TECHNICAL DATA
TYPE 318C 100 kW MEDIUM FREQUENCY BROADCAST TRANSMITTER

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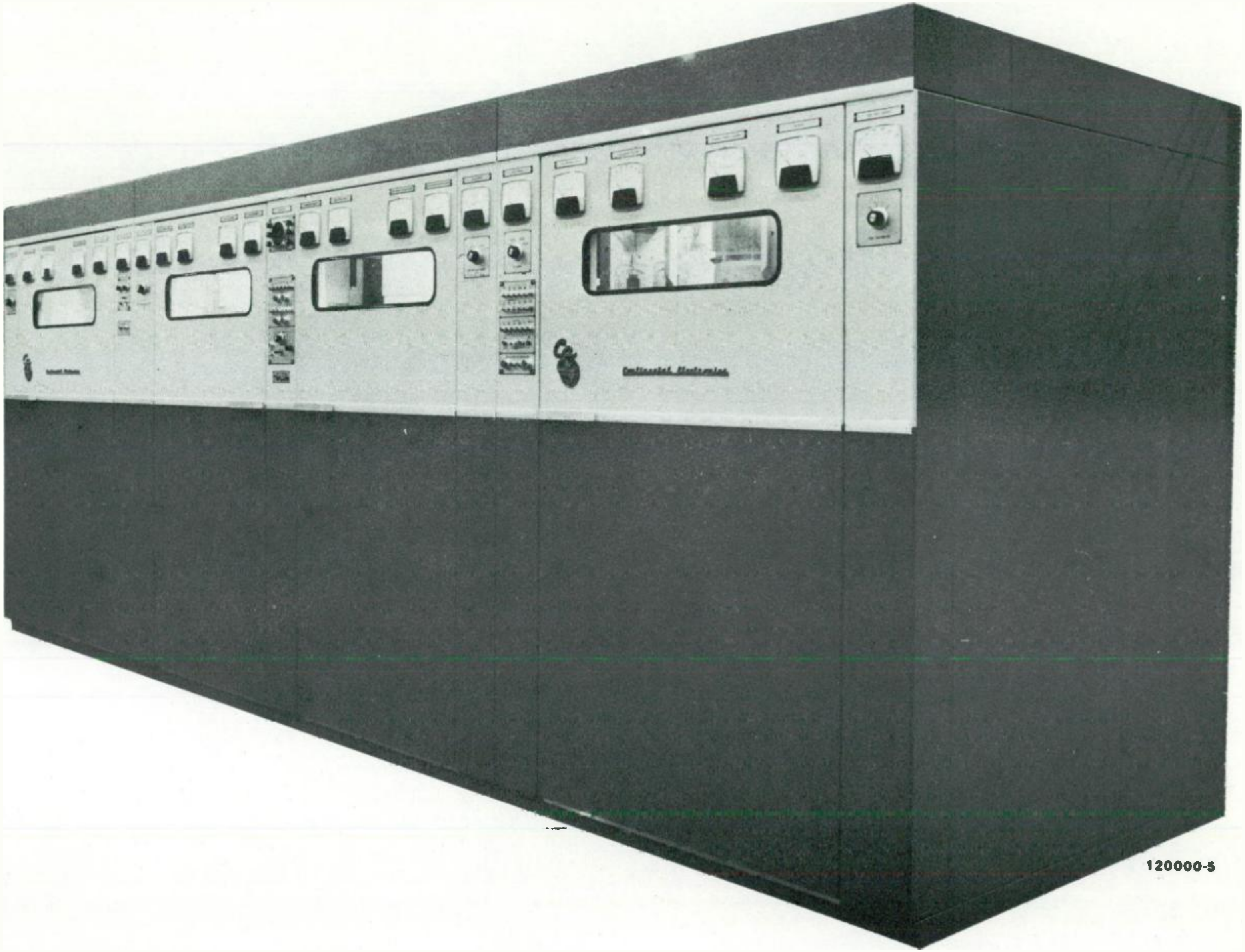

Type 318C 100 Kilowatt Medium Wave Broadcast Transmitter

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M5-29

Continental Electronics
DALLAS, TEXAS

SECTION 1

INTRODUCTION

Using the latest state-of-the-art concepts along with more than 30 years experience in building super power transmitters, Continental Electronics has designed into the Type 318C Transmitter reliability and economy heretofore unheard of.

Many methods of modulation have been used through the years, giving acceptable results for transmitters of low to medium power. These vary from the low efficiency low level type of modulation to the high efficiency high level plate modulation with its attendant high peak voltage problems resulting in lower reliability. In the design of a 100 kilowatt transmitter, the use of either of the extremes mentioned above would result in very high operating costs, or, in less reliable operating conditions. The engineers at Continental Electronics have designed into the Type 318C Transmitter a method of screen modulating a Doherty configuration, operating both carrier and peak tubes in the Class "C" condition. This results in very high efficiency while at the same time limiting the peak voltage to values consistent with reliable operating conditions.

1.1 SALIENT FEATURES

- Compact Size
- Air Cooled Power Amplifier Tubes
- All Power Supplies Solid State
- High Overall Efficiency (56%)
- Employs only four power amplifier tubes
- No heavy modulation components
- Easy accessibility to all components
- Low Harmonic Output (Complies with CCIR Recommendations)
- Employs only three tube types in rf and audio circuits
- Includes Magniphase Protective Device
- Includes HV Protective Device
- External Mounting PA Blower for Low Operating Noise Level
- Low-Loss Output Tank Inductor

The Continental Electronics Type 318C 100 kW Medium Wave AM Transmitter embodies the straightforward simplicity and field proven reliability of the high efficiency screen modulated amplifier. Universal acceptance of this circuit is evidenced by the fact that the Continental Type 317C 50 kW Transmitter, introduced in 1964, is the most widely used 50 kW Transmitter ever built, with more than 50 units now on the air worldwide. In addition, a large number of Continental medium wave transmitters ranging in power from 100 kW to 1000 kW have given efficient, reliable service in large overseas installations.

Some of the features of the Type 318C 100 kW Transmitter are:

a. High overall efficiency since the power amplifier tubes are operated Class C and there is no inefficient high power Class B modulator.

b. No modulation transformer or reactor is required. This means lower installation costs, reduced spare parts cost and the capability of maintaining high average modulation levels. Also, a major source of phase nonlinearity is eliminated.

c. The inherent simplicity of Class C RF amplifiers and Class A low power audio amplifiers familiar to all station engineers is featured. Amplitude modulation is accomplished without the complexity of variable width pulses or variable phase vectors.

d. The maximum instantaneous voltage impressed across the power amplifier tubes in the Continental Type 318C is 33 kV. This compares to 55 - 60 kV which would be across the P.A. tubes of a conventional plate modulated or series tube plate modulated transmitter.

e. The exclusion of audio coupling and modulation transformers in the Continental Type 318C Transmitter makes it possible to use negative feedback from the rectified output envelope to the first audio amplifier. This loop furnishes feedback for the low and mid-range audio frequencies. A second loop from the modulator output to the audio input supplies high frequency audio feedback. The response curves of the two feedback loops complement each other so that the overall output is flat.

f. Excluding the electronic crowbar tube and the oscilloscope tube, only 9 tubes (3 tube types) are used. The Type 4CX35,000A power tubes have a proven record of reliability, with early users of the 317C 50 kW reporting life in excess of 40,000 hours and still running.

g. All low level stages including the RF oscillator/exciter and audio preamplifiers are solid state. This, along with the conservative application of silicon rectifiers to all power supplies, further increases system reliability.

h. The Type 318C Transmitter is completely devoid of critical operational circuits such as neutralizing controls, pulse stabilizing circuits, phase stabilizing circuits, wave-shaping circuits, etc.

i. The solid state Magniphase(R) antenna protective circuit removes RF excitation within microseconds after antenna system faults resulting in VSWR above a preset level. When a second VSWR fault follows the first in close succession, the power output of the transmitter is reduced to about 80 kW before RF excitation is reapplied. A third VSWR fault following closely after the second will remove RF until it is restored manually. A timing circuit insures that these two steps do not take place unless faults are closely spaced. With extended time intervals between operations of the Magniphase, power is always restored at full output level.

j. Complete circuit breaker protection is featured. Every power supply except that furnishing DC control circuit voltage is overload protected. Fuses are only used in metering circuits.

k. The high voltage power supply uses a 12 phase rectifier. This reduces ripple from the rectifier output from a level of 4% to 1%. As a consequence, smoothing is accomplished with capacitance only. No smoothing choke is required. In part, this accounts for the unusually good low frequency response of the Type 318C.

l. Judicious use of solid state circuitry and solid state logic improves reliability. For example, switching between the main and reserve crystal oscillators is accomplished without the use of mechanical relays. In a different application, solid state logic is used to "prove" the presence of anode voltage before RF excitation is applied and to "prove" the presence of RF before audio is applied.

m. The transmitter consists of three cabinets in line with an assembled length of 17 feet 6 inches (5.33 meters) and a depth of 5 feet 6 inches (1.68 meters). Since all transformers are of the dry type, no fireproof transformer vault is required.

1.2 ELECTRICAL SPECIFICATIONS

Carrier Output Power:	100,000 Watts
Frequency Range:	535 - 1605 kHz
Frequency Stability:	Assigned Frequency ±5 Hz.
Type of Power Amplifier:	High Efficiency Screen Modulated
Output Impedance:	40 to 300 ohms as specified by the customer
Audio Frequency Input Impedance:	600/150 Ohms
Carrier Shift:	2% or less at 100% Modulation
Audio Frequency Input Level for 100% Modulation:	10 dBm ±2 dB
Audio Frequency Response:	±0.5 dB, 30 Hz to 7,500 Hz -1.5 dB, 15,000 Hz reference to 1000 Hz at 70% Modulation
Audio Harmonic Distortion:	3.0% or less, 50 to 7500 Hz 4.0% or less, 30 to 10,000 Hz at 95% Modulation
Residual Carrier Noise Unweighted:	-60 dB from reference of 100% Modulation
Harmonic Radiation:	Suppression of harmonics Exceeds CCIR Recommendations

Modulation Capability:	100% continuous at any frequency 20 to 10,000 Hz.
Overall Power Efficiency:	Approximately 56%
Power Line Requirements:	380/460 Volts, 3 phase, 3 Wire, 50 or 60 Hz, ±5% Regulation

1.3 TUBE COMPLEMENT

TYPE	FUNCTION	QUANTITY
4-400A	Second RF Amplifier	2
4-400A	Second Audio Amplifier	1
3CX10000A1	Modulator	2
4CX35000C	Carrier Amplifier Peak Amplifier	2 2
GL7703	Ignitron Crowbar	1
3WP1	CRT Oscilloscope	1

1.4 MECHANICAL SPECIFICATIONS

UNIT	DESCRIPTION	APPROX SIZE W	D	H	APPROX WEIGHT
1	Power Amplifier	7.5 2.29	5.5 1.68	6.5' 1.98m	3500 lbs. 1588 KG
2	Driver-Modulator	4.5 1.37	5.5 1.68	6.5' 1.98m	2700 lbs. 1225 KG
3	Harmonic Filter	5.5 1.68	5.5 1.68	6.5' 1.98m	2300 lbs. 1043 KG

UNIT	DESCRIPTION	APPROX SIZE W	D	H	APPROX WEIGHT
4	Power Vault Space	10.0 3.0	10.0 3.0	8.0' 244m	3420 lbs. 1549 KG (Total for 3 pcs)
5	Air Cooling Equipment	(Vault)			1200 lbs. 544 KG

1.5 ENVIRONMENT CONDITIONS

The Type 318C Transmitter will perform as specified when subjected to the following environmental conditions in any normal combination.

Altitude:	Up to 7500 feet (2286 meters)
Temperature:	-20°C to 50°C (-4 to 122°F)
Humidity:	Up to 95% Relative

1.6 LIST OF EQUIPMENT FURNISHED

Power Amplifier, Unit 1.

Driver/Modulator, Unit 2.

RF Networks, Unit 3.

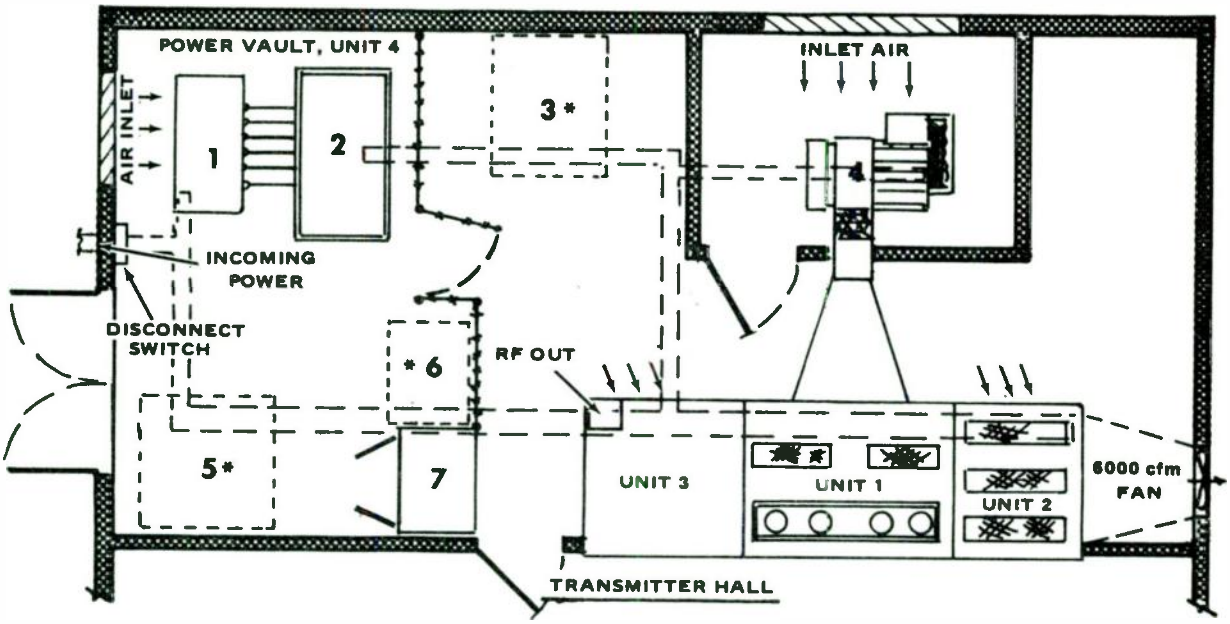
Primary Power Control and Vault, Unit 4.

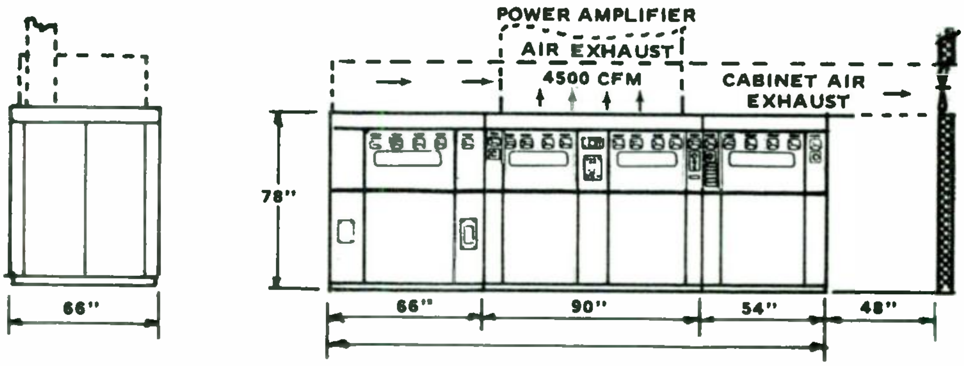
a) Blower Unit

b) Plate Transformers and Rectifiers

c) Low Voltage Distribution Unit

d) Blower Duct.





END VIEW

FRONT VIEW

TRANSMITTER

REF. ENGR. DWG. 143770

ITEM	SIZE		EST. WEIGHT	
1 PLATE TRANSFORMER	28 x 64 x 74"	(0.71 x 1.62 x 1.20 m)	5500 LBS.	(2500 KG)
2 PLATE VOLTAGE RECTIFIER & FILTER RACK	40 x 75 x 60"	(1m x 1.90 x 1.50m)	320 LBS.	(145 KG)
3 DUMMY LOAD	66 x 48 x 78"	(1.68 x 1.22 x 2 m)	400 LBS.	(180 KG)
4 BLOWER			1200 LBS	(540KG)
5 PLATE REGULATOR	57 x 57 x 87"	(1.45 x 1.45 x 220m)	5200 LBS.	(2360 KG)
6 LOW VOLTAGE REGULATOR	44 x 38 x 55"	(1.12 x .96 x 1.40 m)	1760 LBS.	(800KG)
7 460V DISTRIBUTION	33 x 48 x 71"	(.84 x 1.22 x 1.8m)	600 LBS.	(270 KG)
UNIT 1 POWER AMPLIFIER UNIT 2 DRIVER/MODULATOR DISTRIBUTION UNIT 3 R.F. OUTPUT AND MATCHING NETWORK				
* REGULATORS & DUMMY LOAD ARE OPTIONAL EQUIPMENT				

W1-44(16)

Typical Equipment Layout, 100/150 KW Air Cooled Transmitter

SECTION 2

TRANSMITTER DESCRIPTION

2.1 CIRCUIT DESCRIPTION

2.1.1 RF GENERATOR

A high accuracy, high frequency crystal is used in the oscillator circuit. The frequency range is 5.040 MHz to 7.5 MHz. The frequency stability is ± 5 Hz over a range of -10° +60°C.

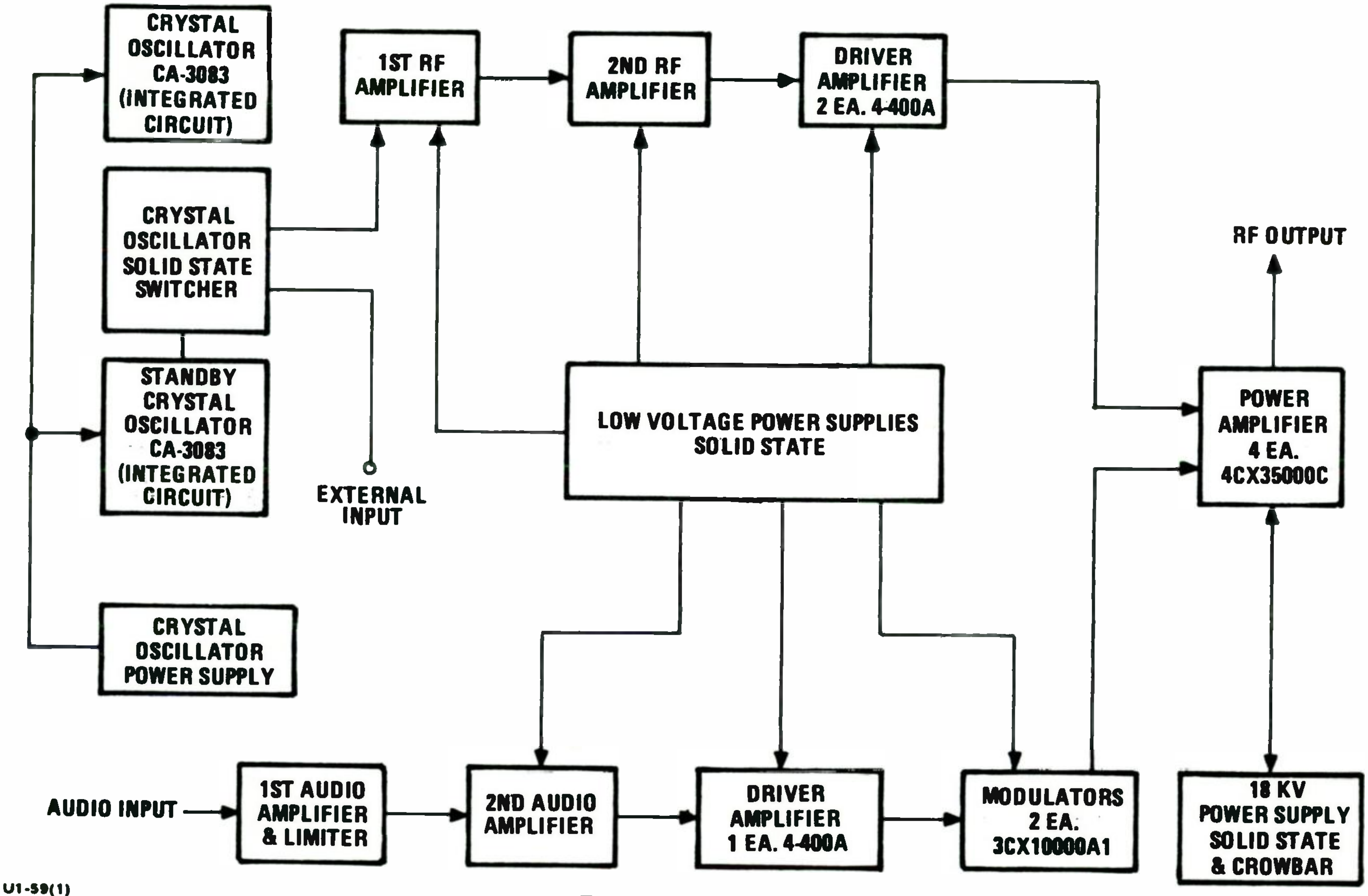
The oscillator is a Motorola integrated circuit crystal oscillator, MC12061. This oscillator chip requires only two external components in addition to the crystal and trimmer capacitors.

The output of this oscillator is compatible with ECL or TTL logic. The output is on the crystal fundamental frequency.

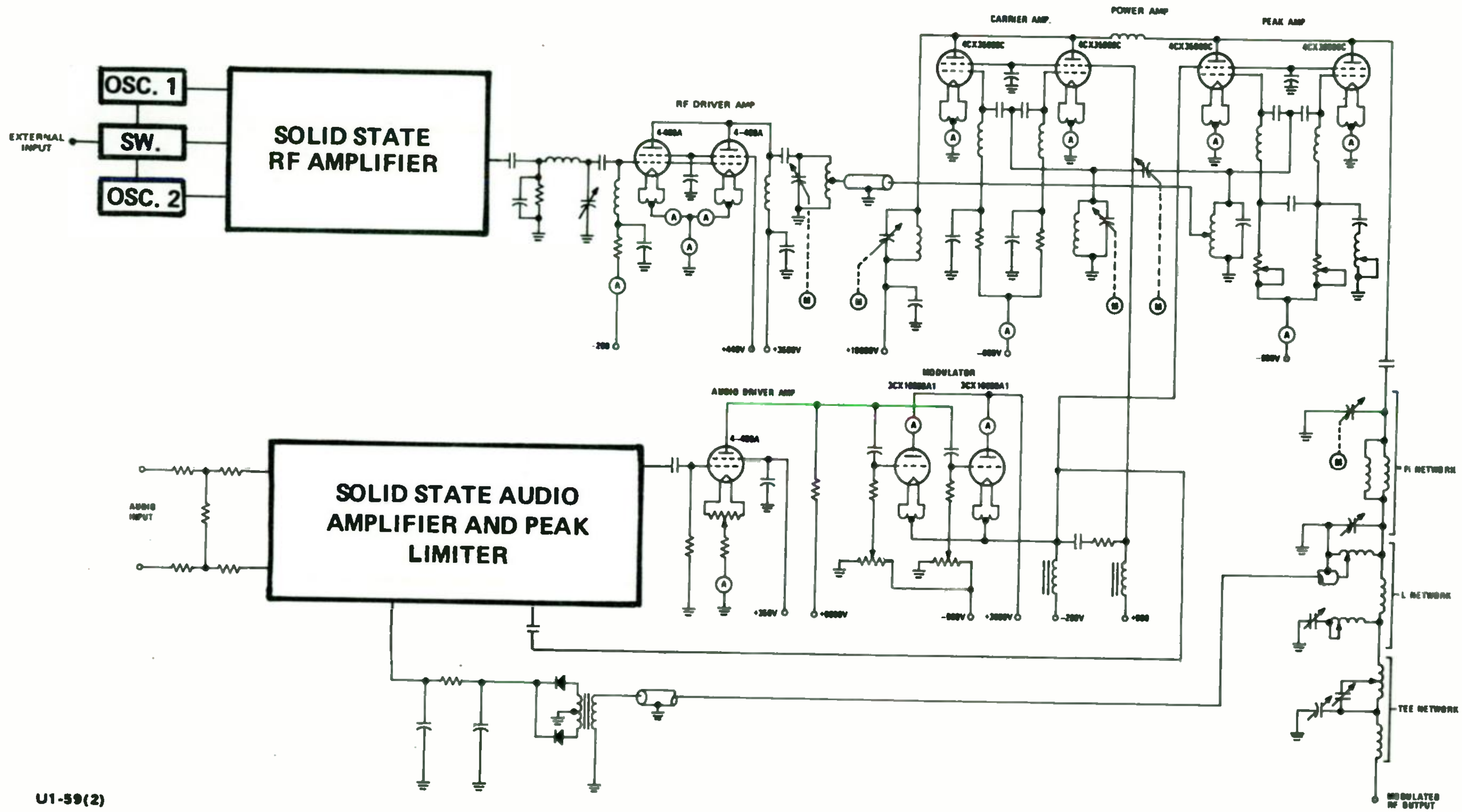
The oscillator is followed by two integrated circuit dividers. The first is a 4 bit binary counter, SN-74931, programmed to divide by 2, 3, 4, or 5 depending on the operating frequency. Trap connections are provided to connect for any of these divide-by-ratios. The final integrated circuit, a S-7476, is a dual J-K flip-flop with both clock inputs tied together.

This circuit provides a divide-by-ratio of 2 at all times giving a final output on the operating frequency.

The oscillator is followed by an RF switch which utilizes a quad 2-input "Nand" gate integrated circuit, an SN-7400. This gate will allow one oscillator signal to pass on to the RF amplifier. When no signal is present on one input of this card, pull down resistors hold this input to logical zero allowing the other signal to toggle the switch. By using this method of switching, no mechanical contacts are involved in the RF signal path.



Transmitter Block Diagram



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TRANSMITTER, SIMPLIFIED SCHEMATIC DIAGRAM

Continental Electronics
DALLAS, TEXAS

Provision is made for external RF input with a mechanical selector switch to select internal or external RF oscillator. A solid state amplifier MM74C04N stage is provided to increase the external oscillator input level.

2.1.2 FIRST RF AMPLIFIER STAGE

The oscillator drive as selected is routed to a low level amplifier, MM74C04N. Output from this low level amplifier is routed to a solid state inhibit switch, MM74C00N. This switch acts to turn-off the RF on command from a Magniphase Input, when changing internal oscillators, or when an excitation enable circuit is interrupted. The Magniphase command signal is isolated and amplified through a 2N2102 transistor stage.

2.1.3 SECOND RF AMPLIFIER STAGE

The RF amplifier consists of three stages of amplification. RF is received from the inhibit switch and amplified Class A by a 2N2102 transistor stage. Its output is coupled to the bases of two parallel transistors, a 2N2102 and 2N4036. The combined output from this stage feeds a transformer and the input of one lRF330 transistor. The stage of two lRF330 transistors operates push pull with its output capacitor coupled to drive the IPA RF amplifier.

2.1.4 RF DRIVER AMPLIFIER

The RF Driver Amplifier stage consists of two Type 4-400A tetrodes operating in parallel. Each of these tubes is capable of a safe plate dissipation of 400 watts, although as used in the Type 318C Transmitter they actually dissipate only 250 watts each. Operating as a Class "C" amplifier, these tubes deliver 1000 watts to the power amplifier. By reference to the simplified schematic diagram, it can be seen that adequate metering is available for test and performance measurements. The anode voltage is shunt fed through an RF choke. The plate tank is tuned by a motor driven vacuum capacitor. The use of an electric motor drive permits electrically correct placement of components and a way of adjusting them without cumbersome shafts, chains and gears usually associated with this type of operation. RF voltage is tapped off of the plate tank inductor to drive the power amplifier stage.

2.1.5 POWER AMPLIFIER

The final or modulated amplifier consists of four type 4CX35000C ceramic tetrodes in a high efficiency screen modulated amplifier[1]. The output of one pair of tubes is connected directly to the load and is called the peak amplifier since it supplies power on the positive peaks of modulation. The output of the second pair of tubes, called the carrier amplifier, is separated from the load by a quarter wave line, a 90° network. The carrier stage is a conventional grounded cathode Class C amplifier that supplies the full 100 kilowatts of carrier power when no modulation is applied. The screen of this stage is maintained at +800VDC by a separate low voltage supply. When modulation is applied, the positive portion of the audio signal has no effect on the carrier tube because the plate swing cannot be increased with an increase in screen voltage. The negative portion of the modulating signal will cause a linear decrease in the plate swing.

In order to completely cut the tube off for 100% negative modulation, the screen must be modulated past zero volts or cathode potential. Carrier cut-off occurs with about -200 volts on the screen, thus, a negative going half sine wave of 1,400 volts peak amplitude is all that is required to modulate the carrier tube.

The peak stage has the same DC plate voltage and RF grid excitation as the carrier tube, but delivers no power at carrier condition because its plate current is cut off due to the -200 volts screen voltage. As the modulating signal starts its swing toward peak positive condition, the peak stage begins to deliver power to the output until at peak positive crest the stage is delivering twice the carrier level power into the load. The impedance inverting characteristic of the 90° plate network reflects an impedance of one-half that of the carrier stage at carrier conditions to the carrier stage. The carrier stage plate swing remains the same as at carrier

[1] Patent No. 3,314,024, United States
764,605, Canada
1,044,479, Great Britain
1,432,543, France

level so the power delivered to the load is twice carrier level because the impedance is halved. With both peak and carrier stages delivering twice carrier power to the load, we have the necessary four times carrier power for 100% modulation.

Since the voltage contributed by the carrier stage undergoes a 90° phase lag by the time it appears across the load, then it is necessary to introduce a 90° phase advance in the carrier stage grid driving voltage in order that the power output of both stages will combine in the proper phase. This is accomplished by a leading 90° grid network. This network has a 1:1 transformation ratio, so that both stages receive equal grid drive.

The power output of the transmitter is adjusted by controlling the screen voltage of the carrier stage.

2.1.6 OUTPUT NETWORKS

The output network of the Type 318C Transmitter includes a "Pi" network to match the plate circuit of the final amplifier to the output network section which consists of an "L" section and a "Tee" section. These sections provide coupling to a wide range of load impedances and have built-in harmonic traps to insure proper attenuation of all harmonics.

The second harmonic is attenuated in the shunt arm of the "L" section while the third harmonic attenuator is a parallel resonant trap in the input arm of the "Tee" network.

2.1.7 FIRST AUDIO AMPLIFIER

The incoming audio program passes through an isolation pad and is then fed to a peak limiter where adjustable positive and negative thresholds will maintain peaks at preset levels. LED flashers indicate limiting activity.

Feedback is also introduced into the first audio amplifier. The 318C employs two feedback loops. For low and mid-range AF, the feedback is derived from a rectifier which is energized from a sample taken from the output of the transmitter. The upper range feedback is taken from the output of the modulator. Both loops complement each other so as to produce an overall flat response. The net result is a favorably low distortion level over the entire audio spectrum and a high degree of suppression of hum and residual carrier noise.

2.1.8 SECOND AUDIO AMPLIFIER

The second audio amplifier is a resistance coupled stage which provides adequate voltage swing to the audio driver stage.

2.1.9 AUDIO DRIVER AMPLIFIER

The audio driver amplifier, like the first and second stage, is resistance coupled. A Type 4-400A tetrode is used here because of the need for a high output voltage to be developed across a low plate load. The plate load has to be low enough to minimize high frequency phase shift because of the input capacitance of the three parallel modulator tubes that follow. To minimize hum the filament is returned to ground through a centering potentiometer.

2.1.10 MODULATOR STAGE

Two Type 3CX10,000A1 triodes are used in the modulator stage. These are parallel connected and are used as a cathode follower to develop the required power at low impedances. Two separate bias adjustments are provided, and by use of the two anode current meters the tubes can be balanced. The cathodes of the two modulator tubes are returned through an inductor to a negative supply. Since the screen grids of the peak amplifier are connected at the cathode of the modulators, they are at a negative voltage which cuts off the flow of peak anode current. The peak amplifier tubes draw current only during the positive audio cycle. Positive potential is applied to the screens of the carrier amplifier tubes through a separate inductor.

2.2 POWER SUPPLIES

All power supplies in the Type 318C Transmitter use semi-conductor diode rectifiers. Wherever practical the supplies have three phase bridge rectifiers. All supplies have adequate safety factor in the ratings of the rectifier and transformers.

2.3 METERING

The Type 318C Transmitter is fully instrumented and all important operating parameters are displayed on large, easy to read meters. These are located on the front of the cabinets. The meters are grouped in an orderly manner.

2.4 CONTROL

The overall control system is designed in such a manner that all switching, timing, overloads, and interlocks are provided by a 24 volt DC control voltage in conjunction with an integrated circuit digital switching system to offer complete protection to equipment and personnel.

The transmitter is operated by means of push-button switches with built-in indicating lamps.

2.5 PERSONNEL SAFETY

A dual type door interlock switch is used through the Type 318C Transmitter. This switch is composed of two individual switches, one switch is used for indication on I.C. Logic Cards, the other switch is series interlocked with all door switches, to operate a control relay.

2.6 FORCED AIR COOLING

The transmitter is cooled by a single air blower. When installed as recommended by the typical installation Drawing No. 119990 this air blower is located in a separate room behind the power amplifier unit. Forced air from this blower is ducted to a plenum chamber in the power amplifier cabinet. From this plenum air is distributed to the electron tubes and circuit components. Air is forced through the power amplifier tube cooling structures from the bottom, removing the dissipated heat, and is exhausted out the top of the cabinet. It is recommended that this exhaust air be discharged to the outside of the transmitter building, such as shown by the typical installation drawing.

The forced air system is equipped with a pressure type air flow switch at the inlet and a vane type air flow switch at the outlet. Failure of either of these switches to remain closed because of air flow problems will shut off filament and plate power to all tubes in the transmitter.

2.7 COOLING OF MODULATOR AND DRIVER TUBES

From the power amplifier plenum chamber a portion of the air is diverted to a smaller plenum in the driver/modulator/distribution unit. Some of this air is used for forced cooling of the three Type 4-400A tubes and the two Type 3CX10,000A1 modulator tubes. Hot air from the modulator/driver tubes is exhausted out the top of the front section of the cabinet. Additional air is released from the small plenum chamber into the rear of the unit cabinet to provide component ventilation. This ventilation air is also exhausted through the roof of the unit cabinet.

2.8 ACOUSTIC NOISE LEVEL

When installed as shown on the typical installation drawing, with the forced air blower in a separate room the acoustical noise level from the Type 318C Transmitter is relatively low.

2.9 CABINET DESIGN

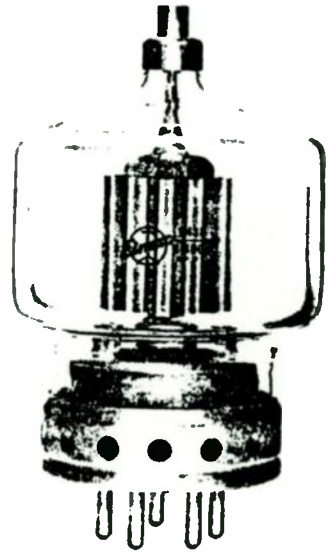
The cabinets are fabricated from aluminum and employ a unitized construction technique. All surfaces are either painted or are given an Iridite treatment to inhibit corrosion. The cabinets are of the modular free standing type, assembled in line with a logical division of circuitry and mechanical components.

2.10 TUBE DATA SHEETS

TECHNICAL DATA

8438
4-400A

RADIAL BEAM POWER TETRODE



The EIMAC 8438/4-400A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 400 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 8438/4-400A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an EIMAC SK-400 Series Air System Socket and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.[3]

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	5.0 ± 0.25 V
Current, at 5.0 volts	14.5 A

Transconductance (Average):

I_b 100 mA, E_{c2} = 500 volts	4000 µmhos

Amplification Factor (Average):

Grid to Screen	5.1

Direct Interelectrode Capacitances (grounded filament)[2]

Input	12.5 pF
Output	4.7 pF
Feedback	0.12 pF

Frequency of Maximum Rating:

CW	110 MHz

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. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.
3. Guarantee applies only when the 4-400A is used as specified with adequate air in the SK-400 or SK-410 Air-System Socket and associated chimney or equivalent.

MECHANICAL

Maximum Overall Dimensions:

Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm

(Effective 7-20-70)

Printed in U.S.A.

EIMAC division of varian / 301 industrial way / san carlos / california 94070

Net Weight	9.0 oz; 255 gm
Operating Position	Vertical, base down or up
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	EIMAC SK-400 Series
Recommended Chimney	EIMAC SK-406
Recommended Heat-Dissipating Connectors:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN
Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	3000	Vdc
Screen Voltage	750	Vdc
Grid Voltage[1]	-130	Vdc
Zero-Signal Plate Current	80	mAdc
Single Tone Plate Current	290	mAdc
Single-Tone Screen Current[2]	13	mAdc
Useful Output Power	470	W
Resonant Load Impedance	5000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-220	-220	Vdc
Plate Current	350	350	350	mAdc
Screen Current[1]	46	46	40	mAdc
Screen Dissipation	23	23	20	W
Grid Current[1]	18	19	18	mAdc
Peak rf Grid Voltage[1]	300	320	320	v
Grid Dissipation	1.8	1.9	1.8	W
Calculated Driving Power[2]	5.4	6.1	5.8	W
Plate Input Power	875	1050	1400	W
Plate Dissipation	235	250	300	W
Plate Output Power	640	800	1100	W

1. Approximate value.
2. Driving Power increases with frequency. At 75 MHz driving power is approximately 12 watts.

TYPICAL OPERATION (110 MHz, two tubes)

Plate Voltage	3500	4000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-170	-170	Vdc
Plate Current	500	540	mAdc
Screen Current	34	31	mAdc
Grid Current	20	20	mAdc
Driving Power[1]	20	20	W
Plate Output Power[1]	1300	1600	W
Useful Output Power	1160	1440	W

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

1. Corresponds to 400 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-220	-220	-220	Vdc
Plate Current	275	275	275	mAdc
Screen Current[1]	30	28	26	mAdc
Screen Dissipation	15	14	13	W
Grid Current[1]	12	12	12	mAdc
Grid Dissipation	1.1	1.1	1.1	W
Peak af Screen Voltage[1] (100% modulation)	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	v
Calculated Driving Power[1]	3.5	3.5	3.5	W
Plate Input Power	550	688	825	W
Plate Dissipation	170	178	195	W
Plate Output Power	380	510	630	W

1. Approximate value.

MAXIMUM RATINGS (Frequencies to 30 MHz, Intermittent Service)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz, Intermittent Service)

Plate Voltage	2000	2500	3000	3650	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage	-220	-220	-220	-225	Vdc
Plate Current	275	275	275	275	mAdc
Screen Current[1]	30	28	26	23	mAdc
Screen Dissipation	15	14	13	12	W
Grid Current[1]	12	12	12	13	mAdc
Grid Dissipation	1.1	1.1	1.1	1.2	W
Peak Screen Voltage (100% modulation)	350	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	315	v
Calculated Driving Power[1]	3.5	3.5	3.5	4.0	W
Plate Input Power	550	688	825	1000	W
Plate Dissipation	170	178	195	235	W
Plate Output Power	380	510	630	765	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Two Tubes) Class AB_1

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	750	750	750	750	Vdc
Grid Voltage[1,4]	-130	-137	-145	-150	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	635	635	610	585	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current[1]	28	26	32	40	mAdc
Peak af Grid Voltage[2]	130	137	145	150	v
Peak Driving Power[3]	0	0	0	0	w
Max Signal Plate Dissipation[2]	370	400	400	400	W
Plate Output Power	850	1100	1330	1540	W
Load Resistance (plate to plate)	6800	8900	11,500	14,000	Ω

TYPICAL OPERATION (Two Tubes) Class AB_2

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage[1,4]	-75	-80	-85	-90	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	700	700	700	638	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current	50	40	38	32	mAdc
Peak af Grid Voltage[2]	133	140	145	140	v
Peak Driving Power[3]	8.6	9.0	10.2	7.0	W
Max. Signal Plate Dissipation[2]	320	363	400	400	W
Plate Output Power	1110	1375	1650	1750	W
Load Resistance (plate to plate)	7200	9100	10,800	14,000	Ω

1. Approximate value.
2. Per tube.
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	13.5	14.7	A
Interelectrode Capacitances [1] (grounded filament connection):			
Input	10.7	14.5	pF
Output	4.2	5.6	pF
Feedback	----	0.17	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING - The 4-400A must be mounted vertically, base up or down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the EIMAC HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C.

When the EIMAC SK-400 or SK-410 Air-System Socket is used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

In the event an Air-System Socket is not used, provision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

BIAS VOLTAGE - The dc bias voltage for the 4-400A should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-400A should not exceed 800 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-400A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate-supply voltage should not exceed 3200 volts, except below 30 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-400A should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation

e_{gk} = Peak positive grid to cathode voltage, and

I_c = dc grid current

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

SCREEN DISSIPATION - The power dissipated by the screen of the 4-400A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-400A should not be allowed to exceed 400 watts. The anode of the 4-400A operates at a visibly red color at its maximum rated dissipation of 400 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 270 watts. The plate dissipation will rise to 400 watts under 100% sinusoidal modulation.

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

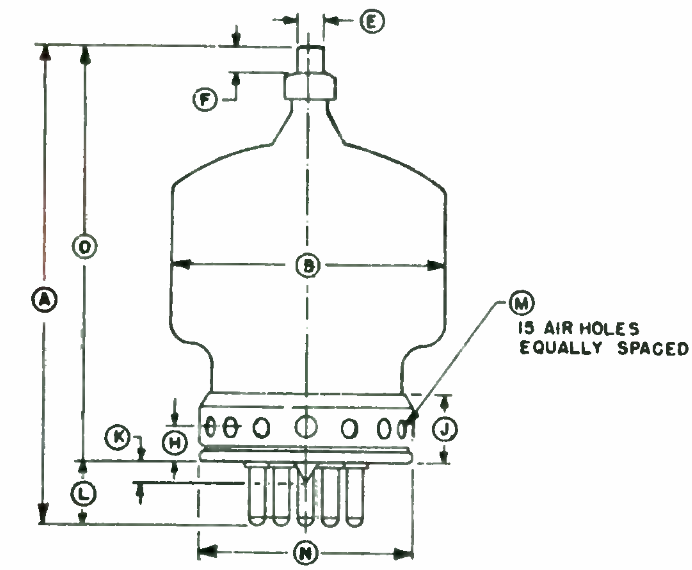
PULSE SERVICE - For pulse service, the EIMAC 4PR400A should be used.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB_1 operation.

CAUTION - GLASS IMPLOSION - The EIMAC 4-400A is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

CAUTION-HIGH VOLTAGE - Operating voltage for the 4-400A 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.

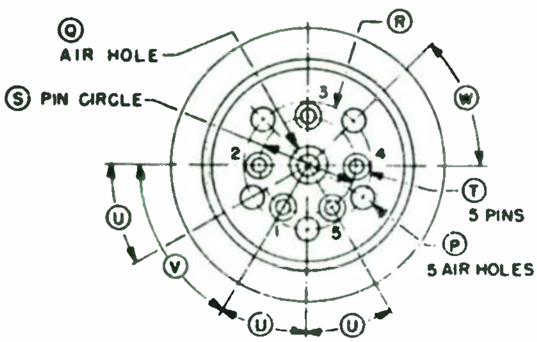
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



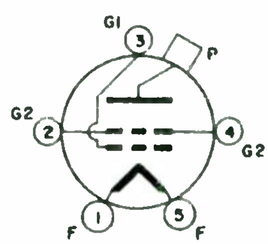
DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN.	MAX.	REF
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	19.05
M	--	--	0.250	--	--	6.35
N	--	2.750	--	--	69.85	--
P	--	--	0.312	--	--	7.92
Q	--	--	0.500	--	--	12.70
R	--	--	1.625	--	--	41.28
S	--	--	1.250	--	--	31.75
T	0.185	0.191	--	4.70	4.85	--
U	--	--	30°	--	--	30°
V	--	--	60°	--	--	60°
W	--	--	45°	--	--	45°

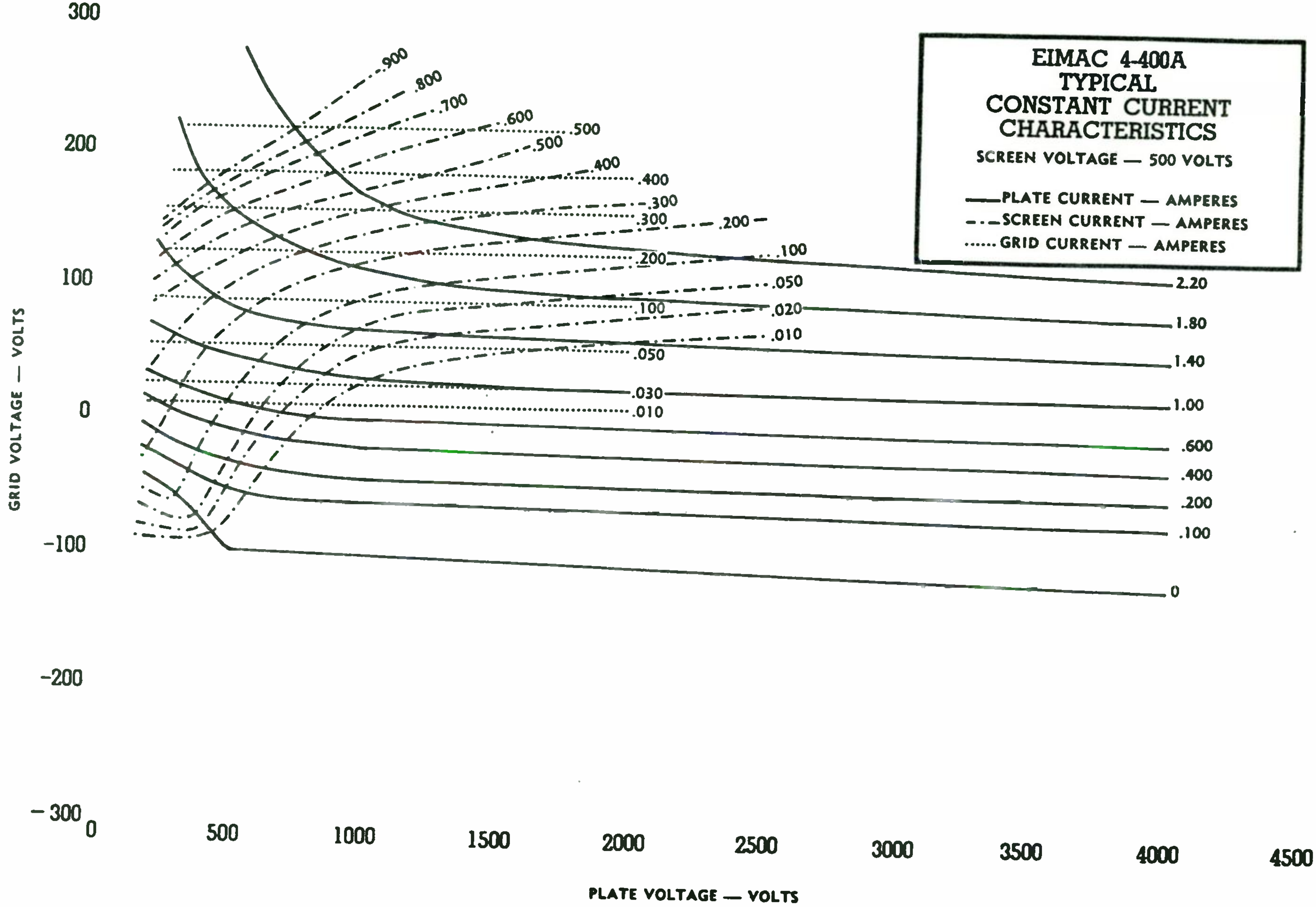
NOTES:
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



BOTTOM VIEW



NOTE:
Base pins T and tubulation K are so alined that they can be freely inserted in a gage ¼ inch (6.35 mm) thick with hole diameters of .204 (5.18 mm) and .500 (12.70 mm), respectively, located on the true centers by the given dimensions S, U, V.



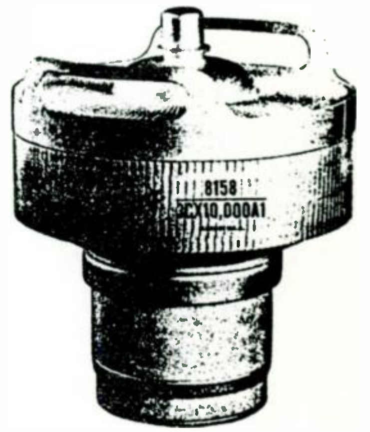
EIMAC 4-400A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
300
200
100
0
-100
-200
-300
0
500
1000
1500
2000
2500
3000
3500
4000
4500
.900
.800
.700
.600
.500
.500
.400
.400
.300
.300
.200
.200
.100
.050
.100
.020
.010
.050
.030
.010
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0

TECHNICAL DATA

8158
3CX10,000A1

LOW-MU POWER TRIODE

The Eimac 8158/3CX10,000A1 is a ceramic and metal power triode intended primarily for use as an audio amplifier or modulator. This tube is also recommended for voltage-regulator applications where high current capability and low tube drop are important. Up to 12 kilowatts of plate power can be dissipated on its air-cooled anode. A water-cooled version, the 3CW20,000A1, is available with a 20 kw dissipation rating.



CHARACTERISTICS

ELECTRICAL

Filament: Thoriated-Tungsten	Min.	Nom.	Max.	
Voltage		7.5		V
Current	94		104	A
Amplification Factor	5.5		7.0	
Interelectrode Capacitances:				
Grid-Filament	45		57	pF
Output	3.4		4.2	pF
Grid-Plate	25		32	
Transconductance (Ib = 2.0 amps, Eb = 3000 volts)	20,000			umhos

MECHANICAL

Base	Coaxial
Recommended Socket	Eimac SK-1300
Recommended Chimney	Eimac SK-1306
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core	250 °C
Ceramic-to-Metal Seals	250 °C
Maximum Dimensions:	
Height	8.75 in
Diameter	7.0 in
Net Weight	12 lbs

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR CLASS-AB₁

MAXIMUM RATINGS (Per Tube)

DC Plate Voltage	7000	volts
DC Plate Current	5.0	amps
Plate Dissipation	12	kW
Grid Dissipation	100	watts

*Adjust for zero-signal plate current
**At max-signal without negative feedback

Effective grid circuit resistance must not exceed 200,000 ohms

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

DC Plate Voltage	7000	7000	volts
DC Grid Voltage*	−1300	−1300	volts
Zero-Sig DC Plate Current	1.5	1.5	amps
Max-Sig DC Plate Current	5.8	7.0	amps
Load Resistance, Plate-to-Plate	2460	1720	ohms
Peak AF Grid Driving Voltage (Per Tube)	1300	1300	volts
Max-Sig Driving Power	0	0	watts
Max-Sig Plate Output Power	24,400	29,100	watts
Total Harmonic Distortion**	2.9	3.6	percent

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR Class-A

MAXIMUM RATINGS

DC Plate Voltage	7000 volts
DC Plate Current	See Class-A derating table on Page 3
Plate Dissipation	12,000 watts

*Adjust to give listed zero-signal DC plate current

TYPICAL OPERATION

DC Plate Voltage	2500	volts
DC Grid Voltage*	−290	volts
DC Plate Current	4.0	amps
Peak AF Grid Driving Voltage	290	volts
Load Resistance	2120	ohms
Plate Output Power	1800	watts

VOLTAGE REGULATOR SERVICE Class-A

MAXIMUM RATINGS

DC Plate Voltage	10,000 volts
DC Plate Current	See Class-A derating table on Page 3
Plate Dissipation	12,000 watts
Grid Dissipation	100 watts

TYPICAL OPERATION

DC Plate Voltage (tube drop)	0-5000	volts
DC Plate Current	0-5	amps

(These values are chosen according to Class-A derating table on Page 3)

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

APPLICATION

Cooling — The maximum temperature rating for the external surfaces of the 3CX10, 000A1 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates through the recommended socket/chimney and tube combination in the base-to-anode direction provides effective cooling of the tube.

Plate** Dissipation (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
4000	85	0.18	125	0.25
6000	145	0.38	210	0.55
8000	215	0.68	315	0.99
10,000	295	1.08	430	1.60
12,000	390	1.62	565	2.35

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 100 watts, allowance has been made in preparing this tabulation for an additional 850 watts dissipation.

APPLICATION

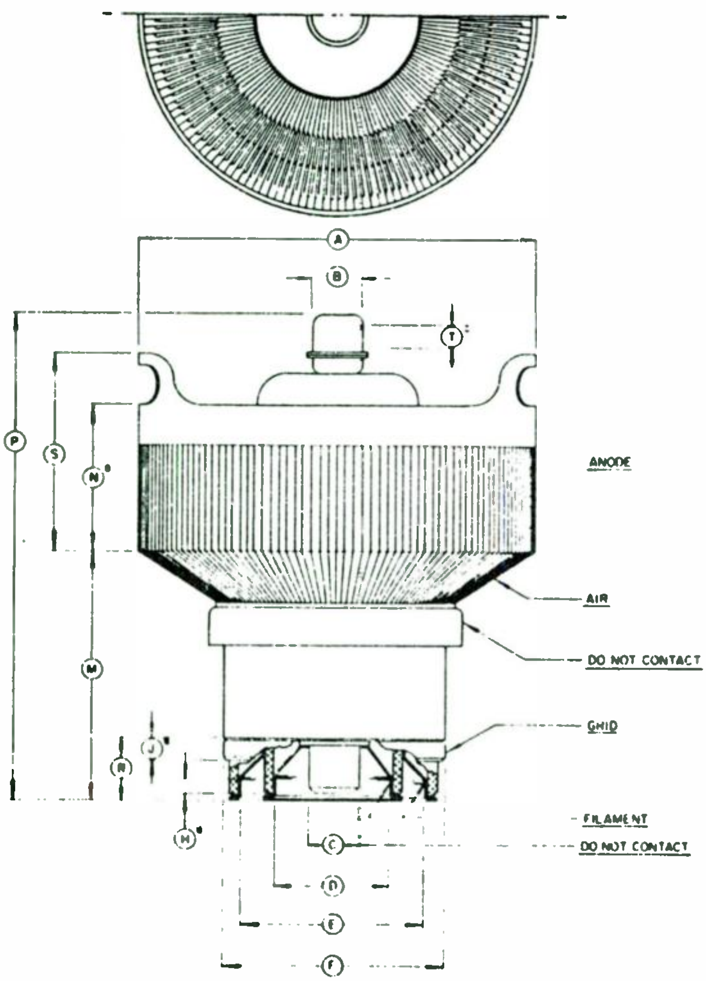
Voltage-Regulator Service — Maximum DC plate current and voltage are restricted according to the following table.

CLASS-A DERATING TABLE	
DC Plate Voltage (Volts)	Max. DC Plate Current (mA)
0 - 2400	5000
3000	4000
4000	3000
5000	2000
6000	1500
7000	1000
8000	700
9000	500
10,000	350

Filament Operation—The rated filament voltage for the 3CX10,000A1 is 7.5 volts. Filament voltage, as measured at the socket, should not be allowed to deviate from the rated value by more than plus or minus five percent.

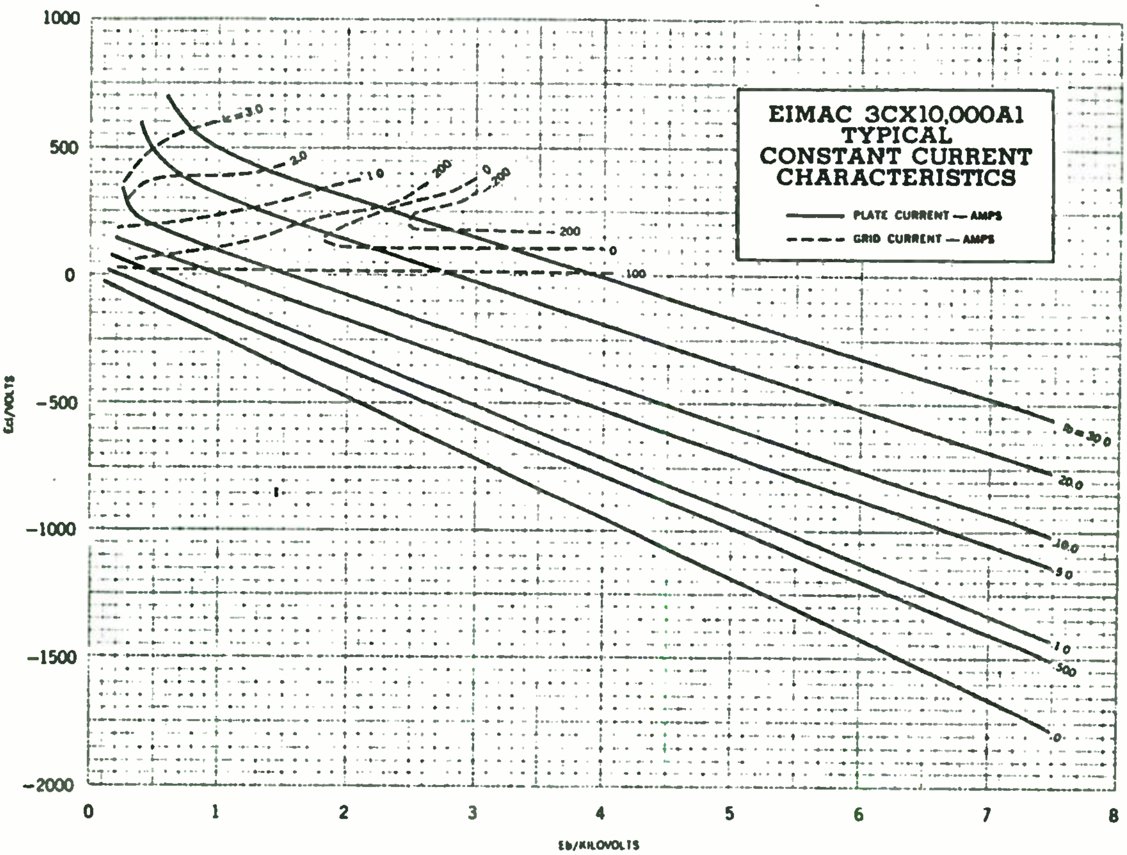
Cooling—The maximum temperature rating for the external surfaces of the 3CX10,000A1 is 250°C. Sufficient forced-air cooling must be provided to maintain the temperature of the ceramic-metal seals and anode core below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates provides effective cooling of the tube. When air-flow is in the anode-to-base direction, special care must be taken to insure adequate cooling of the filament stem structure. A separate supply of air may have to be directed into the area between the filament contact areas to maintain safe seal temperatures.

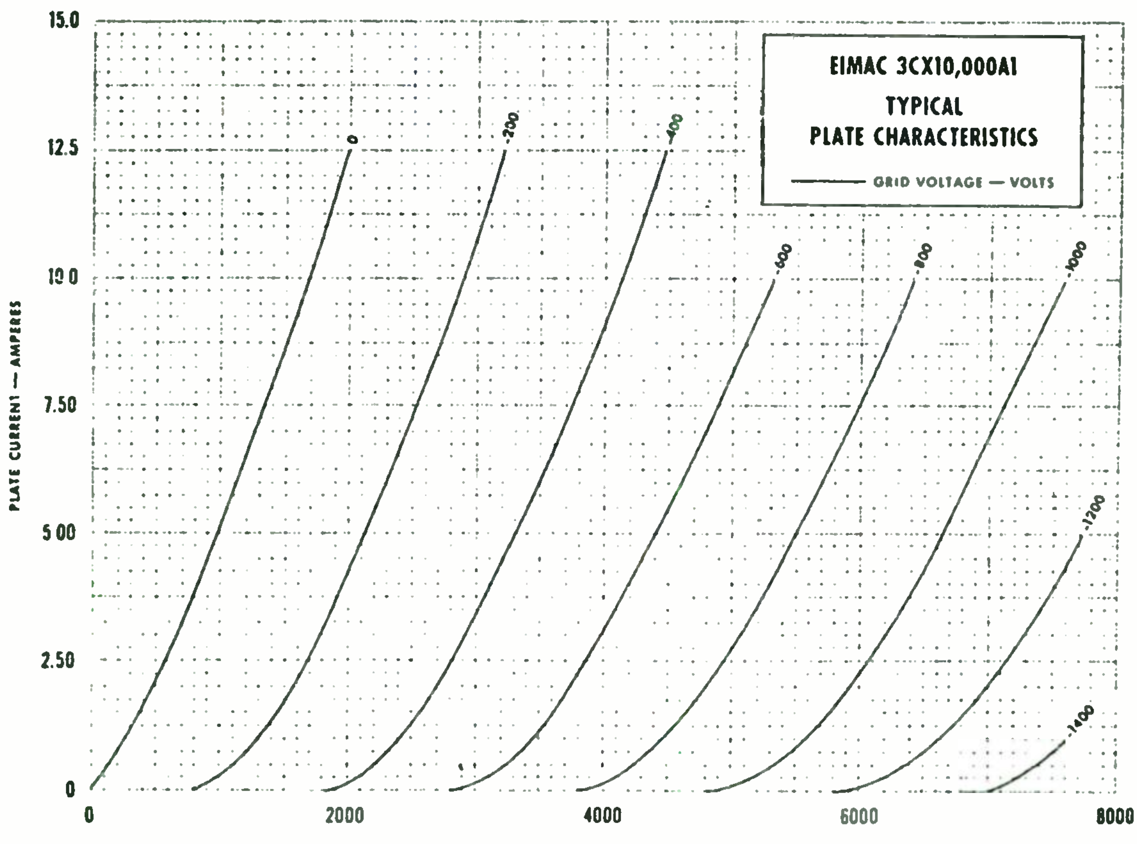
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif., for information and recommendations.



*CONTACT SURFACE
ALL DIMENSIONS IN INCHES

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		6.928	7.050
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3 133	3.173
F		3.792	3.832
H		.188	
J		.188	
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.986	1.050
S		3.412	3.788
T		.375	

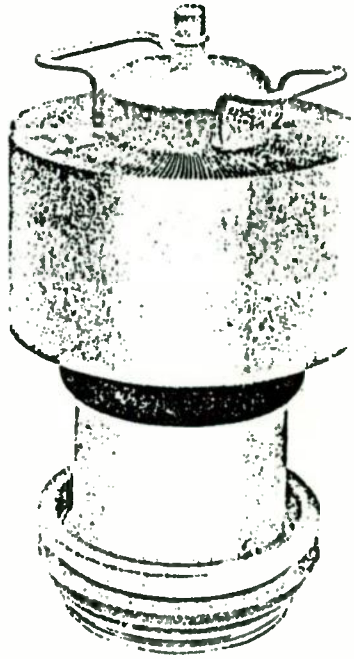

EIMAC 3CX10,000A1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPS
GRID CURRENT — AMPS
Ec/VOLTS
Eb/KILOVOLTS
1000
500
0
-500
-1000
-1500
-2000
0
1
2
3
4
5
6
7
8


EIMAC 3CX10,000A1
TYPICAL
PLATE CHARACTERISTICS
GRID VOLTAGE — VOLTS
PLATE CURRENT — AMPERES
PLATE VOLTAGE — VOLTS
15.0
12.5
10.0
7.50
5.00
2.50
0
2000
4000
6000
8000

TECHNICAL DATA

8349
4CX35,000C

RADIAL-BEAM POWER TETRODE



The EIMAC 8349/4CX35,000C is a ceramic/metal, forced-air cooled power tetrode intended for use at the 50 to 150 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB rf linear amplifier, or a Class-AB push-pull af amplifier or modulator. The 8349/4CX35,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The forced-air cooled anode is rated at 35 kilowatts maximum dissipation.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage . . . . 10.0 V
- Current, at 10.0 volts . . . . 295 A

Amplification Factor (Average):
- Grid to Screen 4.5

Direct Interelectrode Capacitances (grounded cathode)[2]
- Cin . . . . 440 pF
- Cout . . . . 55 pF
- Cgp . . . . 2.3 pF

Frequency of Maximum Rating:
- CW . . . . 30 MHz

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. EIMAC Division of Varian 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 in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:
- Length . . . . 17.34 in; 440.4 mm
- Diameter . . . . 9.75 in; 247.7 mm

Net Weight . . . . 50 lb; 22.7 kg

Operating Position . . . . Vertical, base up or down

Maximum Operating Temperature:
- Ceramic/Metal Seals . . . . 250°C
- Anode Core . . . . 250°C

Cooling . . . . Forced Air

Base . . . . Special, graduated rings

Recommended Socket . . . . EIMAC SK-1500 Series

EIMAC division of varian / 301 industrial way / san carlos / california 94070

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN
Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	15.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-400	Vdc
Zero-Signal Plate Current	1.0	Adc
Single Tone Plate Current	5.7	Adc
Single-Tone Screen Current [2]	0.9	Adc
Peak rf Grid Voltage [2]	250	v
Peak Driving Power [2]	0	w
Plate Dissipation	30	kW
Plate Output Power	55	kW
Resonant Load Impedance	1280	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.5	6.8	6.96	Adc
Screen Current [1]	0.84	0.51	0.80	Adc
Grid Current [1]	0.29	0.23	0.35	Adc
Peak rf Grid Voltage [1]	600	660	730	v
Calculated Driving Power [1]	180	150	258	W
Plate Dissipation	19.3	19.0	21.0	kW
Plate Output Power	55.5	82.5	110	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN
Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	14,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION [1]	23,000	WATTS
SCREEN DISSIPATION [2]	1750	WATTS
GRID DISSIPATION [2]	500	WATTS

1. Corresponds to 35,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	12.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	5.4	Adc
Screen Current [1]	0.52	Adc
Grid Current [1]	0.16	Adc
Peak af Screen Voltage [2] (100% modulation)	500	v
Peak rf Grid Voltage [1]	740	v
Calculated Driving Power	125	W
Plate Dissipation	13.2	kW
Plate Output Power	55.0	kW
Resonant Load Impedance	1120	Ω

1. Approximate value.

2. Approximate value, depending upon degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	12.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1,3]	-400	Vdc
Zero-Signal Plate Current	3.0	Adc
Max Signal Plate Current	9.2	Adc
Max Signal Screen Current [1]	1.8	Adc
Peak af Grid Voltage [2]	280	v
Max Signal Plate Dissipation [2]	20	kW
Plate Output Power	70	kW
Load Resistance (plate to plate)	2860	Ω

2. Per Tube
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection) [2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000C must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500, and SK-1510 have been designed especially for the concentric base terminals of the 4CX35,000C.

COOLING - The maximum temperature rating for the external surfaces of the 4CX35,000C 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/metal seals below 250°C.

Air-flow requirements to maintain core temperature at 225°C in 40° ambient air are tabulated below (for operation below 30 megahertz.) These data are for air flowing in the base-to-anode direction.

	Base-to-Anode Air Flow			
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
15,000	440	1.0	635	1.44
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 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.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 CFM of air directed through the center of the socket is sufficient for this purpose.

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.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CX35,000C is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CX35,000C by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CX35,000C. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appears to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of tube and SK-1500 socket, must not exceed 100 volts.

GRID OPERATION - The 4CX35,000C grid has a maximum dissipation rating of 500 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX35,000C must not exceed 1750 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 1750 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX35,000C is 35,000 watts. When the 4CX35,000C is operated as a plate-modulated rf amplifier, under carrier conditions, the maximum plate dissipation is 23,000 watts.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - Normal operating voltages used with the 4CX35,000C are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all 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 primary circuits of the power supply and to discharge high-voltage condensers 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.

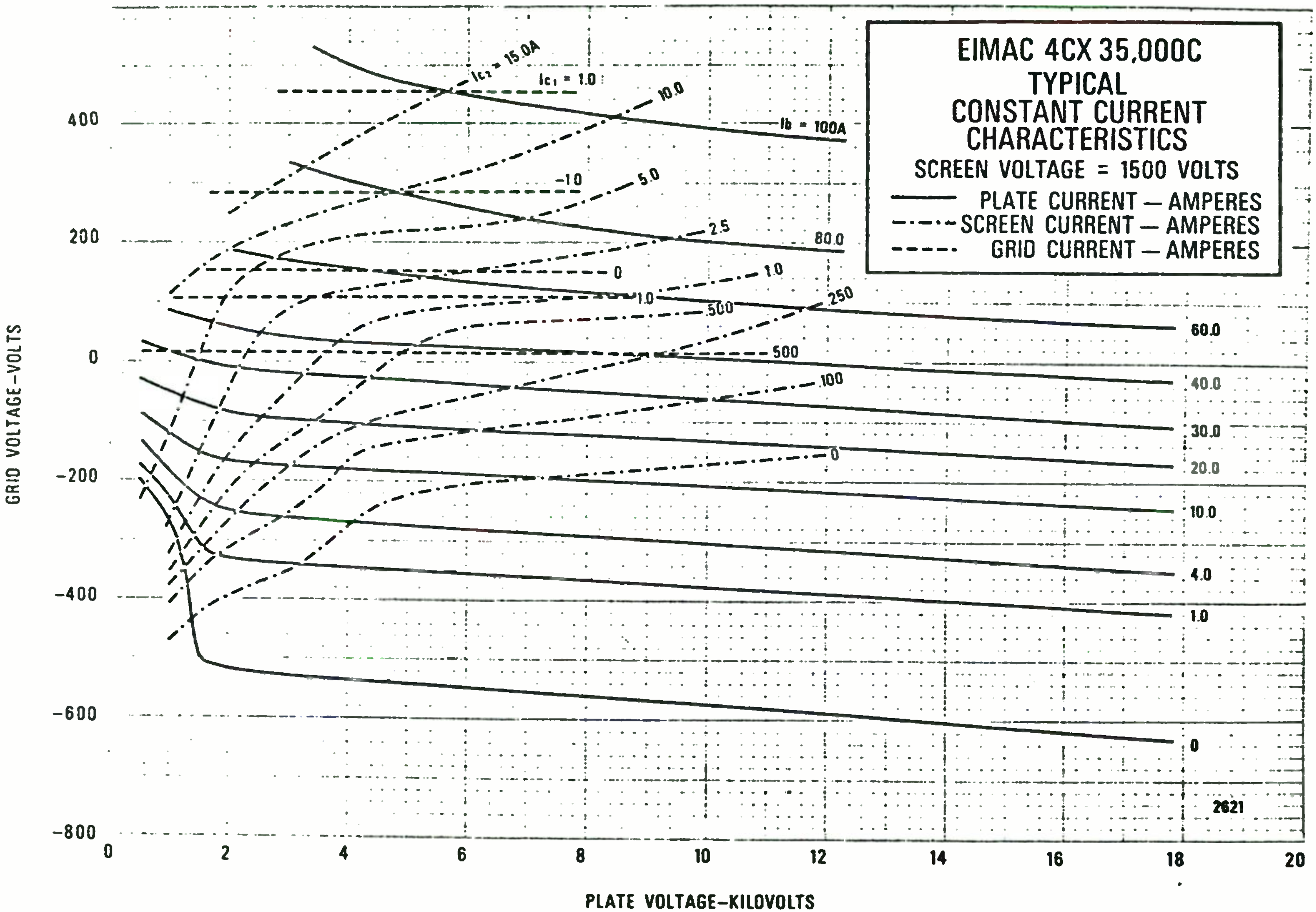
FAULT PROTECTION - In addition to normal cooling airflow interlock and plate and screen over-current interlocks, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least one or two ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. Where stored energy is high, it is recommended that some form of electronic crowbar be used which will discharge power supply capacitors in as short a time as possible following indication of start of a plate arc.

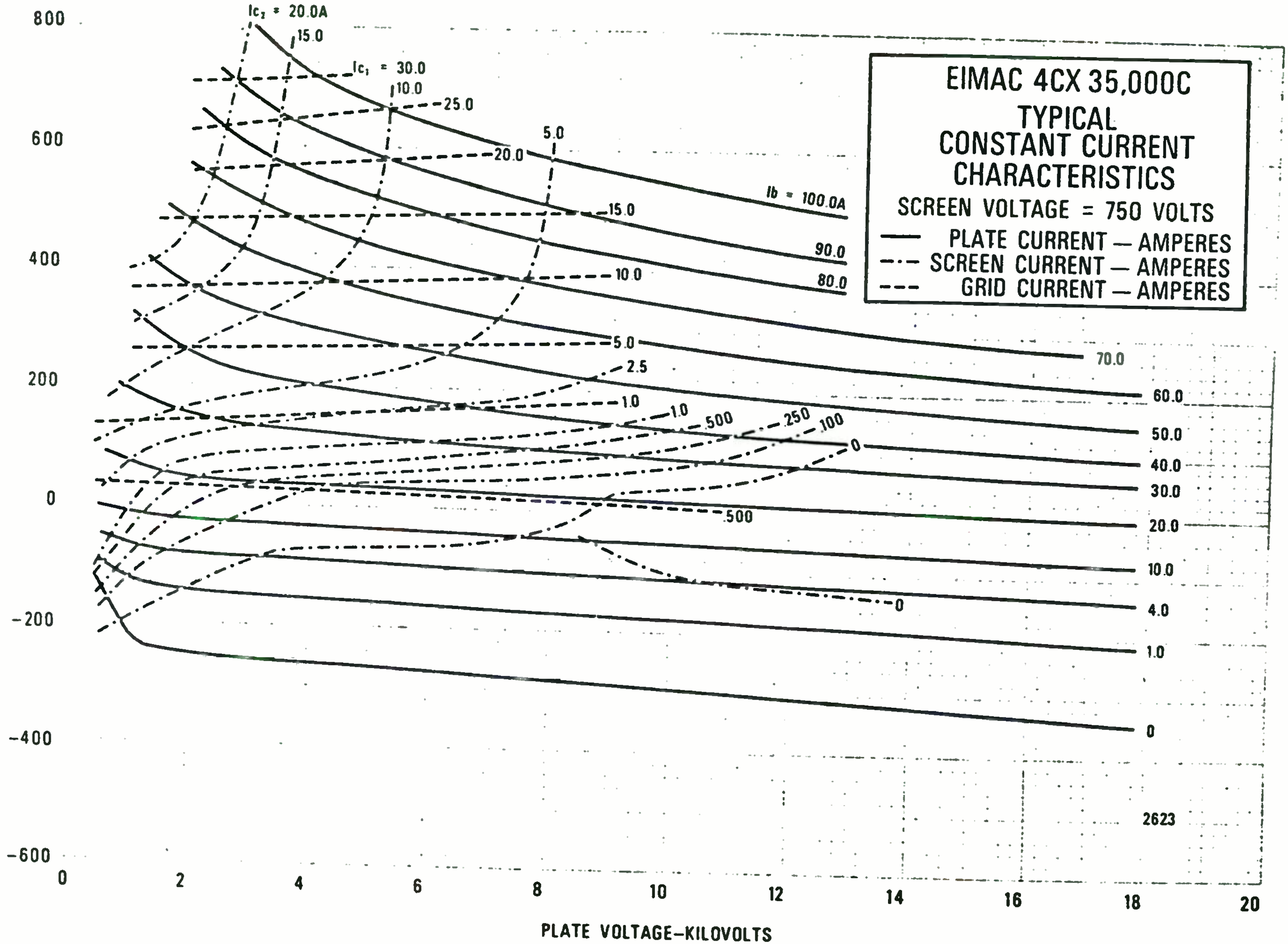
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CX35,000C, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
Ib = 100A
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
Ic2 = 15.0A
10.0
5.0
2.5
1.0
.500
250
100
0
Ic1 = 1.0
-1.0
0
1.0
500
2621
GRID VOLTAGE-VOLTS
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE-KILOVOLTS

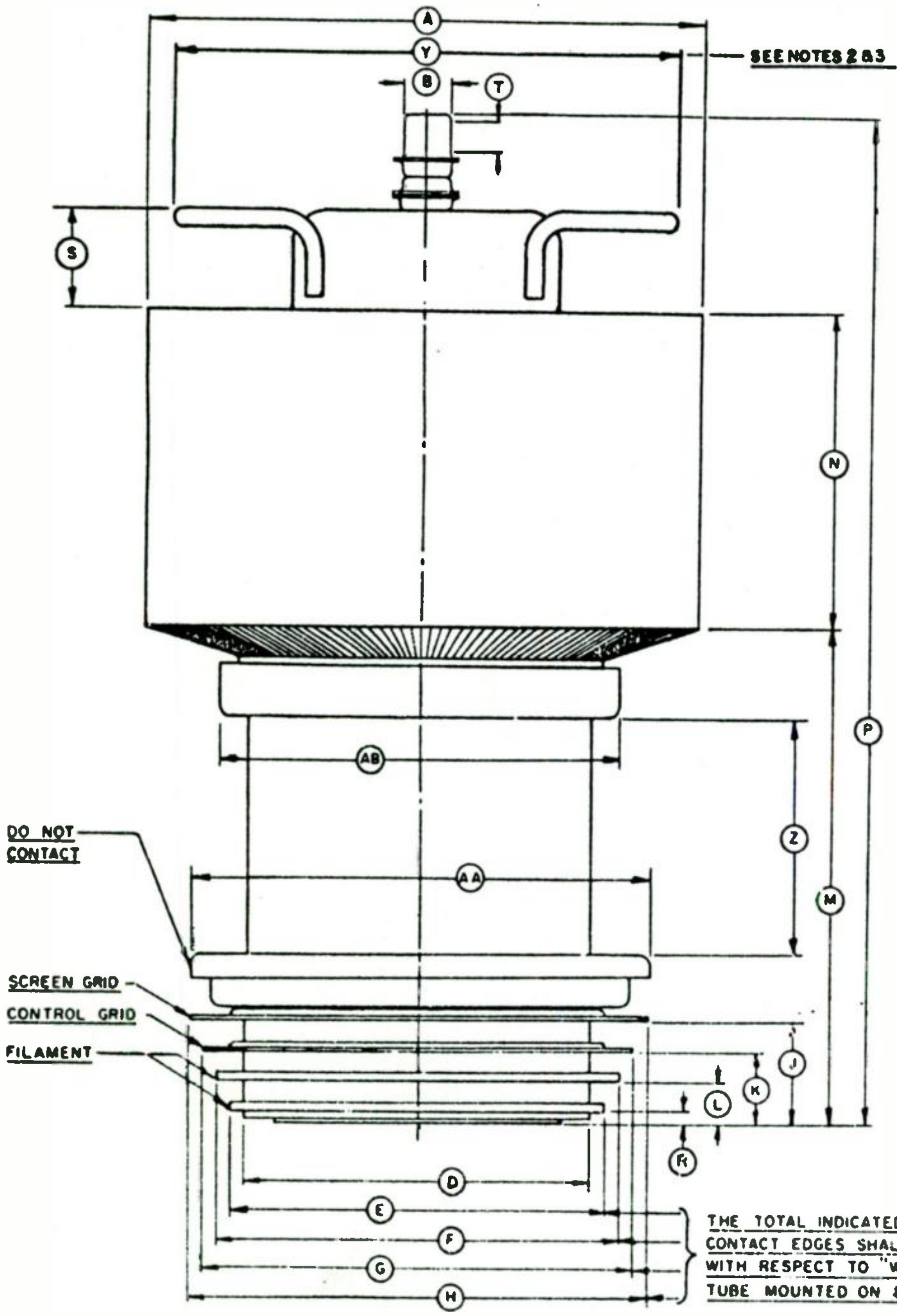
#2621



2-28

#2623

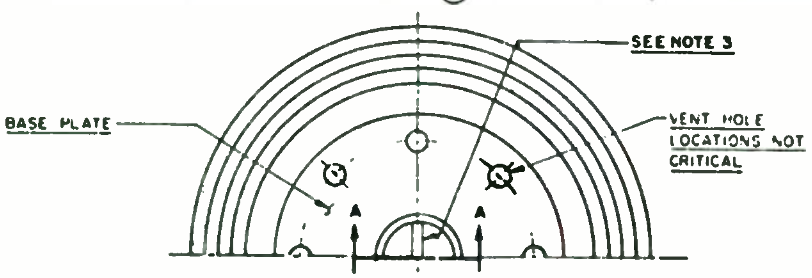
4CX35,000C

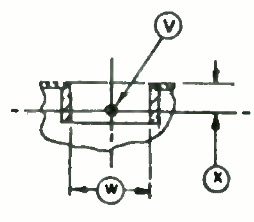


THE TOTAL INDICATED RUNOUT OF THESE CONTACT EDGES SHALL NOT EXCEED .125 WITH RESPECT TO "W" MEASURED WITH TUBE MOUNTED ON BOTTOM CERAMIC

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.





SECTION A-A

GL-7703
IGNITRON

CAPACITOR-DISCHARGE SERVICE — 20,000 VOLTS PEAK
DC SHORT-CIRCUITING-SWITCH SERVICE — 100,000 AMPERES PEAK

The GL-7703 is a sealed, stainless-steel-jacketed ignitron for use as a switch in capacitor-discharge circuits operating up to 20,000 volts. In this service the tube will carry peak currents up to 100,000 amperes. The anode seal is enclosed in an insulating compound to prevent external voltage flashover.

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Main Cathodes	1
Ignitors	1

Mechanical

Envelope—Stainless Steel
Mounting Position—Axis Vertical, Anode Terminal Up
Net Weight . . . 2 Pounds

Thermal

Type of Cooling—Air or Liquid, by clamp around lower portion of tube

Clamp Temperature	10 to 30	C
Cathode Temperature, maximum	35	C
Anode Insulating-Compound Temperature*, maximum	70	C

Capacitor-Discharge Service, Intermittent Pulse Duty, Sinusoidal Current†

Peak Anode Voltage‡

Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current¶

Peak, for ½ cycle of 120 microseconds	60,000	Amperes
Peak, for ½ cycle of 20 microseconds	100,000	Amperes
Maximum Discharge Rate	2	Per Minute
Rate of Rise of Current§, tube inductance 0.04 microhenrys, approx.		
Ionization Time	0.5	Microseconds

DC Short-Circuiting-Switch Service

Peak Anode Voltage‡

Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current

Peak	35,000	Amperes
Average	0.25	Amperes
Maximum Averaging Time	1	Cycle
Rate of Rise of Current§, tube inductance 0.04 microhenrys, approx.		
Ionization Time	0.5	Microseconds

Ignitor Ratings

	Minimum	Maximum	
Separate Excitation			
Ignitor Voltage			
Forward Open Circuit	1500	3000	Volts
Inverse, maximum	-	5	Volts
Ignitor Short-Circuit Current	200	250	Amperes
Length of Firing Pulse, sine wave	5	10	Microseconds

	Minimum	Maximum	
Anode Firing			
Ignitor Voltage			
Forward, maximum	—	3000	Volts
Inverse, maximum	—	5	Volts
Peak Ignitor Current	200	250	Amperes

* Anode-seal, insulating-compound temperature must always be higher than the cathode temperature to prevent mercury condensation on the anode and anode seal. Before tube operation, the anode seals must be heated long enough to vaporize all mercury from the seal area

† The tube may become a closed switch (does not open) carrying current in both directions until the current dampens out.

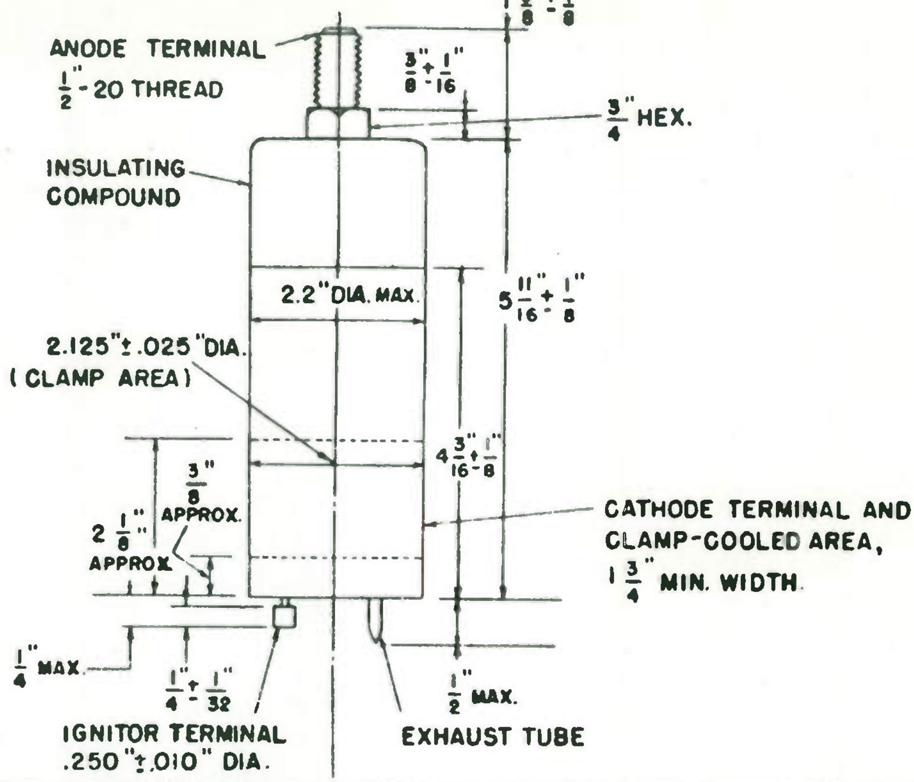
‡ The tube cannot hold off this voltage immediately after conduction. A 1-to-10-second delay may be required before reapplication of voltage.

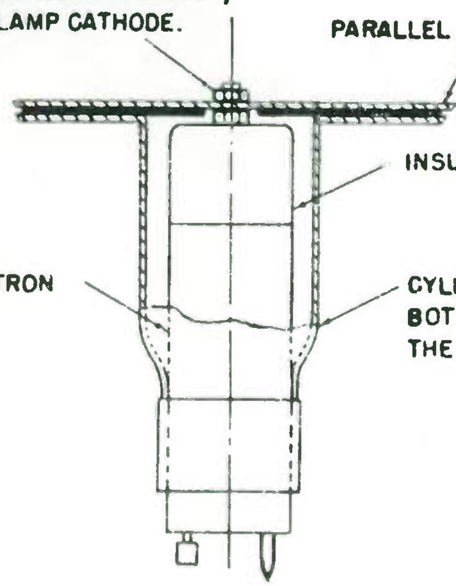
¶ Dampened oscillations are permissible provided the oscillating cycles do not exceed 20. The peak current value for one-half cycle must not be exceeded.

§ Rate of rise depends on circuit.

GENERAL ELECTRIC

OUTLINE IGNITRON GL-7703





SUGGESTED METHOD FOR PROVIDING MOUNTING FOR CO-AXIAL CONNECTION

K-69087-72A948

8-60

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.