

6AR8

SHEET-BEAM TUBE

FOR TV SYNCHRONOUS DETECTOR AND BURST GATE APPLICATIONS

DESCRIPTION AND RATING

The 6AR8 is a miniature double-plate sheet-beam tube which incorporates a pair of balanced deflectors to direct the electron beam to either of the two plates and a control grid to vary the intensity of the beam. The resulting unique characteristics of this tube make it especially suited for service as a synchronous detector in color television receivers. In this application, relatively large, balanced output signals of both positive and negative polarities are developed which eliminate the need for phase-inversion functions in the matrix circuits. Other features of the 6AR8 synchronous detector circuit include low oscillator injection power requirements, freedom from the space-charge coupling effects which are present in dual-control pentodes and heptodes, linear output voltages, insensitiveness to variations in oscillator amplitude over a wide range, and a high ratio of plate to accelerator current. The 6AR8 is also suitable for service in the burst gate circuit of color TV receivers and a variety of other switching and gating applications.

GENERAL

Cathode—Coated Unipotential	
Heater Voltage, AC or DC	6.3 Volts
Heater Current	0.3 Amperes
Envelope—T-6½, Glass	
Base—E9-1, Small Button 9-Pin	
Mounting Position—Any	

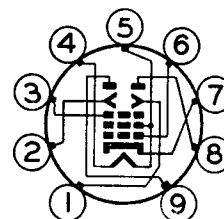
Direct Interelectrode Capacitances, approximate*	
Deflector-Number 1 to A11	4.8 μf
Deflector-Number 2 to A11	4.8 μf
Grid-Number 1 to A11 Except Plates	7.5 μf
Plate-Number 1 to A11	5.0 μf
Plate-Number 2 to A11	5.0 μf
Grid-Number 1 to Deflector-Number 1, maximum	0.040 μf
Grid-Number 1 to Deflector-Number 2, maximum	0.060 μf
Plate-Number 1 to Plate-Number 2	0.4 μf
Deflector-Number 1 to Deflector-Number 2	0.38 μf

MAXIMUM RATINGS

DESIGN-CENTER VALUES

Plate-Number 1 Voltage	300 Volts
Plate-Number 2 Voltage	300 Volts
Accelerator Voltage	300 Volts
Peak Positive Deflector-Number 1 Voltage	150 Volts
Peak Negative Deflector-Number 1 Voltage	150 Volts
Peak Positive Deflector-Number 2 Voltage	150 Volts
Peak Negative Deflector-Number 2 Voltage	150 Volts
Positive DC Grid-Number 1 Voltage	0 Volts
Plate-Number 1 Dissipation	2.0 Watts
Plate-Number 2 Dissipation	2.0 Watts
DC Cathode Current	30 Milliamperes
Grid-Number 1 Circuit Resistance	
With Fixed Bias	0.1 Megohms
With Cathode Bias	0.25 Megohms

BASING DIAGRAM

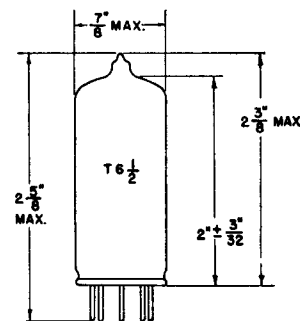


RETMA 9DP
BOTTOM VIEW

TERMINAL CONNECTIONS

- Pin 1—Deflector Number 2
- Pin 2—Deflector Number 1
- Pin 3—Accelerator
- Pin 4—Heater
- Pin 5—Heater, Internal Shield, and Focus Electrodes†
- Pin 6—Grid Number 1 (Control Grid)
- Pin 7—Cathode
- Pin 8—Plate Number 2
- Pin 9—Plate Number 1

PHYSICAL DIMENSIONS



RETMA 6-3

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS WITH DEFLECTORS GROUNDED

Plate-Number 1 Voltage	250 Volts
Plate-Number 2, Connected to Plate-Number 1	
Accelerator Voltage	250 Volts
Deflector-Number 1 Voltage	0 Volts
Deflector-Number 2 Voltage	0 Volts
Cathode-Bias Resistor	300 Ohms
Total Plate Current	10 Milliampere
Accelerator Current	0.4 Milliampere
Grid-Number 1 Transconductance	4000 Micromhos
Grid-Number 1 Voltage, approximate	
I_b (total) = 10 Microampere	-14 Volts

AVERAGE DEFLECTOR CHARACTERISTICS

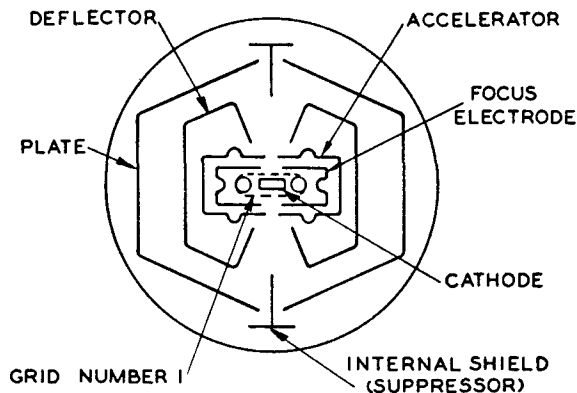
Plate-Number 1 Voltage	250 Volts
Plate-Number 2 Voltage	250 Volts
Accelerator Voltage	250 Volts
Cathode-Bias Resistor	300 Ohms
Deflector Switching Voltage, maximum†	20 Volts
Deflector-Bias Voltage for Minimum Deflector Switching Voltage‡	-8 Volts
Voltage Difference between Deflectors for $I_{b1} = I_{b2}$, approximate	0 Volts
Plate-Number 1 Current, maximum	
$E_{d1} = -15$ Volts, $E_{d2} = +15$ Volts	1.0 Milliampere
Plate-Number 2 Current, maximum	
$E_{d1} = +15$ Volts, $E_{d2} = -15$ Volts	1.0 Milliampere
Deflector-Number 1 Current, maximum	
$E_{d1} = +25$ Volts, $E_{d2} = -25$ Volts	0.5 Milliampere
Deflector-Number 2 Current, maximum	
$E_{d1} = -25$ Volts, $E_{d2} = +25$ Volts	0.5 Milliampere

* Without external shield.

† Pin 5 should be connected directly to ground.

‡ Deflector switching voltage is defined as the total voltage change on either deflector with an equal and opposite change on the other deflector required to switch the plate current from one plate to the other.

Note: The 6AR8 should be so located in the receiver that it is not subjected to stray magnetic fields.



CROSS-SECTION SCHEMATIC DIAGRAM OF THE 6AR8

OPERATING CONSIDERATIONS FOR THE 6AR8

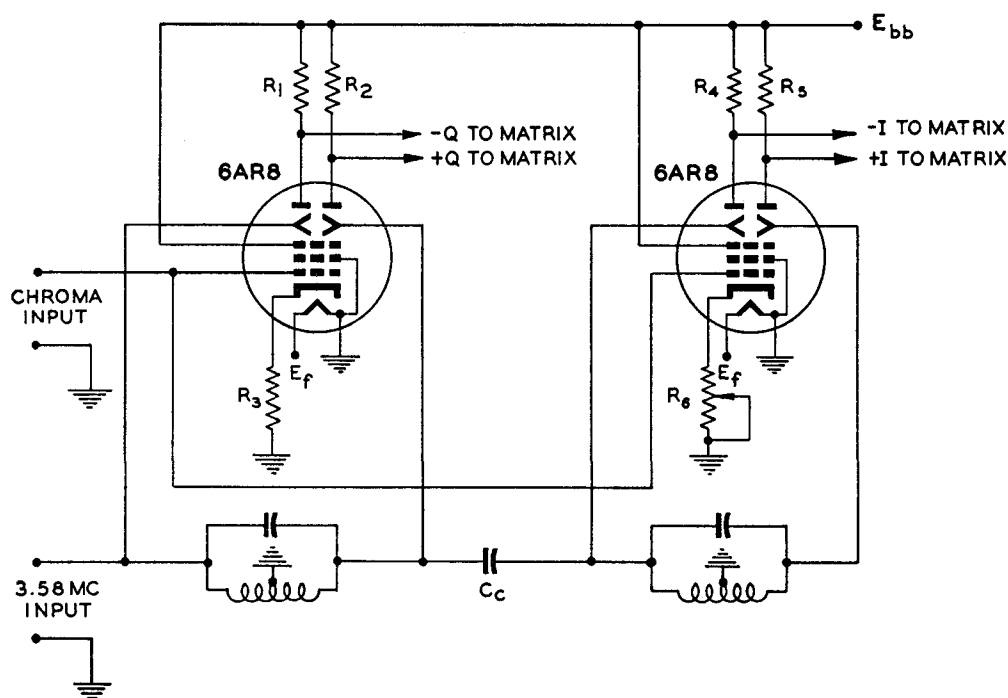
A cross-section schematic diagram of the construction of the 6AR8 is shown. In this tube, the electrons pass from the cathode to either of the two plates in the form of a planar beam or "sheet." Before the electron stream emerges from the openings in the accelerator structure, it is acted on by the focus electrodes and the control grid. The focus electrode tends to converge the electrons into the required sheet beam, while the conventional grid-number 1 structure which surrounds the cathode serves to control the intensity of the beam.

Between the accelerator and the plates the electron beam passes between the deflector electrodes. Depending on the voltages applied to the deflectors, the beam will be directed entirely to either one or the other of the two plates or proportioned between them. The internal shield, located between the two plates, acts to suppress the interchange of secondary-emission electrons between the plates. The suppressor and the focus electrodes are internally connected to one side of the heater.

In normal operation, positive d-c voltages are applied to the accelerator and plates, and signal voltages are applied to the deflectors and control grid. The frequency of the signal applied to the deflectors determines the rate at which the plate current is switched between the two plates; the grid-number 1 voltage varies the magnitude of the plate current. The interesting tube characteristics which result from the unique construction of the 6AR8 are indicated by the average tube characteristic curves which follow. The tube may be considered as equivalent to a voltage-controlled single-pole double-throw switch through which a current, the magnitude of which is also voltage-controlled, flows.

If both plates and the accelerator are operated at +250 volts and a cathode-bias resistor of 300 ohms is employed, the deflectors require a peak switching voltage of 20 volts (or a peak voltage difference between deflectors of 40 volts) maximum to switch the plate current from one plate to the other. In a practical circuit, however, in which the deflectors are driven in push-pull with the center-tap of the source grounded, a somewhat higher value of deflector drive voltage must be used. The increased drive voltage is required to allow for those tubes in which the switching characteristics are somewhat offset with respect to zero voltage difference between deflectors.

For an accelerator voltage of +250 volts, the minimum deflector switching voltage occurs at a d-c deflector bias of approximately -8 volts; however, the d-c deflector bias is not particularly critical for focus as the deflection sensitivity



CIRCUIT DIAGRAM OF TWO 6AR8 TUBES USED AS SYNCHRONOUS DETECTORS

OPERATING CONSIDERATIONS FOR THE 6AR8 (Cont'd)

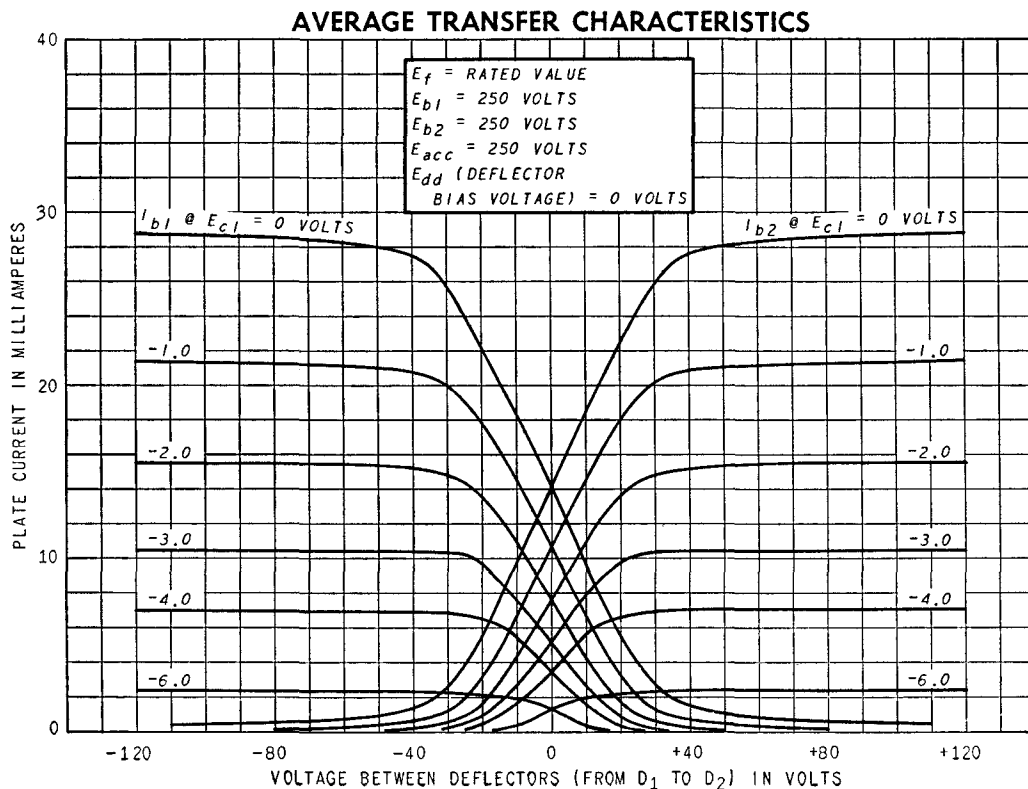
characteristic exhibits a broad maximum. Care should be exercised, nevertheless, to assure that defocusing effects are not present whenever the tube is operated at conditions other than those recommended.

The circuit diagram for two 6AR8 tubes employed as synchronous detectors π in a color television receiver is shown. In this arrangement, positive voltages are applied directly to the accelerator grids and through load resistors R1, R2, R4 and R5 to each of the plates. The chrominance signal is applied to the control grid of each tube. The 3.58-megacycle reference signal is applied in push-pull between the deflectors of each tube. The small coupling capacitor, Cc, between the tuned driving circuits provides the necessary 90-degree phase shift for the I and Q detectors. Also each tube is biased with a cathode resistor, R3 and R6; resistor R6 is variable so that the relative gains of the two demodulators can be adjusted.

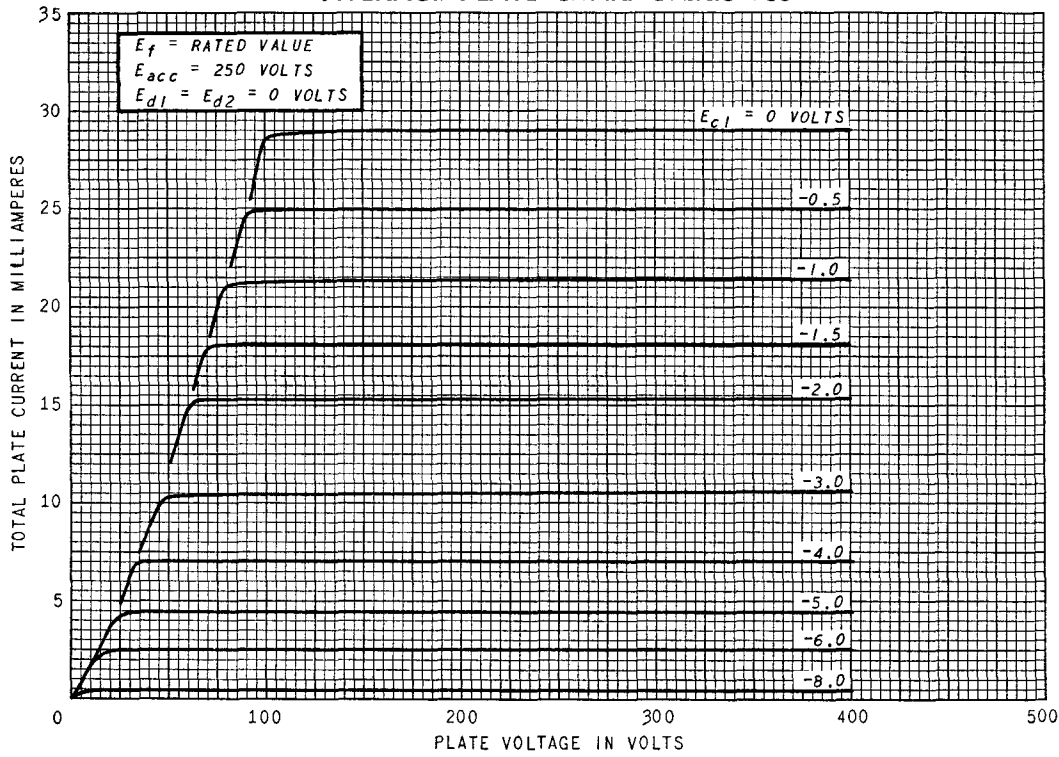
In principle, the 6AR8 circuit is a product-demodulator type of synchronous detector; however, because the circuit uses a double-plate sheet-beam tube rather than a dual-control pentode or heptode, certain significant operating features result. First the 6AR8 circuit is capable of delivering relatively large and balanced output voltages which exhibit good linearity. Because output voltages are available of both positive and negative polarities, the need for the incorporation of phase-inverter circuits in the matrix section of the color receiver is completely eliminated. Also, providing the oscillator reference voltage is adequate to switch the plate currents between the two plates, the circuit is insensitive to variations in the amplitude of the oscillator voltage over a wide range. Furthermore, unlike the pentode or heptode synchronous detector circuits in which the third grid is driven positive by the oscillator reference voltage, the deflectors of the 6AR8 require very little excitation power. Consequently, less power is required from the 3.85-megacycle reference oscillator in the sheet-beam tube circuit.

Another feature is that space-charge coupling effects, which are inherently present in dual-control pentodes and heptodes, are unnoticeable in the 6AR8. Also, unlike most dual-control pentodes and heptodes in which the screen current is an appreciable percent of the plate current, the accelerator current of the 6AR8 is less than one-twentieth of its plate current.

π R. Adler and C. Heuer, "Color Decoder Simplifications Based on a Beam-Deflection Tube," Trans. IRE, PGBTR-5, Jan. 1954.



AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS

