4CX1500B

RADIAL BEAM POWER TETRODE

JEDEC DESIGNATION

8660

The EIMAC 4CX1500B is a ceramic and metal, forced air cooled, radial beam tetrode with a rated maximum plate dissipation of 1500 Watts. It is a low voltage, high-current tube specifically designed for exceptionally low intermodulation distortion and low grid interception. The low distortion characteristics make the 4CX1500B especially suitable for radio-frequency and audio-frequency linear amplifier service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide Coated, Unipotential				
Heating Time	3			Minutes
Heater: Voltage		6.0		Volts
Current	9.0		11.0	Amperes
Transconductance:				
(I=0.5 amperes, E 2=225 Volts)		30,000		Umhos
Direct Interelectrode Capacitance (Grounded Cathode)[2]				
Cin	75		88	pF
Cout	10.8		12.8	pF
Cgp			0.3	pF
Direct Interelectrode Capacitance (Grounded Grid and Screen)[2]				
Cin		38		pF
Cout		12		pF
Cgp			0.005	pF

[1]Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.

[2]Capacitance values are for a cold tube as measured in a special shielded fixture.

(Pub. 4940 Effective 9/15/86)

MECHANICAL

Maximum Overall Dimensions:	
Length	4.6 in
Diameter	3.37 in
Net Weight	27 oz
Operating Position	Any

Maximum Operating Temperature:

Ceramic to Metal Seals	225°C
Anode Core	200°C
Base	Special, Breechblock Terminal Surfaces
Recommended Socket	EIMAC SK-800 Series

RADIO FREQUENCY LINEAR AMPLIFIER
Class AB

MAXIMUM RATINGS:

DC Plate Voltage	3000 Volts
DC Screen Voltage	400 Volts
DC Plate Current	0.900 Amperes
Plate Dissipation	1500 Watts
Screen Dissipation	12 Watts
Control Grid Dissipation	1 Watt

TYPICAL OPERATION
(Frequencies Below 30 MHz) Class AB_2
Grid Driven, Peak Envelope or Modulation Crest Conditions

DC Plate Voltage	2500	2750	2900	Volts
DC Screen Voltage	225	225	225	Volts
DC Grid Voltage[1]	-34	-34	-34	Volts
Zero-Signal DC Plate Current	300	300	300	mA
Single-Tone DC Plate Current	720	755	710	mA
Two-Tone DC Plate Current	530	555	542	mA
Single-Tone DC Grid Current	1.3	0.95	0.53	mA
Two-Tone DC Grid Current	0.06	0.20	0.06	mA
Single-Tone DC Screen Current	-7	-14	-15	mA
Two-Tone DC Screen Current	-11	-11	-11	mA
Peak rf Grid Voltage	46	45	41	Volts
Driving Power[2]	1.5	1.5	1.5	Watts
Useful Output Power	900	1100	1100	Watts
Resonant Load Impedance	1900	1900	2200	Ohms
Intermodulation Distortion Products[3]				
3rd Order	-38	-40	-43	dB
5th Order	-47	-48	-47	dB

[1]Adjust to the specified zero-signal plate current.

[2]The driving power specified includes the power dissipated in a 1000 ohm swamping resistor between the control grid and the cathode.

[3]The intermodulation distortion products will be as specified or better for all levels from zero-signal to maximum output power and are referenced against one tone of a two equal tone signal.

AUDIO AMPLIFIER OR MODULATOR
Class AB_1

MAXIMUM RATINGS:

DC Plate Voltage	3000 Volts
DC Screen Voltage	400 Volts
DC Plate Current	900 Amperes
Plate Dissipation	1500 Watts
Screen Dissipation	12 Watts
Grid Dissipation	1.0 Watt

TYPICAL OPERATION
(Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	2000	2500	2900	Volts
DC Screen Voltage	325	325	325	Volts
DC Grid Voltage[1]	-60	-60	-60	Volts
Zero-Signal DC Plate Current	500	500	500	mA
Max.-Signal DC Plate Current	1.68	1.69	1.69	Amperes
Zero-Signal DC Screen Current[2]	-30	-25	-20	mA
Max.-Signal DC Screen Current[2]	-27	-33	-32	mA
Effective Load, Plate to Plate	1948	2715	3333	Ohms
Driving Power	0	0	0	Watts
Max.-Signal Plate Output Power	1604	2258	2774	Watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from the published characteristic curves and confirmed by direct tests. Adjustment of the grid bias to obtain the specified zero-signal plate current is assumed. When grid drive is applied, the screen voltage required to obtain the specified value of plate current without drawing grid current may vary somewhat from the typical values shown.

APPLICATION

COOLING - The maximum temperature rating for the anode core of the 4CX1500B is 250°C. Sufficient forced air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-to-metal seals to below 250°C. Air flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated below (for operation below 30 megahertz). Tube mounted in recommended socket and chimney.

	Sea Level		10,000 feet	
Plate Dissipation watts	Air Flow CFM	Pressure Drop inches water	Air Flow CFM	Pressure Drop inches water
1000	18	.23	24	.31
1500	34	.60	45	.80

*Since the power dissipated by the heater represents about 60 watts and since grid plus screen dissipation can, under some conditions, represent another 13 watts, allowance has been made in preparing this tabulation for an additional 73 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures, the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

HEATER - The rated heater voltage for the 4CX1500B is 6.0 Volts. The voltage, as measured at the socket should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

INTERMODULATION DISTORTION - The Radio Frequency Linear Amplifier operating conditions including the distortion data are the results of actual operation in a neutralized grid-driven amplifier. Plots of IM distortion versus power output under two-tone conditions, as a function of zero-signal plate current, are included to illustrate the effect of this parameter upon distortion. Because the 4CX1500B has very low grid interception, it is possible to drive the grid positive without any adverse effects upon the distortion level or upon the driver. Class Ab_2 linear amplifier operation is therefore possible and recommended. It is also recommended that a low impedance driver be used and that the input of the 4CX1500B be swamped with a 1000 ohm resistor from grid to cathode so as to provide an almost constant load to the driver.

CONTROL-GRID OPERATION - The control gird dissipation rating of the 4CX1500B is 1 Watt. The design features which make the 4CX1500B such an extremely linear tube also contribute to very low grid interception. It will be found that the grid will be driven into the positive grid region in the typical operation of the tube. The grid current will usually be less than 1.0 milliampere.

SCREEN-GRID OPERATION - Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CX1500B and, under some operating conditions, indicated negative screen currents in the order of 35 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CX1500B is 12 Watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the "Typical Operation" values.

The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected form screen to cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

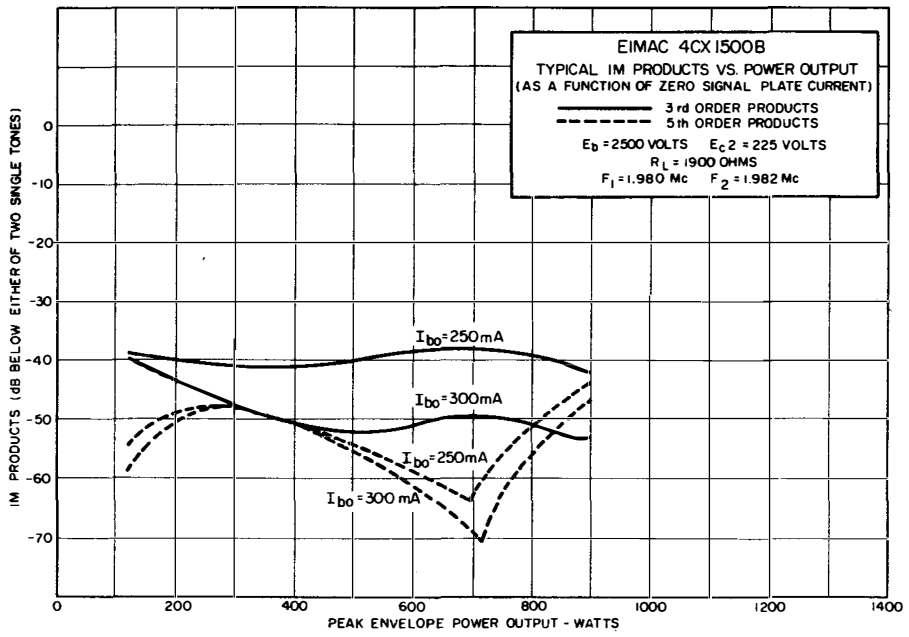
PLATE OPERATION - The maximum rated plate dissipation power is 1500 Watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

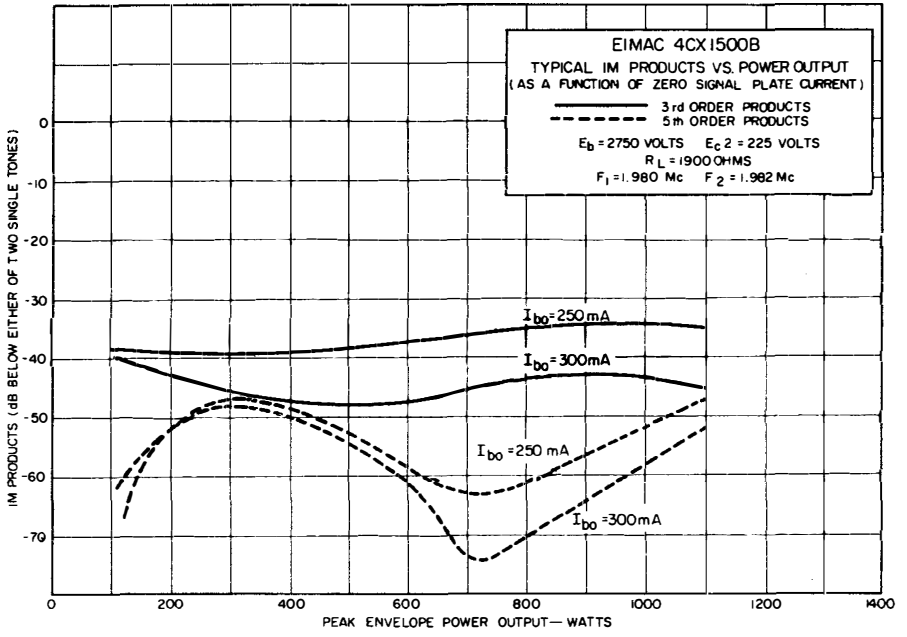
The top cap on the anode cooler may be used as a plate terminal at low frequencies or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used at high frequencies.

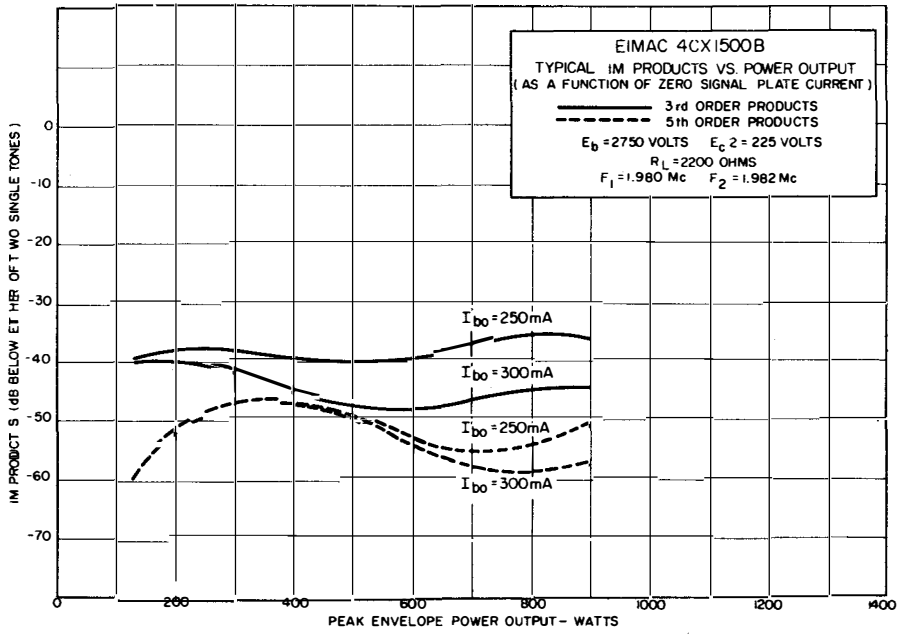
Points of electrical contact with the anode cooler should be kept clean and free of oxide to minimize radio-frequency losses. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

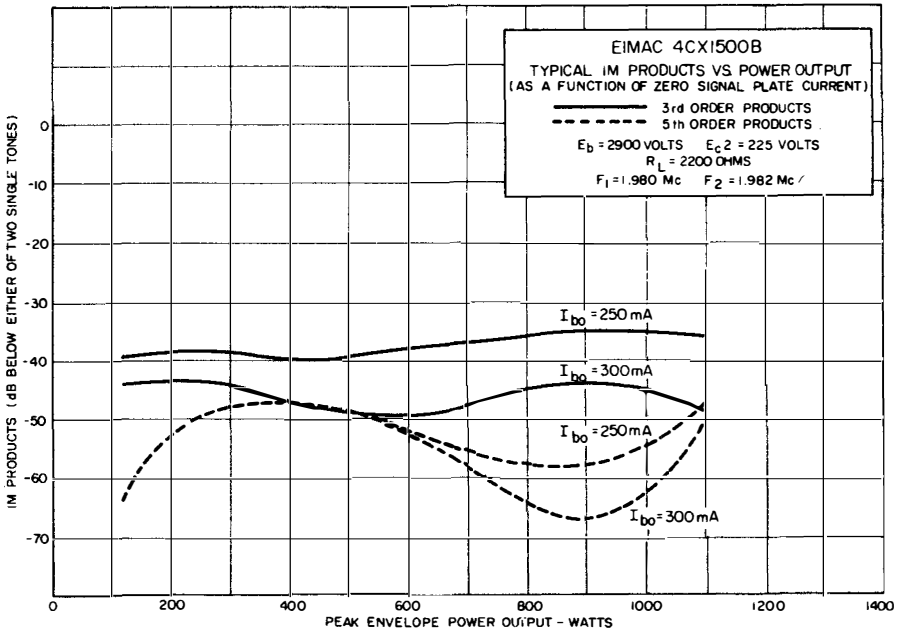
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Tube Marketing Department, **Varian EIMAC, 1678 South** Pioneer Road, Salt Lake City, UT 84104, for information and recommendations.

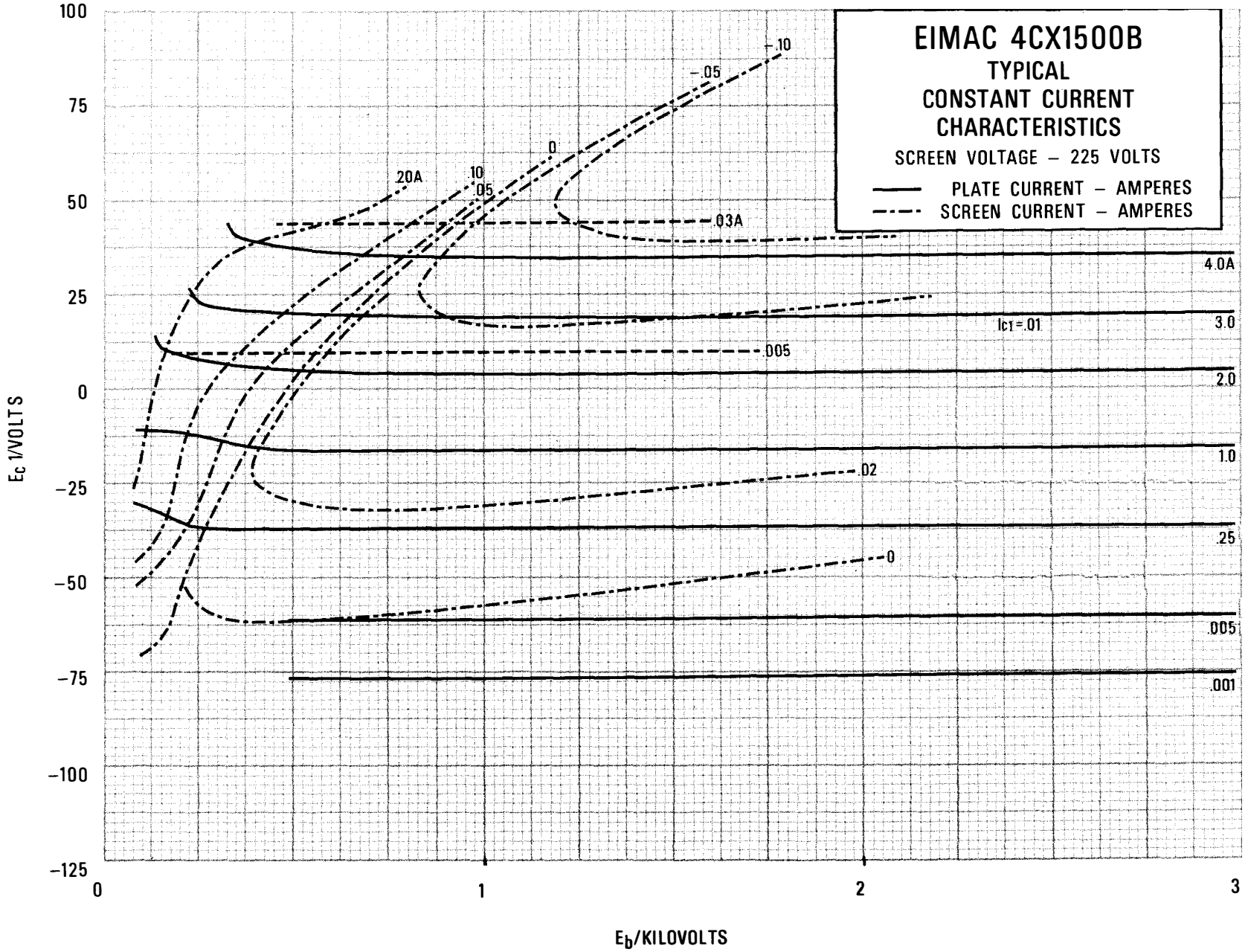
CAUTION-HIGH VOLTAGE - Operating voltage for this tube can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

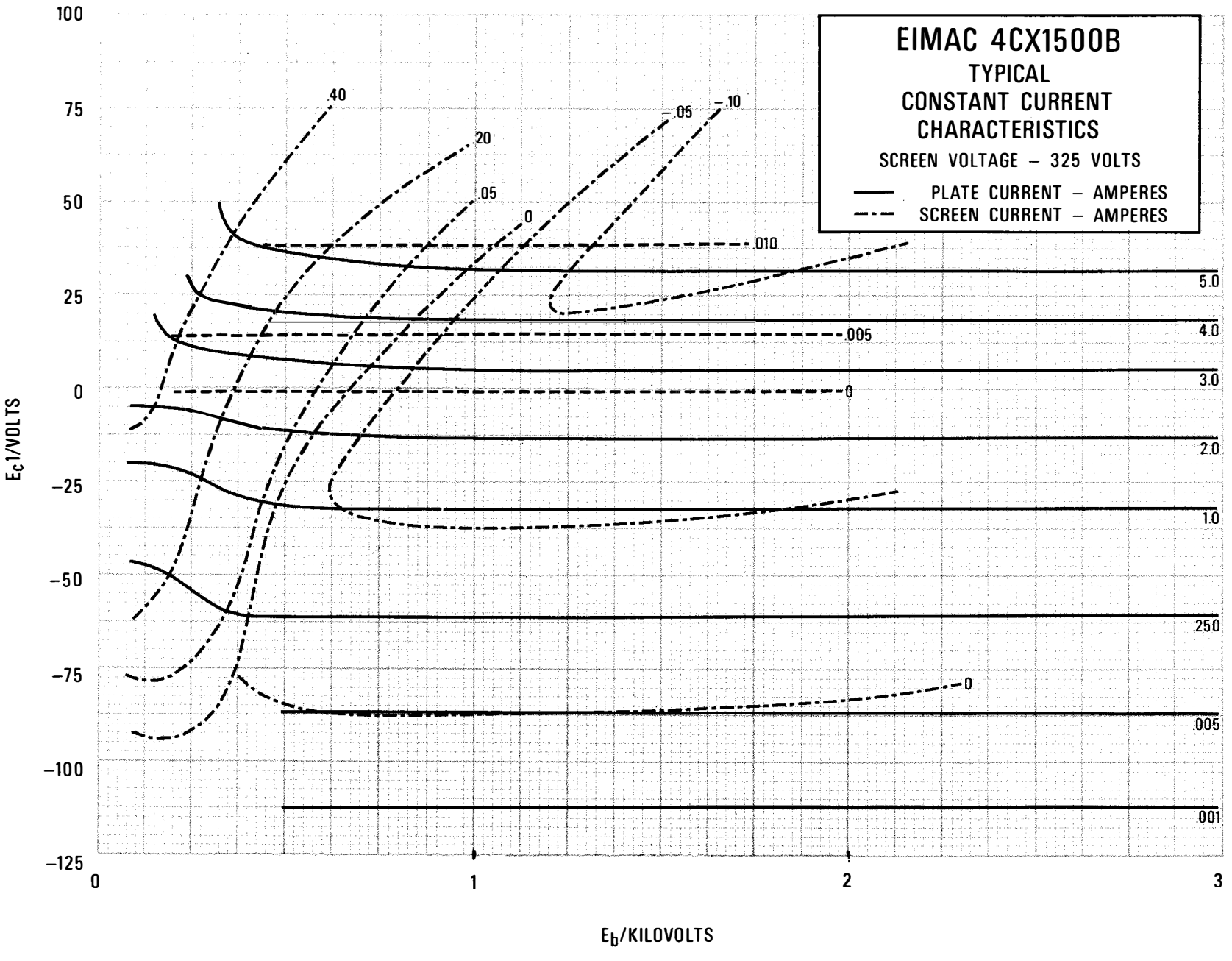

EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2500 VOLTS Ec2 = 225 VOLTS
RL = 1900 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo = 250mA
Ibo = 300mA
Ibo = 250mA
Ibo = 300 mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2750 VOLTS Ec2 = 225 VOLTS
RL = 1900 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo = 250mA
Ibo = 300mA
Ibo = 250 mA
Ibo = 300mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT— WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2750 VOLTS Ec2 = 225 VOLTS
RL = 2200 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo = 250mA
Ibo = 300mA
Ibo = 250mA
Ibo = 300mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2900 VOLTS Ec2 = 225 VOLTS
RL = 2200 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo = 250 mA
Ibo = 300mA
Ibo = 250mA
Ibo = 300 mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE – 225 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
100
75
50
25
0
–25
–50
–75
–100
–125
0
1
2
3
Ec 1/VOLTS
Eb/KILOVOLTS
.10
.05
0
20A
10
.05
.03A
4.0A
3.0
Ic1=.01
.005
2.0
1.0
.02
.25
0
.005
.001


EIMAC 4CX1500B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE – 325 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
100
75
50
25
0
–25
–50
–75
–100
–125
0
1
2
3
Ec1/VOLTS
Eb/KILOVOLTS
.40
.20
.05
0
–.05
–.10
.010
.005
0
5.0
4.0
3.0
2.0
1.0
.250
0
.005
.001