The IE-series of "1-inch" cathode-ray tubes consists of three types—IEPI, IEP2, and IEP11—utilizing electrostatic focus and electrostatic deflection. They differ one from the other only in the spectral-energy emission and persistence characteristics of their respective phosphors PI, P2, and P11.

Design features of the IE-types include a flat-face bulb, a minimum useful screen diameter of 1-1/16 inches, separate base-pin terminal for each deflecting electrode to permit use of balanced deflection, and a very sturdy structure.

**RCA-IEPI**

Medium-Persistence Type

The IEPI is designed especially for use in small, lightweight equipment, such as portable test equipment or aircraft equipment. It is also useful in larger equipment, such as computers or transmitters, where continuous monitoring of a waveform is desired. The IEPI provides a trace having high brightness at relatively low ultirot voltage on a screen which has green fluorescence and medium persistence.

The spectral distribution of the energy emitted by the PI phosphor is shown in Fig.1; and the persistence of the PI phosphor is given in Fig.2. Because of its medium persistence, the IEPI is particularly useful where either medium-speed non-recurring phenomena or medium- and high-speed recurring phenomena are to be observed. The persistence is such that the IEPI can be operated with scanning frequencies as low as 20 cycles per second without excessive flicker.

The recommended minimum ultirot voltage for the IEPI in general service is 500 volts, but a value as low as 300 volts may be used under conditions of low-velocity deflection and low ambient-light levels.

The curves in Fig.3 show how line width of the IEPI varies with brightness for two values of ultirot voltage.
RCA-1EP2

Long-Persistence Type

The 1EP2 is intended for use in lightweight portable equipment, or in continuous monitoring service for large electronic equipment. It is especially useful in applications where a temporary record of electrical phenomena is desired. The 1EP2 utilizes a long-persistence screen which exhibits greenish-yellow fluorescence of short persistence and greenish-yellow phosphorescence which persists for over a minute under conditions of adequate excitation and low ambient light.

The spectral distribution of the energy emitted by the P2 phosphor is shown in Fig.4; and the persistence of the P2 phosphor is given in Fig.5.

Because of its long persistence, the 1EP2 is particularly useful where either low-speed non-recurring or high-speed recurring phenomena are to be observed.

The persistent light of the 1EP2 permits the user to view a curve produced on the face of the tube by a single, high-speed sweep of the electron beam and, if desired, to make a tracing of the curve for record purposes.

In general, operation of the 1EP2 at an anode voltage less than 750 volts is not recommended.

The curves in Fig.6 show how line width of the 1EP2 varies with brightness for two values of anode voltage.
**RCA-IEP11**

*Short-Persistence Type*

The IEP11 is intended for use in light-weight portable equipment, or in continuous monitoring service for large electronic equipment. It is particularly useful in those applications involving photographic recording of electrical phenomena. The blue radiation of its fluorescent screen is highly actinic and has sufficiently short persistence to permit use of the IEP11 in all photographic applications without blurring except in those where the film moves at high speed.

The IEP11 is also quite satisfactory for visual observation of phenomena because it utilizes a phosphor having unusually high brightness for a blue screen.

**Fig. 5 - Persistence Characteristics of Phosphor P11.**

**Fig. 7 - Spectral-Energy Emission Characteristics of Phosphor P11.**

The spectral distribution of the energy emitted by the P11 phosphor is given in Fig. 7.

Persistence characteristics of the P11 phosphor for different screen-current densities are shown in Fig. 8. Because of its short persistence, the IEP11 is especially useful where either high-speed non-recurring phenomena or medium- and high-speed recurring phenomena are to be observed.

In general, operation of the IEP11 at an ultraviolet voltage less than 750 volts is not recommended.

The curves in Fig. 9 show how line width of the IEP11 varies with brightness for two values of ultraviolet voltage.

In the case of moving photographic film, the use of high-contrast film and developer will minimize blurring caused by the image persistence. For maximum photographic-recording sensitivity with films generally available, the use of high-speed orthochromatic film is suitable.
In cases where a large amount of recording is to be done, the use of special, high-speed, blue-sensitive film may have an economic advantage.

**DATA**

For All 1F-Types

**General:**
- Heater, for unipotential Cathode:
  - Voltage (4C or DC) ...
  - Current ...
- Direct Interelectrode Capacitances (Approx.):
  - Grid No. 1 to all other electrodes ...
  - Deflecting Electrode Df1 to deflecting Electrode Df2 ...
  - Deflecting Electrode Df3 to deflecting Electrode Df4 ...
  - Df1 to all other electrodes ...
  - Df2 to all other electrodes ...
  - Df3 to all other electrodes ...
  - Df4 to all other electrodes ...
- Faceplate, Flat ...
- Focusing Method ...
- Deflection Method ...
- Maximum Overall Length ...
- Seated Length ...
- Diameter ...
- Minimum Useful Screen Diameter ...
- Bulb ...
- Base ...
- Weight (Approx.) ...
- Mounting Position ...
- Maximum Ratings, Design-Center Values:
  - ULTRAVOLTAGE ...
  - GRID-No.3 VOLTAGE ...
  - GRID-No.1 VOLTAGE:
    - Negative bias value ...
    - Positive bias value ...
    - Positive peak value ...
  - PEAK VOLTAGE BETWEEN ULTRON AND ANY-DEFLECTING ELECTRODE ...
  - PEAK HEATER-CATHODE VOLTAGE:
    - Heater negative with respect to cathode ...
    - Heater positive with respect to cathode ...
- Equipment Design Ranges:
  - FOCUS: ...
  - Grid-No.3 Voltage for Focus ...
  - Grid-No.3 Voltage for Visual Extinction of Undelected Focused Spot ...
- Grid-No.3 Current for Any Operating Condition ...
- Deflection Factors:
  - Df1 & Df2 ...
  - Df3 & Df4 ...
  - Spot Position ...
- Examples of Use of Design Ranges:
  - For Ultraviolet 500 1000 volts ...
  - Grid-No.3 Voltage for Focus ...
  - Grid-No.1 Voltage for Visual Extinction of Undelected Focused Spot ...
  - Deflection Factors:
    - Df1 & Df2 ...
    - Df3 & Df4 ...
  - Maximum Circuit Values:
    - Grid-No.1-Circuit Resistance ...
    - Resistance in Any Deflecting Electrode Circuit 500 ...

**Fig. 8 - Persistence Characteristics of Phosphor P11**

**Fig. 9 - Average Characteristics of Type 1EP11**
The "ulator" in a cathode-ray 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 IE-types, the utor function is performed by grid No. 4. Since grid No. 4, grid No. 2, and collector are connected together within the IE-types, they are collectively referred to simply as "ulator" for convenience in presenting data and curves.

Brilliantness and definition decrease with decreasing utor voltage. Recommended minimum value of utor voltage for the IE2 in general service is 500 volts, but a value as low as 300 volts may be used under conditions of low-velocity deflection and low ambient light levels. For operation between 300 and 500 volts, it is essential that the utor voltage be applied before beam-current flow. Otherwise, a screen charge may develop to block off or distort the scanning pattern. Recommended minimum value for the IE2 and IE21 is 750 volts.

The center of the undeflected focused spot will fall within a circle having 2.5-mm radius concentric with the center of the tube face.

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

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data 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 the line-center value of 117 volts.

Support for the IE-types may be provided by any convenient method required by the application. When the tube is supported by a clamp around the bulb, the clamp should be fastened only tight enough to support the equipment. Fastening the clamp too tight may cause glass strains with immediate or delayed cracking of the bulb.

The bulb, except for the face, should be enclosed in a grounded shield if the tube is to be operated in the presence of magnetic fields. The shield should be made of high-permeability metal having low residual magnetism in order to minimize the effects of extraneous magnetic fields.

The base pins of the IE-types fit the Unidekar 11-contact socket, such as Aiden Nos. 411 SBU (connector type) or 411 SBUP (with mounting plate for panel or chassis mounting), or equivalent. The design of the socket should be such that the circuit wiring cannot impress lateral strains through the socket contacts on the base pins. The point of bearing of the contacts on the base pins should not be closer than 1/8" from the bottom of the seated tube.

Two pairs of electrostatic deflecting electrodes, producing fields approximately at right angles to each other, 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. Each electrode of each pair should be connected through a resistor of not more than 2 megohms to the grid No. 4 socket terminal. Under operating conditions involving high current to the screen or scanning beyond the limits of the screen, a small amount of current is collected by the deflecting electrodes. If the circuit resistance between each deflecting electrode and grid No. 4 is high, the current collected by the deflecting electrodes produces negative potentials on the deflecting electrodes. Such potentials distort or shift the spot on the screen. These effects can be minimized by reducing equally the resistances of the deflecting-electrode circuits, by reducing the scanning width, by reducing the beam current, or by applying a small and equal ac compensating voltage to deflecting electrodes DJ3 and DJ4. This voltage should be positive with respect to grid No. 4.

Operation with one pair of deflecting electrodes at an average potential different from that of grid No. 4 may be desired in certain applications. In such cases, the different potential should be applied to the pair of deflecting electrodes (DJ4 and DJ2) nearer the screen, and its average value should not differ from the operating grid No. 4 voltage by more than 15%. This type of operation causes spot-shape dis-

![Diagram](image-url)

Fig. 10 - Typical Oscillograph Circuit for IE-Types.
DJ1 and DJ2 (positive or negative with respect to grid No.4). The dc voltages for grid No.1, grid No.3, and grid No.4 may be obtained conveniently from a high-voltage vacuum-tube rectifier and filter. Since these cathode-ray tubes require very little current, the rectifier system can be of either the half-wave or the voltage-doubler type. Likewise, the filter requirements are simple. A 0.5 \( \mu F \) capacitor will ordinarily provide sufficient filtering. If this is inadequate, a two-section filter is recommended. If the electrode voltages are obtained from a voltage-divider circuit, a

![Graph](image)

*Fig. 11 - Average Characteristics for 1E-Types.*

... current of 1.0 milliampere through the voltage divider is satisfactory. Considerably higher values may require more filtering than that provided by a single capacitor shunted across the dc supply. A typical circuit for the 1E-types is shown in Fig. 10.

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

The high voltages at which these types are 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 circuits of the power supply when access to the equipment is...
required. 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 cathode-ray 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 spot is normally close to the geometric center of the tube face. However, to compensate for stray magnetic fields, such as that of the earth, and for variation from tube to tube, designers should provide an adjustable and reversible supply of at least 35 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 spot may be centered.

A high intensity spot will burn the fluorescent screen if the spot is allowed to remain stationary. To prevent this possibility, the beam should always be kept in motion over a reasonably large area, or the beam current should be reduced. Such burning is especially noticeable when the IE-types are operated with ultor voltages less than 1000 volts.
**DIMENSIONAL OUTLINE**

**BASE DRAWING**

**SMALL-BUTTON UNIDEKAR 11-PIN BASE JETEC NRE11-22**

- $1\frac{1}{16}''$ MIN.
- $3\frac{3}{8}''$ MAX.
- $3\frac{3}{4}''$ MAX.
- $4\frac{1}{16}''$ MAX.
- $5\frac{1}{16}''$ MAX.
- $687''$

**BASE PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT THE PINS WILL FIT A FLAT-PLATE GAUGE HAVING THICKNESS OF $1/4''$ AND TWELVE HOLES $0.050'' \pm 0.0005''$ SO LOCATED ON A $0.6870'' \pm 0.0005''$ DIAMETER CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS $0.1778'' \pm 0.0005''$ THE GAUGE IS ALSO PROVIDED WITH A HOLE $0.3750'' \pm 0.0005''$ CONCENTRIC WITH THE PIN-CIRCLE DIAMETER. PIN FIT IN GAUGE SHALL BE SUCH THAT THE ENTIRE LENGTH OF PINS WILL, WITHOUT UNDUE FORCE, ENTER INTO AND DISENGAGE FROM THE GAUGE.

**SOCKET CONNECTIONS**

**Bottom View**

- **PIN 1**: HEATER
- **PIN 2**: HEATER
- **PIN 3**: GRID NO. 1
- **PIN 4**: CATHODE
- **PIN 5**: GRID NO. 3
- **PIN 6**: DEFLECTING ELECTRODE DJ

- **PIN 7**: DEFLECTING ELECTRODE DJ
- **PIN 8**: ULTORS (GRID NO. 2, GRID NO. 4, COLLECTOR)
- **PIN 9**: DEFLECTING ELECTRODE DJ
- **PIN 10**: DEFLECTING ELECTRODE DJ
- **PIN 11**: INTERNAL CONNECTION—DO NOT USE