



3FP7-A

CATHODE-RAY TUBE

Electrostatic Focus
Electrostatic Deflection

Combination Long- and
Short-Persistence Screen

10 Inches Long
3-Inch Bulb

RCA-3FP7-A is a cathode-ray tube of the electrostatic deflection and electrostatic focus type having a fluorescent screen two and one-half inches in diameter. The tube has a supplementary high-voltage anode which permits increasing the brightness of the fluorescent spot. The trace produced fluoresces a blue-white color which subsides immediately leaving a yellow long-persistence phosphorescence. Its brightness, while much lower than that of the fluorescence, is considerably higher than that of screens previously available. The difference in the colors of the fluorescence and the phosphorescence permits the use, by means of color filters, of the tube in applications requiring either a short or a long persistence characteristic.

The 3FP7-A employs an improved electron gun for projecting the electron beam onto the fluorescent screen. The improved gun provides sharper focus of the beam and is designed so that its anode No. 1 takes essentially no current. This feature permits the use of a bleeder system requiring very little current and, consequently, a smaller filter capacitance. As a result of the extremely small anode-No. 1 current, variation in focus which may otherwise take place with change in beam current is minimized.

The 3FP7-A is recommended for use in oscillographic applications where the features of the P7 screen are advantageous, and where the inertialess character of the electron beam, electrostatic deflection, and a brilliant image of the phenomena under observation are of importance.

RCA-3FP7-A supersedes RCA-3FP7.

DATA

General:

Heater, for Unipotential Cathode:			
Voltage (AC or DC)	6.3 $\pm 10\%$	Volts	
Current	0.6	Ampere	
Direct Interelectrode Capacitances (Approx.):			
Grid No. 1 to All Other Electrodes . . .	8.5	μf	
Cathode to All Other Electrodes . . .	8.0	μf	
DJ1 to DJ2	2.0	μf	
DJ3 to DJ4	2.0	μf	
DJ1 to All Other Electrodes	8.0	μf	
DJ3 to All Other Electrodes	6.0	μf	
DJ1 to All Other Electrodes except DJ2 . .	6.0	μf	
DJ2 to All Other Electrodes except DJ1 . .	5.0	μf	
DJ3 to All Other Electrodes except DJ4 . .	4.0	μf	
DJ4 to All Other Electrodes except DJ3 . .	6.0	μf	
Phosphor	No. 7		
Fluorescence	Blue-white		
Phosphorescence	Yellow		
Persistence	Combination Long and Short		
Focusing Method	Electrostatic		
Deflection Method	Electrostatic		
Deflecting-Electrode Arrangement . . .	See Outline Drawing		
Overall Length	10" $\pm 1/4$ "		
Greatest Diameter of Bulb	3" $\pm 1/16$ "		

Minimum Useful Screen Diameter. 2-1/2"
Cap Recessed Small Ball
Base Medium Shell Diheptal 12-Pin
Mounting Position Any

Maximum Ratings, Absolute Values:

ANODE-NO. 3 VOLTAGE	4400 max.	Volts
ANODE-NO. 2 & GRID-NO. 2 VOLTAGE	2200 max.	Volts
RATIO OF ANODE-NO. 3 VOLTAGE to ANODE-NO. 2 VOLTAGE	2.3:1 max.	
GRID-NO. 1 (CONTROL ELECTRODE) VOLTAGE:		
Negative Value	200 max.	Volts
Positive Value	0 max.	Volts
PEAK VOLTAGE BETWEEN ANODE-NO. 2 and ANY DEFLECTING ELECTRODE	550 max.	Volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	125 max.	Volts
Heater positive with respect to cathode	10 max.	Volts

Typical Operation:

Anode-No.3 Voltage** . . .	2000	3000	4000	. .	Volts
Anode-No.2 & Grid No.2 Voltage***	2000	1500	2000	. .	Volts
Anode-No.1 voltage for Focus at 75% of Grid-No.1 Volt. for Cutoff#	575	430	575	. .	Volts
Grid-No.1 voltage for Visual Cutoff##	-60	-45	-60	. .	Volts
Max. Anode-No.1 Current Range^	Between -50 and +10 . . μ amp.				
Deflection Sensitivity:					
DJ1 and DJ2	0.127	0.135	0.102	mm/volt dc	
DJ3 and DJ4	0.172	0.188	0.141	mm/volt dc	
Deflection Factor:###					
DJ1 and DJ2	200	188	250 voltsdc/in.		
DJ3 and DJ4	148	135	180 voltsdc/in.		

** It is recommended that for high-speed scanning, anode-No. 3 voltage should not be less than 3000 volts.

*** Brilliance and definition decrease with decreasing anode-No. 2 voltage. In general, anode-No. 2 voltage should not be less than 1500 volts.

Individual tubes may require between -20% and +35% of values shown with grid-No. 1 voltage between zero and cutoff.

Visual extinction of stationary focused spot. Supply should be adjustable to $\pm 50\%$ of these values.

Individual tubes may vary from these values by $\pm 20\%$.
^ See curve for average values.

Spot Position:

The undeflected focused spot will fall within a 12-mm square centered at the geometric center of the tube face and having one side parallel to the trace produced by DJ1 and DJ2. Suitable test conditions are: anode-No. 3 volts, 4000; anode-No. 2 volts, 1500; anode-No. 1 volts, adjusted for focus; deflecting-electrode resistors, 1 megohm each, connected to anode No. 2; the tube shielded from all extraneous fields. To avoid damage to the tube, grid-No. 1 voltage should be near cutoff before application of any anode voltages.

Maximum Circuit Values:

Grid-No. 1-circuit Resistance	1.5 max.	Megohms
Impedance of Any Deflecting-Electrode circuit at heater-supply frequency	1.0 max.	Megohm
Resistance in Any Deflecting-Electrode circuit^	5.0 max.	Megohms

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

INSTALLATION and APPLICATION

The base pins of the 3FP7-A fit the 12-pin diheptal socket which may be installed to hold the tube in any position. The socket alone, however,



should not be used to support the tube. Other support, such as a yoke or saddle arrangement, should be used near the screen end of the tube. The socket should be made of good insulating material; a type having insulating baffles between contacts provides an additional factor of safety.

The *bulb* should be enclosed in a grounded shield made of high permeability metal having low residual magnetism in order to minimize the effects of extraneous magnetic fields. When a grounded metal shield is used around the tube, it may be necessary to insulate the tube from the shield to avoid the effects of corona or leakage currents.

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. The mid-tap or one side of the heater winding should preferably be connected to the cathode. If necessary, the heater may be operated with a bias of not more than -125 volts or +10 volts with respect to the cathode.

The *cathode* is connected to base pin 2 to which the grid and anode circuit returns should be made.

The *fluorescent screen* employs phosphor No.7 which fluoresces blue-white and phosphoresces light yellow. After excitation, the fluorescence drops rapidly to a small fraction of its initial value; after this initial period, the rate of decay of the phosphorescence is relatively low and, therefore, the yellow pattern remains visible for several minutes. In the case of recurrent phenomena of short duration, a yellow filter such as Wratten No.15 can be used to greatly reduce the fluorescent flashes. The P7 phosphor may also be used with a blue filter such as Wratten No.47A to suppress the yellow phosphorescence and, thereby, to obtain a relatively short-persistence pattern.

The *dc voltages* for the grid and the three anodes may be obtained conveniently from a high-voltage vacuum-tube rectifier. Since a cathode-ray tube requires very little current, the rectifier system can be of either the half-wave or the voltage-doubler type. The Typical Oscillograph Circuit shown indicates a voltage doubler as the recommended type of circuit. Likewise, the filter requirements are simple. A 0.1 μ 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 bleeder circuit, a bleeder current of about 0.2 milliamperes usually is satisfactory. Considerably higher values may require more filtering than that provided by a single capacitor shunted across the dc supply.

In most applications, it is recommended that anode No.2 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; when anode No.3 is operated at a higher positive potential than that of anode No.2, anode No.3 is at high positive potential with respect to ground. This is a desirable arrangement because, for a given anode-No.3 potential, the voltage to ground is reduced about one-half as compared with operation where the cathode is at ground potential.

Anode No.3 should be operated at or above the potential of anode No.2. Operation with a lower potential or without an applied potential is not recommended; operation with anode-No.3 potential below that of anode No.2 should never be permitted for even a short time as the screen will be darkened permanently. Application of anode-No.3 potential above that of anode No.2 provides acceleration of the electron beam after deflection and a more brilliant fluorescent spot than is obtained with anode No.3 at the potential of anode No.2. Under these conditions, also, there is a reduction of deflection sensitivity as may be seen by comparison of the first and third columns under TYPICAL OPERATION.

The high voltages at which the tube is operated are very dangerous. Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltages. 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 required. In most applications, it is recommended that the anode No.2 terminal be grounded rather than the cathode terminal. With this method, which places the cathode and heater 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 due to capacitor breakdown or to 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 charged capacitors grounded.

Focusing of the fluorescent spot produced by the electron beam is controlled by adjustment of the ratio of anode-No.2 voltage to anode-No.1 voltage. Ordinarily, the ratio is adjusted by variation of anode-No.1 voltage. For this purpose, a potentiometer is required in the bleeder circuit; the necessary range of adjustment is indicated under TYPICAL OPERATION.

Regulation of spot brilliance can be accomplished by varying the current to anode No.3. This current can be increased by decreasing the bias voltage applied to the control electrode. An increase in this current increases the spot.



size and the quantity of light. To obtain the smallest spot, a slight readjustment of focus may be necessary. An increase in the voltage applied to anode No.2 increases the beam current and the sharpness of focus and, therefore, the spot brilliance. Likewise, as discussed in an earlier paragraph, an increase in the voltage applied to anode No.3 increases the brilliance of the spot.

In applications involving extremely accurate measurements, the anode-No.2 and anode-No.3 currents should be reduced to the minimum consistent with the desired brilliance of the pattern. In cases where high brilliance is an important consideration, the voltage applied to the high-voltage anodes may be increased to the maximum rated values with due consideration to line-voltage variations. This procedure, however, is not always desirable since it results in reduced deflection sensitivity.

It is important to note that a high-intensity spot will burn the screen if the spot is allowed to remain stationary. To prevent this possibility, it is recommended that the spot be kept in motion over a reasonably large area or the beam current should be reduced.

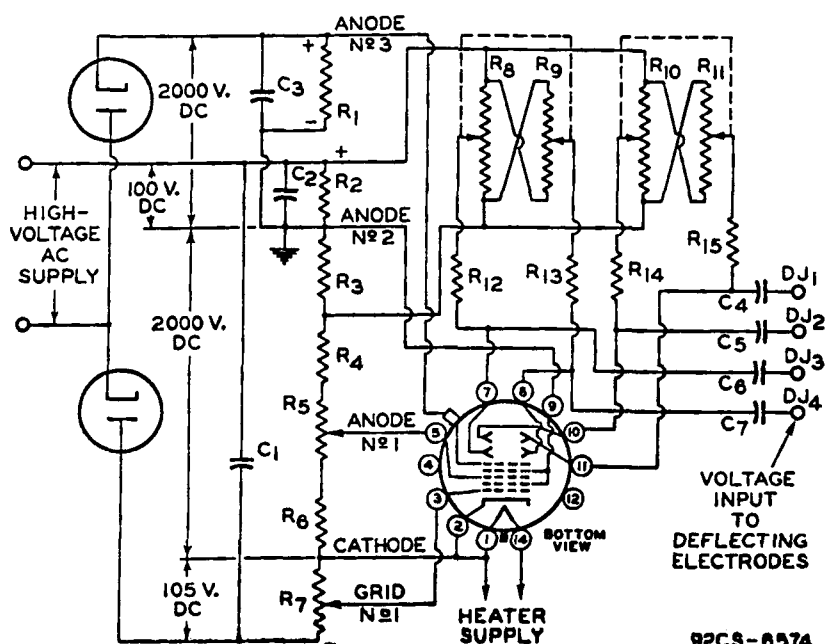
Two pairs of *electrostatic electrodes*, producing fields at right angles, are located within the bulb neck to provide for deflection of the electron beam. The electrostatic field of each pair of deflecting electrodes causes deflection of the beam in the direction of the gradient lines of the field and perpendicular to the plane of the deflecting electrodes; therefore, the deflections caused by the two fields are at right angles. Each set of deflecting electrodes should be maintained essentially at the dc potential of anode No.2. To do this, each electrode of each set should be connected through a resistor of

not more than 5 megohms to the anode-No.2 socket terminal (ordinarily at ground potential). This arrangement permits a choice of resistor values such that the electron beam is not distorted by dc potentials built up on the deflecting electrodes. If, during operation, the zero axes should shift, it usually is because the beam current is too high for the resistor value used. When it is necessary to use a high value of beam current, as when photographs are taken, the value of the deflecting-electrode resistors should be reduced to minimize the shift of the zero axes.

The deflection sensitivities and the deflection factors for each pair of deflecting electrodes for typical anode-No.2 voltages are given under TYPICAL OPERATION.

Photographs of the phenomena appearing on the viewing screen can be made with an ordinary camera. The photographing is done preferably in complete darkness in order to obtain as much contrast as possible between the fluorescent pattern and the screen. The time of exposure will depend on the speed of the camera lens, the kind of film or plate emulsion used, and the brightness of the pattern. Where transients are to be photographed, maximum brightness may be required because of the short duration of the phenomena; where recurrent wave forms are to be photographed, patterns having low brightness can be compensated for by longer exposure. The use of emulsions having high green sensitivity is recommended; orthochromatic types of film and high-speed films have been found to give excellent results.

For high-speed photographic work involving non-recurrent phenomena, it is permissible to



- C1: 0.1 μ f
- C2: 1.0 μ f
- C3: 0.1 μ f
- C4 C5 C6 C7: 0.05- μ f Blocking Capacitors*
- R1: 50 Megohms
- R2 R3: 2 Megohms
- R4: 5.5 Megohms
- R5: 2-Megohm Potentiometer
- R6: 1.5 Megohms
- R7: 0.5-Megohm Potentiometer
- R8 R9: Dual 5-Megohm Potentiometer
- R10 R11: Dual 5-Megohm Potentiometer
- R12 R13 R14 R15: 2 Megohms

* When cathode is grounded, capacitors should have high voltage rating; when anode No.2 is grounded, they may have low voltage rating. For dc amplifier service, deflecting electrodes should be connected direct to amplifier output. It is preferable usually to remove deflecting-electrode resistors to minimize loading effect on amplifier. In order to minimize spot defocusing, it is essential that anode No.2 be returned to a point in the amplifier system which will give the lowest possible potential difference between anode No.2 and the deflecting electrodes.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

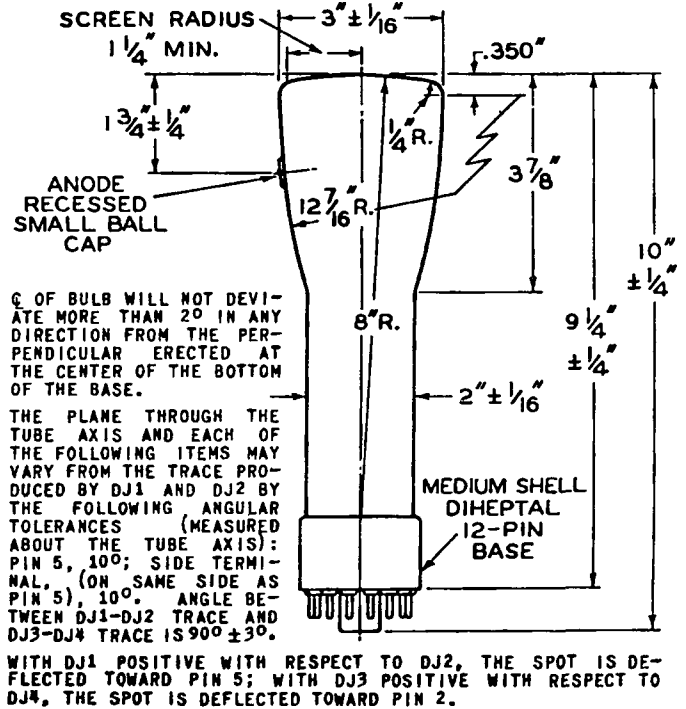
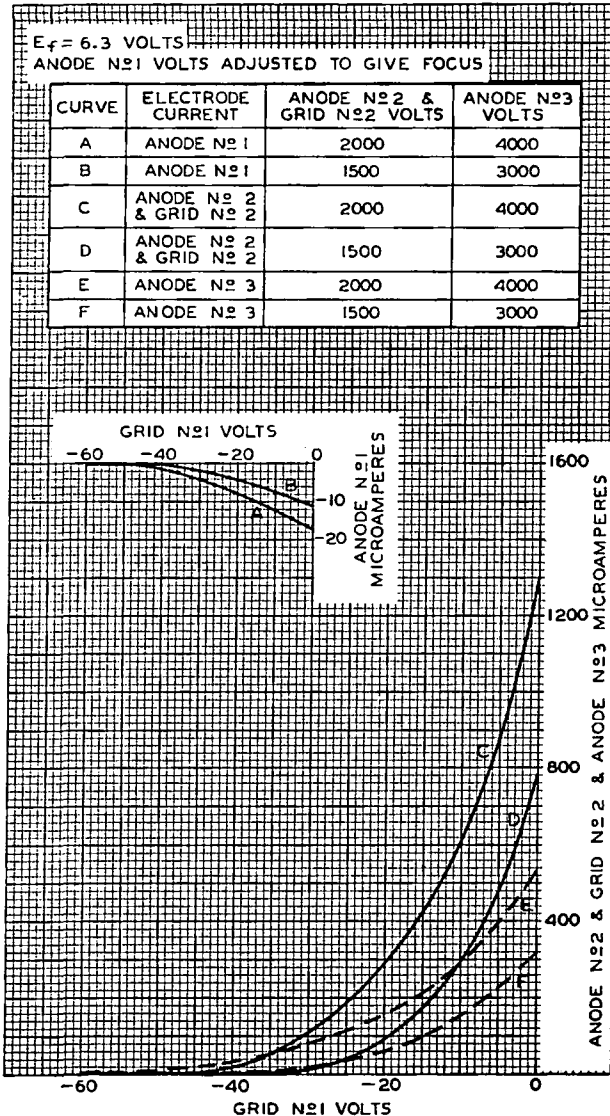
92CS-6574
Typical Oscilloscope Circuit



increase the trace brightness, for the short interval required to make the exposure, above that required for visual observation. The extent to which the anode current may be increased without harming the screen is proportional to the velocity of beam travel and pattern size, and an inverse function of the duration of the phenomena.

Short-interval operation at increased current can be obtained by means of a temporary decrease in the grid-No.1 voltage. A switching arrangement should be provided to switch the grid-No.1 voltage rapidly between a negative and a less negative value. The exposure is made while the grid-No.1 voltage is at the less negative value.

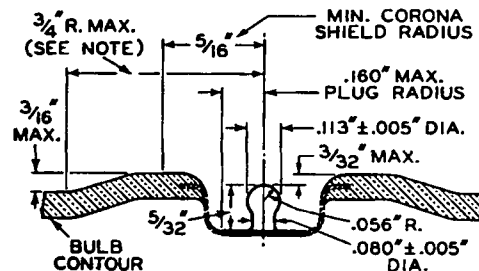
AVERAGE CHARACTERISTICS



92CM-6405R2

DETAILS OF RECESSED SMALL BALL CAP & BULB ASSEMBLY

ESSENTIAL DIMENSIONS FOR CONNECTOR DESIGN



NOTE: PROTRUSION OF GLASS AROUND CAP ABOVE BULB CONTOUR IS LIMITED TO AREA BOUNDED BY CIRCLE CONCENTRIC WITH CAP AXIS AND HAVING RADIUS OF 3/4" MAX.

92CS-6535R2

Bottom View of Socket Connections

