TECHNICAL DATA

# 8165
# 4-65A

RADIAL-BEAM
POWER TETRODE
MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 8165/4-65A is a small radial-beam tetrode with a maximum plate-dissipation rating of 65 watts. In most applications, no forced air is required, normal radiation and convection cooling being adequate. An instant-heating, thoriated tungsten filament is employed, allowing all electrode voltages to be applied simultaneously and permitting the conservation of power during standby periods. The 8165/4-65A is, therefore, a good choice for many mobile applications.

Short, heavy leads and low interelectrode capacities assure stable, efficient operation at high frequencies and permit its use at maximum ratings through 150 megacycles. The 8165/4-65A is equally useful in audio-amplifier or modulator service.


## GENERAL CHARACTERISTICS

### ELECTRICAL

| | Min. | Nom. | Max. | |
|---|---|---|---|---|
| Filament: Thoriated Tungsten | | | | |
| Voltage | | 6.0 | | volts |
| Current | 3.2 | | 3.8 | amperes |
| Grid-Screen Amplification Factor | 5 | | 7 | |
| Direct Interelectrode Capacitances: | | | | |
| Grid-Plate | | | 0.12 | uuf |
| Input | 6.0 | | 8.3 | uuf |
| Output | 1.9 | | 2.6 | uuf |
| Frequency for Maximum Ratings | | | 150 | mc |

### MECHANICAL

| | |
|---|---|
| Base | 5-pin—National HX-29 or Johnson 122-101 |
| Maximum Seal Temperature | 200° C |
| Maximum Envelope Temperature | 225° C |
| Recommended Socket Operating Position | Vertical, base down or up |
| Cooling | Convection and radiation |
| Recommended Heat Dissipating Connector | Eimac HR-6 |
| Maximum Over-all Dimensions | |
| Length | 4.19 inches |
| Diameter | 2.38 inches |
| Net Weight | 3 ounces |
| Shipping Weight (Approximate) | 1.5 pounds |

### RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions)

| | |
|---|---|
| D-C PLATE VOLTAGE | 3000 MAX. VOLTS |
| D-C SCREEN VOLTAGE | 400 MAX. VOLTS |
| D-C GRID VOLTAGE | —500 MAX. VOLTS |
| D-C PLATE CURRENT | 150 MAX. MA |
| PLATE DISSIPATION | 65 MAX. WATTS |
| SCREEN DISSIPATION | 10 MAX. WATTS |
| GRID DISSIPATION | 5 MAX. WATTS |

TYPICAL OPERATION (Frequencies up to 150 megacycles)

| | | | | |
|---|---|---|---|---|
| D-C Plate Voltage | 1500 | 2000 | 2500 | 3000 volts |
| D-C Screen Voltage | 250 | 250 | 250 | 250 volts |
| D-C Grid Voltage | —105 | —105 | —105 | —105 volts |
| D-C Plate Current | 150 | 137 | 124 | 112 ma |
| D-C Screen Current* | 39 | 32 | 26 | 22 ma |
| D-C Grid Current* | 19 | 15 | 13 | 9 ma |
| Peak R-F Grid Voltage* | 205 | 195 | 185 | 175 volts |
| Driving Power* | 3.9 | 2.9 | 2.4 | 1.6 watts |
| Plate Input Power | 225 | 275 | 310 | 335 watts |
| Plate Output Power | 160 | 210 | 245 | 270 watts |

*Approximate values

### PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony

MAXIMUM RATINGS (Carrier conditions)

| | |
|---|---|
| D-C PLATE VOLTAGE | 2500 MAX. VOLTS |
| D-C SCREEN VOLTAGE | 400 MAX. VOLTS |
| D-C GRID VOLTAGE | —500 MAX. VOLTS |
| D-C PLATE CURRENT | 120 MAX. MA |
| PLATE DISSIPATION | 45 MAX. WATTS |
| SCREEN DISSIPATION | 10 MAX. WATTS |
| GRID DISSIPATION | 5 MAX. WATTS |

TYPICAL OPERATION (Frequencies up to 150 megacycles)

| | | | | |
|---|---|---|---|---|
| D-C Plate Voltage | 1000 | 1500 | 2000 | 2500 volts |
| D-C Screen Voltage | 250 | 250 | 250 | 250 volts |
| D-C Grid Voltage | —150 | —150 | —150 | —150 volts |
| D-C Plate Current | 120 | 120 | 113 | 102 ma |
| D-C Screen Current* | 40 | 40 | 37 | 26 ma |
| D-C Grid Current* | 20 | 20 | 18 | 13 ma |
| Peak R-F Voltage* | 255 | 255 | 250 | 235 volts |
| Driving Power* | 5.1 | 5.1 | 4.8 | 3.1 watts |
| Plate Input Power | 120 | 180 | 226 | 255 watts |
| Plate Output Power | 85 | 140 | 182 | 210 watts |

*Approximate values

## AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB$_1$

MAXIMUM RATINGS

| | |
|---|---|
| D-C PLATE VOLTAGE | 3000 MAX. VOLTS |
| D-C SCREEN VOLTAGE | 600 MAX. VOLTS |
| D-C PLATE CURRENT | 150 MAX. MA |
| PLATE DISSIPATION | 65 MAX. WATTS |
| SCREEN DISSIPATION | 10 MAX. WATTS |

## RADIO-FREQUENCY SSB POWER AMPLIFIER

Class-AB$_1$

MAXIMUM RATINGS

| | |
|---|---|
| D-C PLATE VOLTAGE | 3000 MAX. VOLTS |
| D-C SCREEN VOLTAGE | 600 MAX. VOLTS |
| D-C PLATE CURRENT | 150 MAX. MA |
| PLATE DISSSIPATION | 65 MAX. WATTS |
| SCREEN DISSIPATION | 10 MAX. WATTS |

TYPICAL OPERATION

Class-AB$_1$ (Sinusoidal wave, two tubes except where noted)

| | | | | |
|---|---|---|---|---|
| D-C Plate Voltage | 1500 | 2000 | 2500 | 3000 volts |
| D-C Screen Voltage | 500 | 500 | 400 | 400 volts |
| D-C Grid Voltage[1] | —90 | —105 | —85 | —90 volts |
| Zero-Signal D-C Plate Current | 60 | 40 | 30 | 30 ma |
| Max.-Signal D-C Plate Current | 166 | 150 | 132 | 120 ma |
| Max.-Signal D-C Screen Current* | 10 | 6 | 6 | 6 ma |
| Peak A-F Grid Voltage (per tube)* | 70 | 80 | 77 | 77 volts |
| Effective Plate-to-Plate Load | 13,300 | 24,000 | 37,500 | 50,000 ohms |
| Max.-Signal Plate Input Power | 250 | 300 | 330 | 360 watts |
| Max.-Signal Plate Output Power | 120 | 170 | 200 | 240 watts |

[1]Adjust to obtain listed zero-signal d-c plate current.
*Approximate values.

TYPICAL OPERATION

Class-AB1 (Frequencies to 150 megacycles)

| | | | | |
|---|---|---|---|---|
| D-C Plate Voltage | 1500 | 2000 | 2500 | 3000 volts |
| D-C Screen Voltage | 500 | 500 | 400 | 400 volts |
| D-C Grid Voltage[1] | —90 | —105 | —85 | —90 volts |
| Zero-Signal D-C Plate Current | 30 | 20 | 15 | 15 ma |
| Max.-Signal D-C Plate Current | 83 | 75 | 66 | 60 ma |
| Max.-Signal D-C Screen Current* | 5 | 3 | 3 | 3 ma |
| Peak R-F Grid Voltage* | 70 | 80 | 77 | 77 volts |
| Max.-Signal Plate Input Power | 125 | 150 | 165 | 180 watts |
| Max.-Signal Plate Output Power | 60 | 85 | 100 | 120 watts |

[1]Adjust to obtain listed zero-signal d-c plate current.
*Approximate Values.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

In class-C operation, adjustment of the r-f grid drive to obtain listed plate current at the listed grid bias, screen voltage, and plate voltage is assumed. Resultant screen and grid currents will vary from tube to tube, but little change in output power will be noted.

In class-AB$_1$ linear operation, screen current will also vary from tube to tube but is a useful indicator of relative linearity. In general, less screen current means better linearity, providing other conditions are held constant. The same degree of linearity will be obtained from different tubes if loading and drive are adjusted to give the same plate and screen current, although output power may vary from tube to tube.

# APPLICATION

## MECHANICAL

**Mounting**—The 4-65A must be operated vertically, base up or base down. The socket must provide clearance for the glass tip-off which extends from the center of the base. A flexible connecting strap should be provided between the plate terminal and the external plate circuit, and the Eimac HR-6 connector (or equivalent) used on the tube plate lead. The socket must not apply lateral pressure against the base pins. The tube must be protected from severe vibration and shock.

Adequate ventilation must be provided so that the seals and/or envelope under operating conditions do not exceed their rated maximum temperatures. For operation above 50 Mc. the plate voltage should be reduced, or special attention should be given to seal cooling.

When the ambient temperature does not exceed 30° C it will not ordinarily be necessary to provide forced-air cooling of the envelope or plate seal at frequencies below 50 Mc. provided that a heat-radiating plate connector is used and the tube is so located that normal circulation of air past the envelope is not impeded.

## ELECTRICAL

**Filament Voltage**—The filament voltage, as measured at the filament pins, should be 6.0 volts. For long life, excursions from this value should not exceed ± 5 percent.

**Bias Voltage**—D-C bias voltage for the 4-65A should not exceed —500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

**Screen Voltage**—The d-c screen voltage for the 4-65A should not exceed 400 volts except in the case of class-AB audio operation and Single-Side-Band r-f amplifier operation where it should not exceed 600 volts.

**Screen Dissipation**—The power dissipated by the screen of the 4-65A must not exceed 10 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load is removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 10 watts in the event of circuit failure.

**Plate Voltage**—The plate-supply voltage for the 4-65A should not exceed 3000 volts. Above 50 Mc. it is advisable to use a lower plate voltage than the maximum, since the seal heating due to r-f charging currents in the screen leads increases with plate voltage and frequency. See instructions on seal cooling under "Mechanical" and "Shielding."

**Plate Dissipation**—Under normal operating conditions, the plate dissipation of the 4-65A should not be allowed to exceed 65 watts in unmodulated applications.

In high-level-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 45 watts.

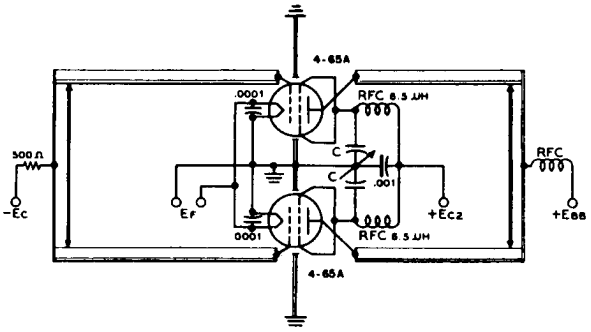
Plate dissipation in excess of the maximum rating is permissable for short periods of time, such as during tuning procedures.

## OPERATION

**Class-C FM or Telegraphy**—The 4-65A may be operated as a class-C FM or telegraphy amplifier without

neutralization up to 110 Mc. if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. In single-ended circuits, plate, grid, filament, and screen by-pass capacitors should be returned through the shortest possible leads and short, heavy leads should be used to inter-connect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier in order to minimize grid-plate coupling between these leads external to the amplifier.

Where shielding is adequate, the feedback at frequencies above 110 Mc. is due principally to screen-lead-inductance effects and it becomes necessary to introduce in-phase voltage from the plate circuit into the grid cricuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately ¾" square and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope. An alternate neutralization scheme for use above 110 Mc. is illustrated in the diagram shown below. In this circuit, feedback is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together as shown on the diagram, by the shortest possible lead, and the lead from the mid point of this screen strap to the capacitor, C, and from the capacitor to ground should be made as short as possible.

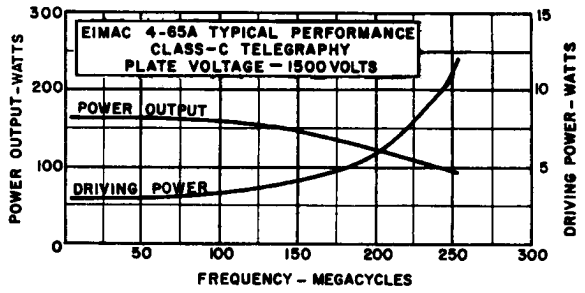



Screen-tuning neutralization circuit for use above 100 Mc. C is a small split-stator capacitor.

$$C(\mu\mu fd) = \frac{640{,}000}{f^2\ (Mc.)}\text{, approx.}$$

Typical driving power and output power versus frequency are shown below. The output power shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output should exceed the driving power requirements by a sufficient margin to allow for coupling-circuit losses. The use of silver-plated linear tank-circuit elements is recommended at frequencies above 75 Mc.

**Class-C AM Telephony**—The r-f circuit considerations discussed above under class-C FM or telegraphy also apply to amplitude-modulated operation of the 4-65A. When the 4-65A is used as a class-C high-level-modulated amplifier, both the plate and screen




should be modulated. Modulation voltage for the screen may be obtained by supplying the screen voltage through a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead, or from a separate winding on the modulation transformer. When screen modulation is obtained by either the series-resistor or the audio-reactor methods, the audio-frequency variations in screen current, which result from the variations in plate voltage as the plate is modulated, automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two to three times the operating d-c screen current. To prevent phase-shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate r-f by-passing.

For high-level modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

**Class-AB$_1$ and Class-AB$_2$ Audio**—Two 4-65As may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB$_1$ audio operation are given in the tabulated data.

Screen voltage should be obtained from a source having good regulation, to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage-regulator tubes in a standard circuit should provide adequate regulation.

Grid-bias voltage for class-AB$_2$ service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used, the d-c resistance of the bias source should not exceed 250 ohms. Under class-AB$_1$ conditions the effective grid-circuit resistance should not exceed 250,000 ohms.

In some cases the maximum-signal plate dissipation shown under "Typical Operation" is less than the maximum rated plate dissipation of 4-65A. In these cases, with sine-wave modulation, the plate dissipation reaches a maximum value, equal to the maximum rating, at a point somewhat below maximum-signal conditions.

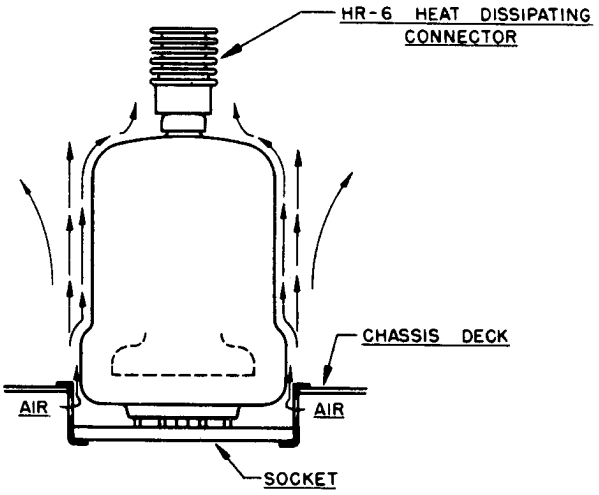
The output-power figures given in the tabulated data refer to the total output power from the amplifier tubes. The useful output power will be from 5 to 15 percent less than the figure shown, due to losses in the output transformer.

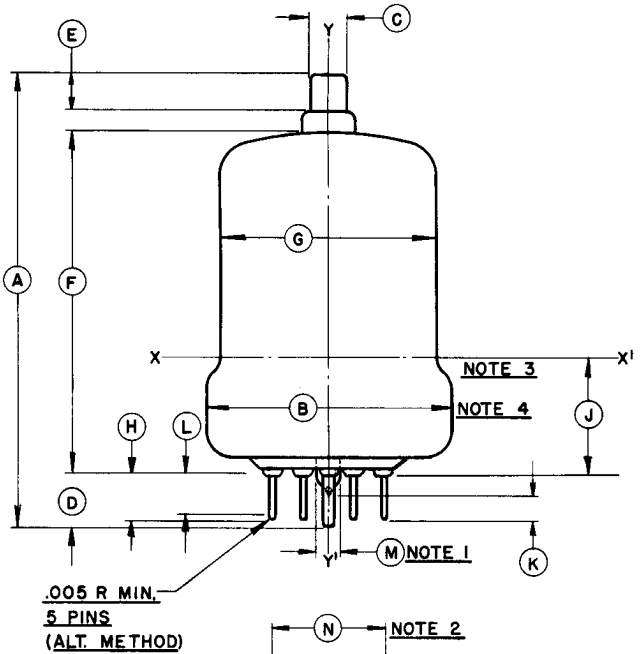
**Shielding**—The internal feedback of the tetrode has been substantially eliminated and in order to fully utilize this advantage, it is essential that the design of the equipment completely eliminate any feedback external to the tube. This means complete shielding of the output cricuit from the input circuit and earlier stages, proper reduction to low values of the inductance of the screen lead to the r-f ground, and elimination of r-f feedback in any common power-supply leads.

Complete shielding is easily achieved by mounting the socket of the tube flush with the deck of the chassis as shown in the sketch shown at the right.

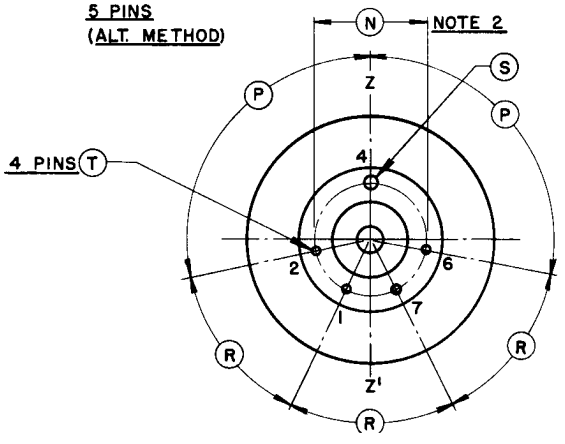
The holes in the socket permit the flow of convection air currents from below the chassis up past the seals in the base of the tube. This flow of air is essential to cool the tube and in cases where the complete under-part of the chassis is enclosed for electrical shielding, screened holes or louvers should be provided to permit air circulation. Note that shielding is completed by aligning the internal screen shield with the chassis deck and by proper r-f by-passing of the screen leads to r-f ground. The plate and output circuits should be kept above deck and the input circuit and circuits of earlier stages should be kept below deck or completely shielded.

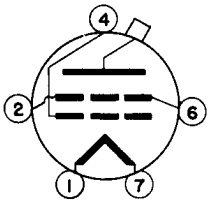
**Special Applications**—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations. Copies of characteristic curves, either constant-grid-voltage or constant-current, for various screen potentials may be obtained from this department on request.



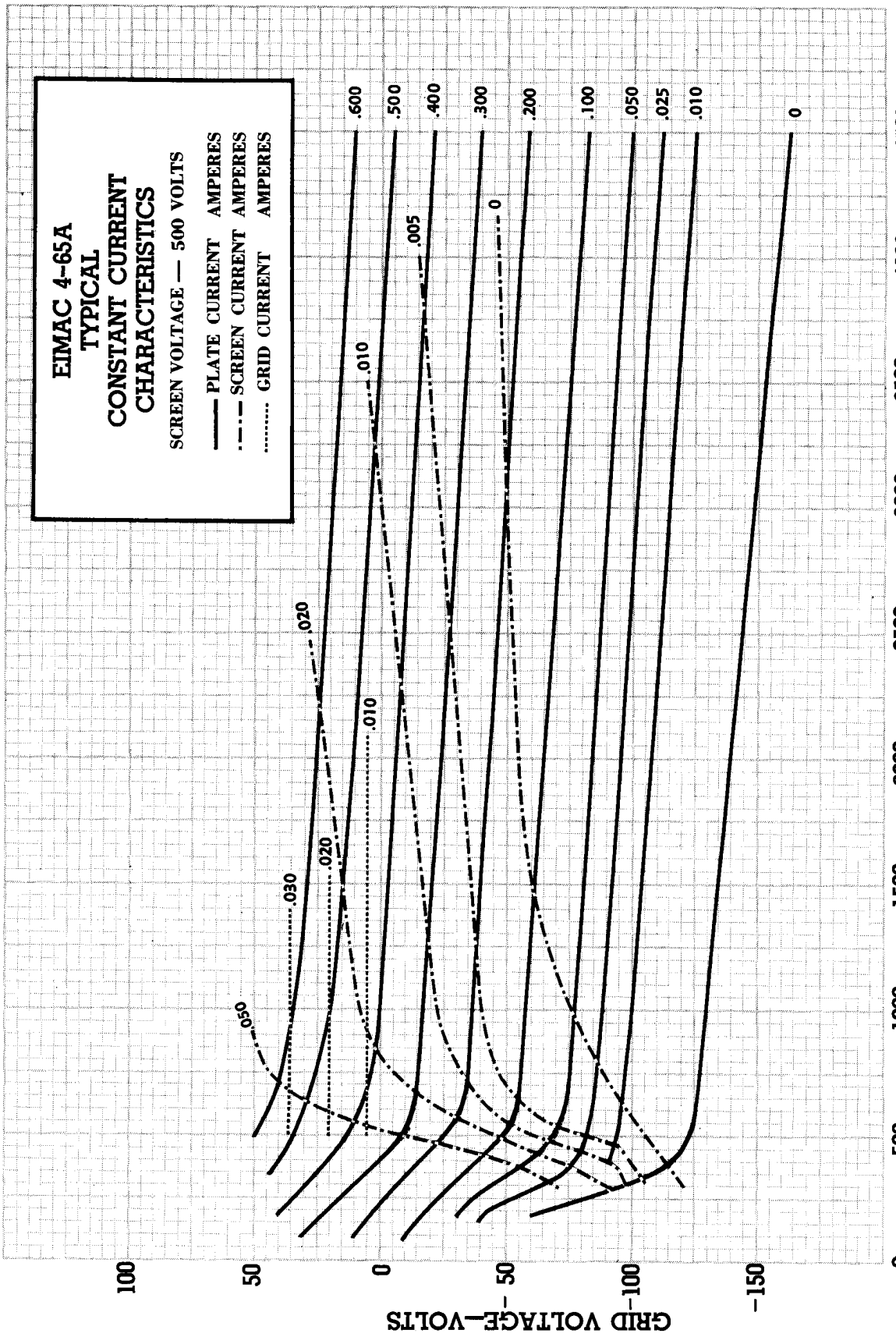



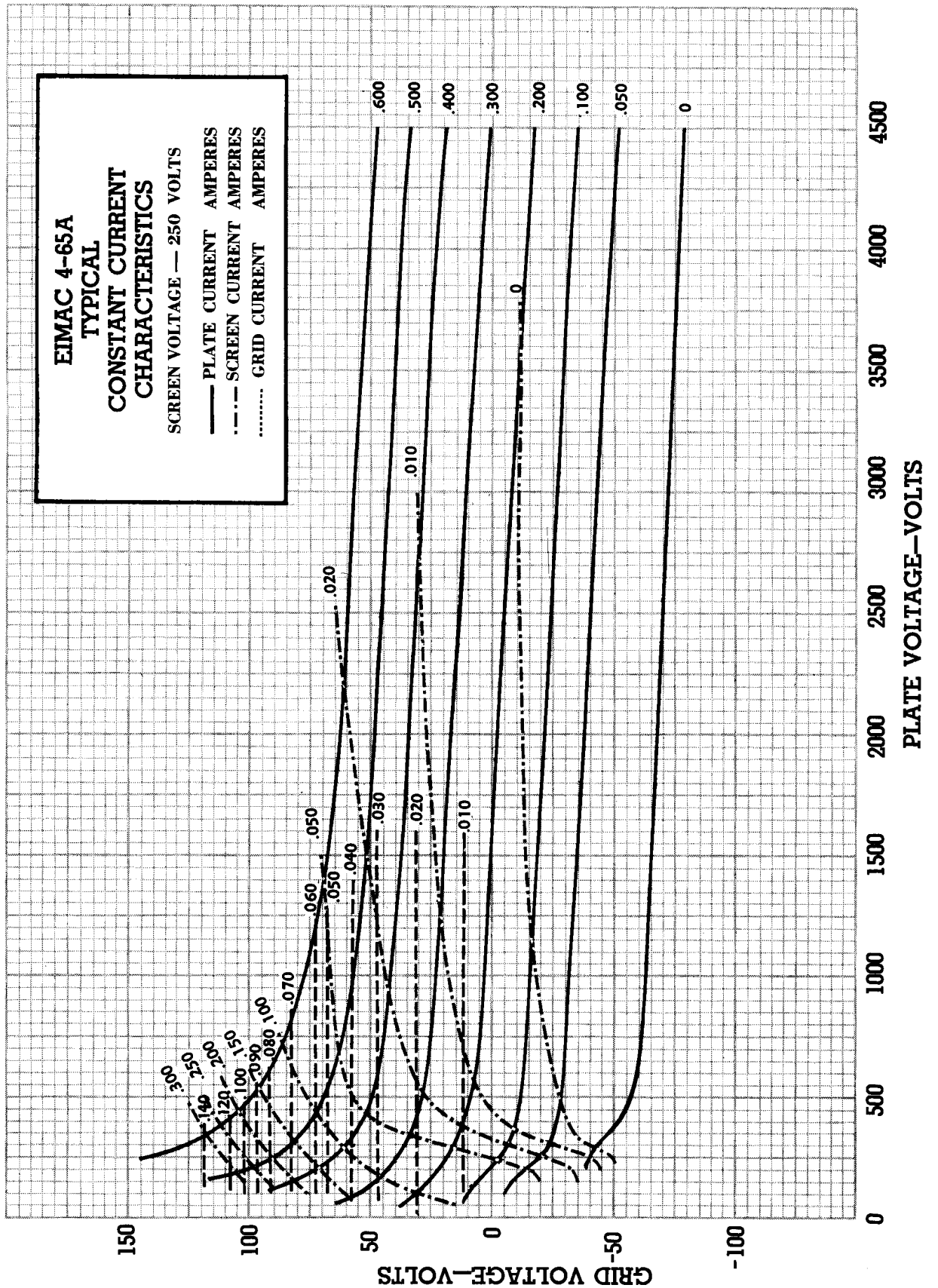

| DIMENSION DATA | | | |
|---|---|---|---|
| REF. | NOM. | MIN. | MAX. |
| A | | 4 | 4 3/16 |
| B | | | 2 3/8 |
| C | | .350 | .365 |
| D | | 7/16 | 9/16 |
| E | | 21/64 | |
| F | | 2 15/16 | 3 5/16 |
| G | | | 2 1/8 |
| H | | 3/8 | 1/2 |
| J | | .844 | 1.219 |
| K | | .000 | |
| L | | 5/16 | |
| M | | | 3/8 |
| N | 1.000 | | |
| P | 102° | | |
| R | 52° | | |
| S | | .122 DIA. | .128 DIA. |
| T | | .055 DIA. | .061 DIA. |




ALL DIMENSIONS IN INCHES.


EIMAC 4-65A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT AMPERES
SCREEN CURRENT AMPERES
GRID CURRENT AMPERES
.600
.500
.400
.300
.200
.100
.050
.025
.010
0
.005
.010
.020
.030
.050
.020
.010
0
100
50
0
−50
−100
−150
GRID VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
PLATE VOLTAGE—VOLTS

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