layer by increasing the grid-No.1 voltage to cutoff, biasing the target negatively, or removing the grid-No.4, grid-No.3, and grid-No.2 electrode voltages. Circuits should be incorporated to perform one or more of these functions automatically the instant scanning power fails or is reduced, at any time, to an abnormally low value.

HORIZONTAL PEAK-TO-PEAK RESPONSE TO A SQUARE-WAVE TEST PATTERN AT CENTER OF PICTURE WITHOUT APERTURE CORRECTION - PER CENT

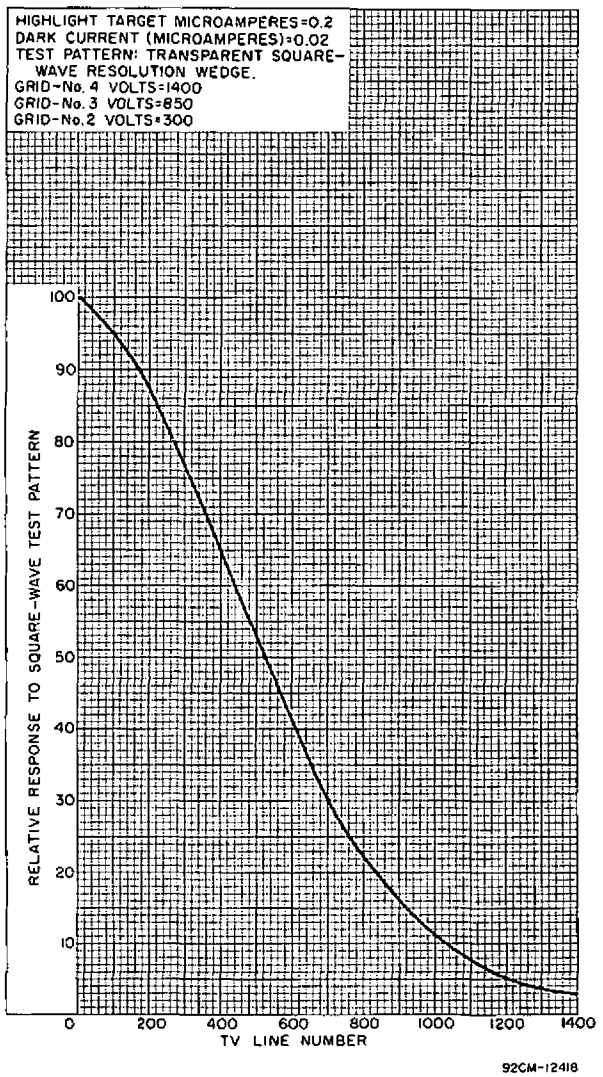


Fig.6

The *lens of the camera should always be capped* when the camera is not in use or is being transported to avoid the inadvertent exposure of the photoconductive layer to an image of the sun or other very intense source of illumination. The focusing of the image of a very bright light source on the tube face can cause permanent damage to the photoconductive layer.

SET-UP PROCEDURE

The sequence of adjustments for operating the 8521 is as follows: With Grid-No.1 Voltage Control set for maximum negative bias (beam cutoff), Target-Voltage Control set for the minimum voltage shown under *Typical Operation*, and Deflection Controls set for maximum overscan, apply other voltages to the 8521 as indicated under *Typical Operation*.

Next, with a 0.6" x 0.8" mask centered on the face of the tube, and with the iris set for minimum opening, decrease the grid-No.1 bias to just discharge the highlight details of the picture on the monitor. If the picture signal is very low with normal amplifier gain settings, increase the target voltage and/or the lens opening to obtain a usable signal level. Adjust the Beam-Focus Voltage Control and the optical focus to obtain the picture which has best resolution. Reduce the horizontal and vertical scanning so that the edges of the image extend just outside of the scanned area on the monitor. Then adjust the alignment field so that the center of the picture does not move as the beam-focus voltage is varied. Some readjustment of each operating control is often necessary after adjustment of the individual controls to obtain final optimum operating conditions.

For *Maximum-Sensitivity Operation* of the 8521 where the light level is very restricted, the following procedure is recommended: With no illumination on the face of the tube, increase the target voltage until non-uniformities in the dark-current signal become objectionable. Next uncap the lens and adjust the iris to obtain a picture of the desired quality and depth of focus. Adjust the grid-No.1 bias voltage to just discharge the highlights. If the beam current is higher than necessary, a picture of poor resolution and distorted half-tones may result. If the highlights cannot be discharged or the picture quality is unsatisfactory, it may be an indication that the light level on the tube is higher than that required. The target voltage should then be reduced to a value corresponding to that shown under *Average Sensitivity Operation* and the grid-No.1 bias readjusted to just discharge the highlights.

Proper adjustment of the target voltage and iris opening to give the lowest value of dark current consistent with necessary signal-output current will result in a picture of good quality with minimum lag or smear of moving objects.

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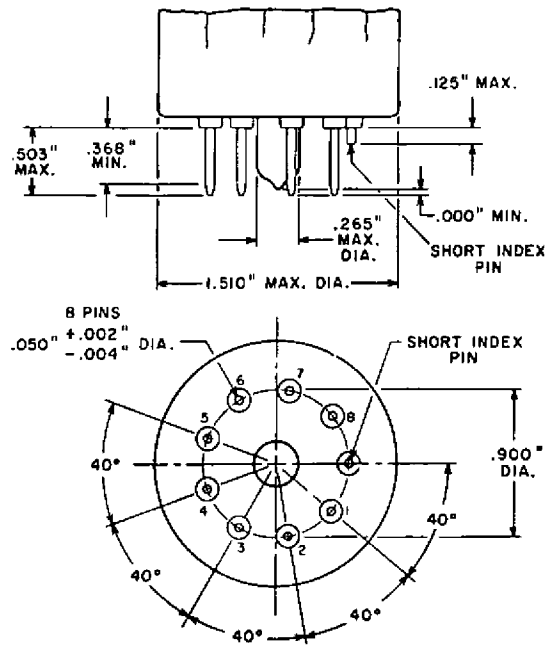
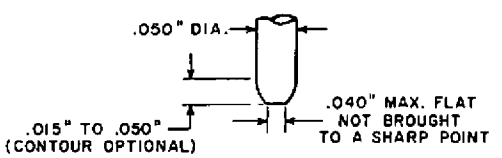
BASE DRAWING

SMALL-BUTTON SUPER-DITETRAR
8-PIN BASE
JEDEC No. E8-78



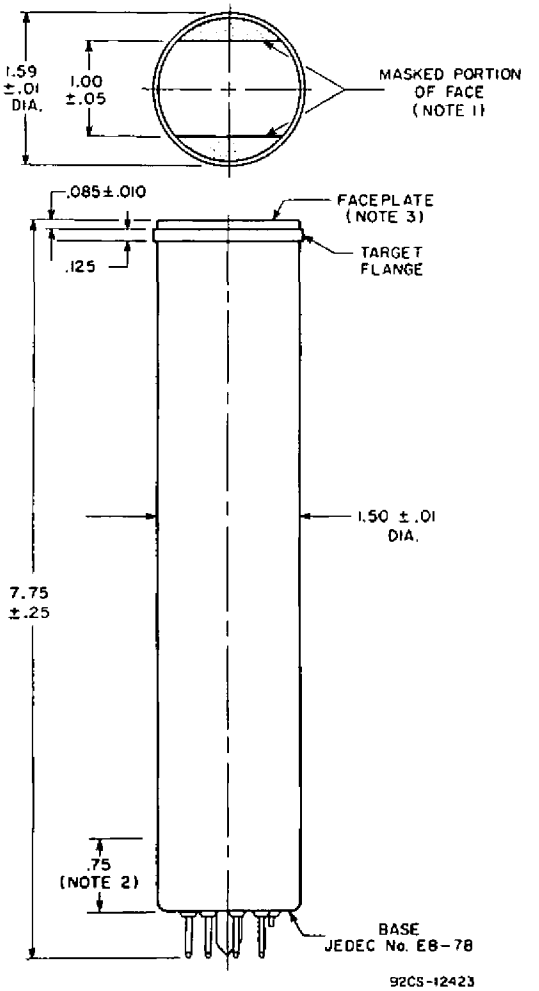
PIN CONTOUR



92CM-11158

BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT ENTIRE LENGTH OF PINS WILL, WITHOUT UNDUE FORCE, PASS INTO AND DISENGAGE FROM A FLAT-PLATE GAUGE HAVING A THICKNESS OF 1/4" AND NINE HOLES WITH DIAMETERS OF 0.0700" ± 0.0005" SO LOCATED ON A 0.9000" ± 0.0005" DIAMETER CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.3078" ± 0.0005". GAUGE IS ALSO PROVIDED WITH A HOLE HAVING DIAMETER OF 0.300" ± 0.001" CONCENTRIC WITH THE PIN CIRCLE.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

NOTE 1: STRAIGHT SIDES OF MASKED PORTIONS ARE PARALLEL TO THE PLANE PASSING THROUGH TUBE AXIS AND SHORT INDEX PIN.

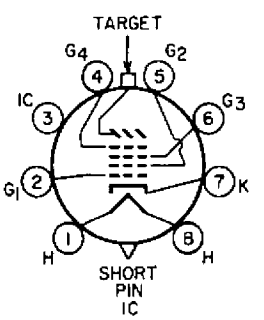
NOTE 2: WITHIN THIS AREA THE MINIMUM BULB DIAMETER DIMENSION DOES NOT APPLY.

NOTE 3: FACEPLATE THICKNESS IS 0.135" ± 0.005".

BASING DIAGRAM

Bottom View

PIN 1 – HEATER
PIN 2 – GRID No. 1
PIN 3 – INTERNAL CONNECTION— DO NOT USE
PIN 4 – GRID No. 4
PIN 5 – GRID No. 2
PIN 6 – GRID No. 3



PIN 7 – CATHODE
PIN 8 – HEATER
FLANGE – TARGET
SHORT INDEX PIN – INTERNAL CONNECTION— MAKE NO CONNECTION

DIRECTION OF LIGHT:
INTO FACE END OF TUBE

8LB