

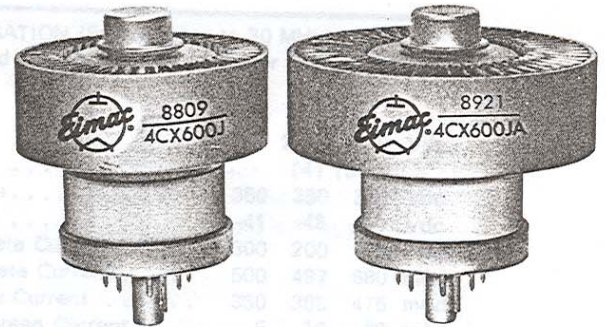


TECHNICAL DATA

8809
4CX600J

8921
4CX600JA
ULTRA LINEAR
POWER TETRODE

The EIMAC 8809/4CX600J is a ceramic/metal, forced-air cooled, radial beam tetrode with a rated maximum plate dissipation of 600 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 8809/4CX600J especially suitable for radio-frequency and audio-frequency linear amplifier service.



The 8921/4CX600JA has a larger anode cooler for reduced cooling air pressure-drop. It is electrically identical to the 4CX600J.

GENERAL CHARACTERISTICS¹

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: Voltage	6.0 ± .3 V
Current, at 6.0 volts	5.4 A
Cathode-Heater Potential (maximum)	±150 V

Transconductance (Average):

$I_b = 0.3 \text{ Adc}, E_{c2} = 350 \text{ Vdc}$	27,000 μmhos
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Direct Interelectrode Capacitance (grounded cathode)²

C_{in}	50.0 pF
C_{out}	6.3 pF
C_{gp}	0.13 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. 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:

	4CX600J	4CX600JA
Length	2.71 in; 68.8 mm	2.71 in; 68.8 mm
Diameter	2.08 in; 52.8 mm	2.52 in; 64.0 mm
Net Weight	7.7 oz; 218 gm	9.0 oz; 255 gm
Operating Position	Any	
Maximum Operating Temperature:		
Ceramic/Metal Seals	250°C	
Anode Core	250°C	

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301 Industrial Way
San Carlos, CA 94070-2582
(650) 592-1221



Cooling	Forced air
Base	JEDEC B8-236
Recommended Air System Socket	SK-607
Recommended Air Chimney (4CX600J)	SK-646
Recommended Air Chimney (4CX600JA)	SK-656

**RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN Class AB**

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

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	450 VOLTS
DC PLATE CURRENT	0.6 AMPERE
PLATE DISSIPATION	600 WATTS
SCREEN DISSIPATION	15 WATTS
GRID DISSIPATION	1 WATT

1. Adjust to specified zero-signal dc plate current.
2. 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.
3. Approximate values.
4. Cathode resistor 11 ohms, bypassed by 4000 pF.
5. Cathode resistor 11 ohms, no bypass capacitor.
6. Complex signal such that dc plate current maximum rating of 600 mA not exceeded.

Plate Voltage	2000	2000	2500	Vdc
See Notes	---	(4)	(5 & 6)	
Screen Voltage	350	350	350	Vdc
Grid Voltage 1	-41	-48	-50	Vdc
Zero-Signal Plate Current	300	200	175	mAdc
Single-Tone Plate Current	500	497	680	mAdc
Two-Tone Plate Current	350	365	475	mAdc
Single-Tone Screen Current ³	5	16	30	mAdc
Two-Tone Screen Current ³	-2	3	10	mAdc
Single-Tone Grid Current ³	0	0	0.5	mAdc
Two-Tone Grid Current ³	0	0	0.2	mAdc
Peak rf Grid to Ground Voltage ³	32	39.5	70	v
Single-Tone Useful Output Power	550	553	1100	W
Resonant Load Impedance	2000	2000	2000	Ω
Intermodulation Distortion Products ²				
3rd Order	-43	-46	-40	db
5th Order	-43	-51	-40	db

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

TYPICAL OPERATION (Two Tubes) Class AB1

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	450 VOLTS
DC PLATE CURRENT6 AMPERE
PLATE DISSIPATION	600 WATTS
SCREEN DISSIPATION	15 WATTS
GRID DISSIPATION	1 WATT

Plate Voltage	2000	2500	2800	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage 1/3	-52	-52	-52	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max. Signal Plate Current	1.13	1.14	1.14	Adc
Zero-Signal Screen Current	-1	-2	0	mAdc
Max. Signal Screen Current	52	48	52	mAdc
Peak rf Grid Voltage ²	46	46	46	v
Plate Output Power	1430	1720	1985	W
Load Resistance(plate to plate)	3850	4200	4800	Ω

1. Approximate value.
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.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.
Heater: Current at 6.0 volts	5.0	5.8 A
Cathode Warmup Time	5	-- minutes

Interelectrode Capacitances¹(grounded cathode connection)

	Min.	Max.
Cin	46.0	54.0 pF
Cout	5.7	7.0 pF
Cgp	---	0.2 pF

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

APPLICATION

COOLING - The maximum temperature rating for the anode core and the metal/ceramic seals of these tubes is 250°C. Sufficient forced-air cooling must be provided to maintain operating temperatures within this rating. Air flow requirements to maintain tube temperatures at 225°C with a cooling air inlet temperature of 50°C are tabulated below, for operation below 30 MHz, for the tube mounted in the recommended air-system socket and chimney, in the special mounting plate shown on the outline drawing, with air flowing in the base-to-anode direction. Pressure drop will be higher if the socket is not mounted in the special mounting plate.

Since the power dissipated by the heater represents about 33 watts and since grid plus screen dissipation can represent additional power, allowance has been made in preparing this tabulation for an additional 40 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 below plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling.

Plate Dissipation Watts	4CX600J				
	Sea Level		10,000 FEET		
	Air Flow CFM	Press.Drop in. water	Air Flow CFM	Press.Drop in. water	
450	10	0.33	14.6	0.47	
600	14	0.58	20.5	0.85	
Plate Dissipation Watts	4CX600JA				
	450	6	0.08	8.8	0.12
	600	11	0.15	16	0.22

HEATER - The rated heater voltage for these tubes 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 the rated value except for short periods.

It is recommended that the heater voltage be applied for a period of not less than 5 minutes before other operating voltages are applied.

Refer to EIMAC Division of Varian for special instructions if it is necessary to reduce cathode warmup time.

GRID OPERATION - The grid dissipation rating of these tubes is 1 watt. The design features which make these such extremely linear tubes also contribute to very low grid interception. The grid may be driven into the positive grid region in the typical operation of the tube.

SCREEN OPERATION - Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on the individual tube. The 4CX600J and 4CX600JA, under some operating conditions, may indicate negative screen currents in the order of 10 milliamperes.

The maximum rated power dissipation for the screen grid is 15 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 from screen to cathode; a zener regulator 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 regulator is employed. The screen bleeder current

should approximate 20 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 600 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.

INTERMODULATION DISTORTION - The typical radio frequency linear amplifier operating conditions, including the distortion data, are based on actual operation in a grid-driven amplifier. Because the 4CX600J and 4CX600JA have very low grid interception it is possible to drive the grid positive with minimum adverse effects upon the distortion level or upon the driver. Class AB2 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 4CX600J or 4CX600JA be swamped with a 1000 ohm resistor from grid to cathode so as to provide an almost constant load to the driver.

In general, linearity is improved as grid bias value is shifted toward Class A operation. Linearity may also be improved without sacrifice of efficiency by use of cathode resistors bypassed for rf, or with no bypass capacitor. See "Radio Frequency Linear Amplifier, Typical Operation".

FAULT PROTECTION - These tubes operate at voltages which can cause severe damage in the event of an internal arc, unless the tube is properly protected. This damage may be relatively minor in tubes operating from low energy power supplies, but will become catastrophic in those cases where large amounts of stored energy or follow-on current are involved. Some means of protection is advised in all cases but is mandatory in those instances where destructive quantities of energy are involved. In addition to protecting the tube in the event of a tube or circuit malfunction, these protective measures can also protect associated circuitry.

The addition of a series resistor in the anode and/or screen grid line will limit peak currents and provide a means of dissipating the energy in the event of a tube or circuit arc. This resistance should be as high as can practically be used without dissipating an excessive amount of power. Typically, a resistance of 20 to 50 ohms is sufficient to protect the tube structure in the event of an arc. It will also serve as protection to the other circuit components, such as bypass capacitors, rf chokes, meters, and diodes. A maximum of 4 joules total energy should be permitted to be dumped into an internal arc.

Any amount in excess of 4 joules will permanently damage either the oxide cathode or the fine wire grid structure. In a typical case involving a 2000 Vdc power supply with a 2 μ fd filter capacitor a total of 4 joules is stored in the capacitor alone, not including the energy resulting from follow-on current from the power supply.

EIMAC Application Bulletin #17 titled "FAULT PROTECTION" is available on request, and includes additional information, including recommendations for those cases where tubes are operated in parallel, or in distributed amplifiers, where stored power supply energy is very high, and suggests a test procedure to determine if the protective circuitry being employed is adequate.

CAUTION-HIGH VOLTAGE - Operating voltage for the 4CX600J and 4CX600JA 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.

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.

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.

GRID VOLTAGE (V)

60
40
20
0
-20
-40
-60
-80

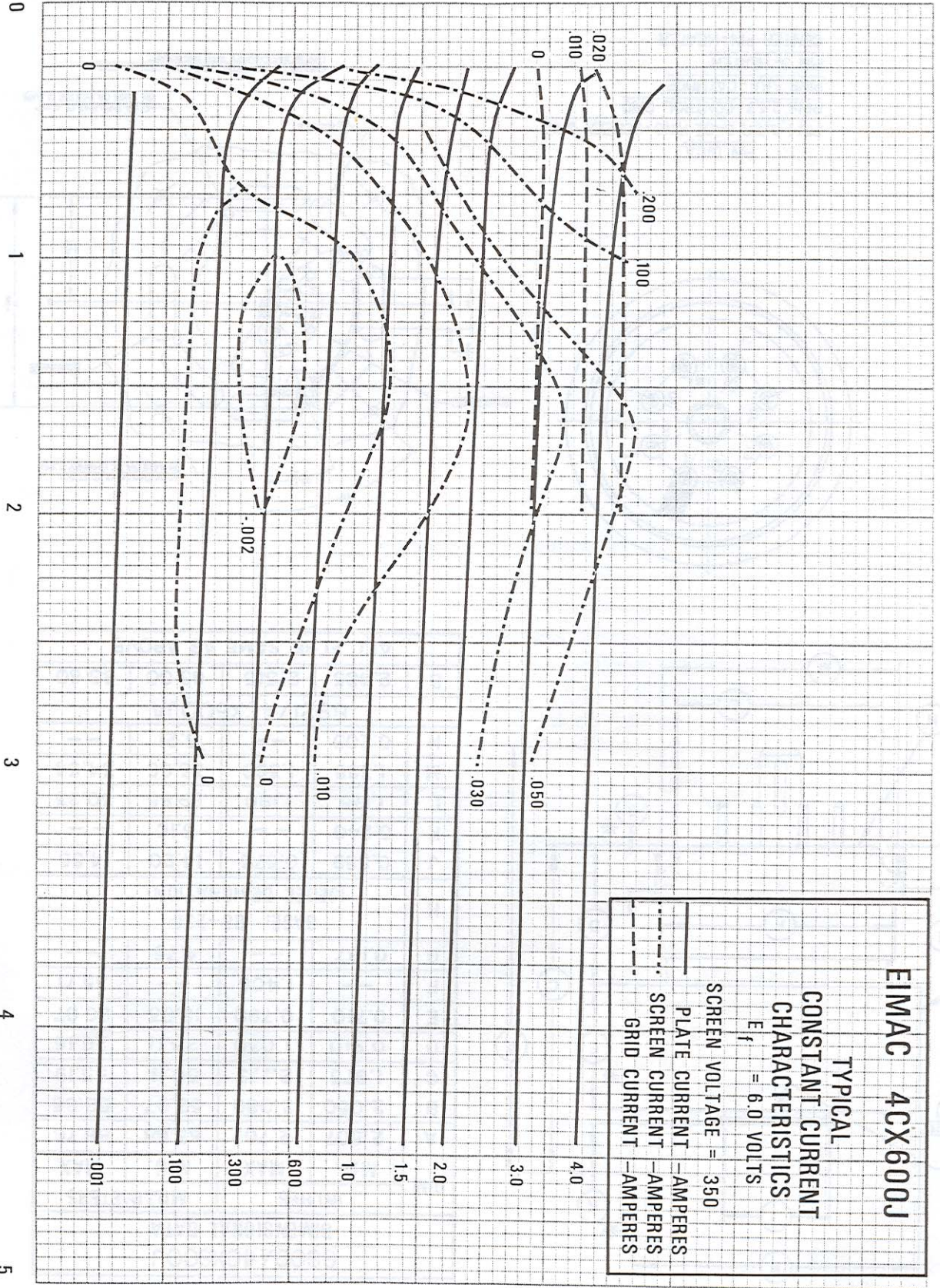
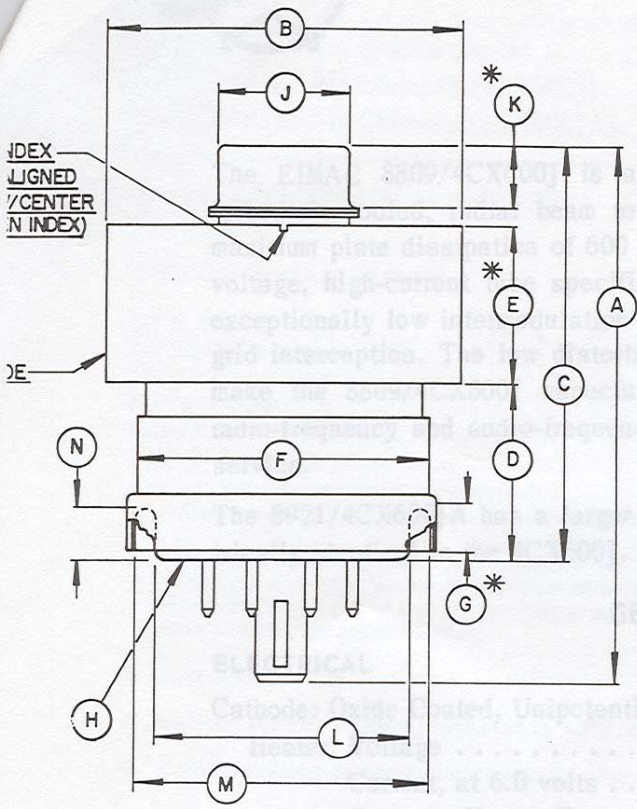


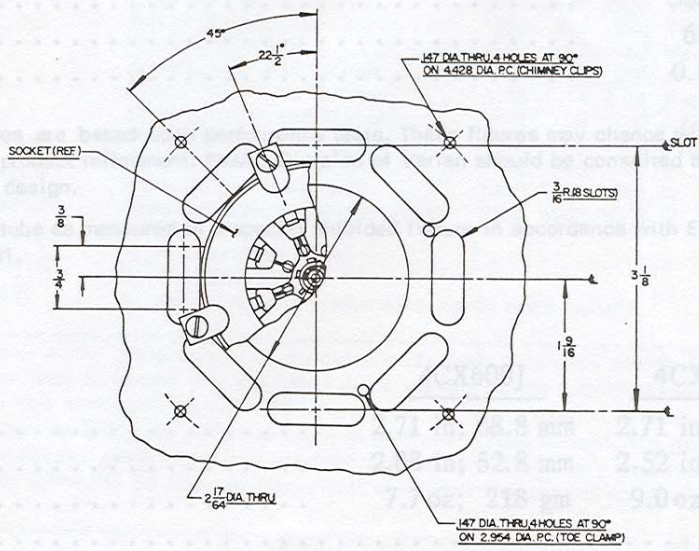
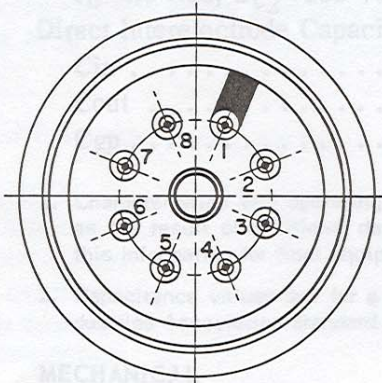
PLATE VOLTAGE (KV)

CURVE #3836

4CX600J/4CX600JA



8809/4CX600J				
DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	2.507	2.707	63.68	68.76
B	2.050	2.080	52.07	52.83
C	1.973	2.173	50.11	55.19
D	0.910	1.030	23.11	26.16
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE: B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--
L	1.175	1.190	29.85	30.23
M	1.325	1.360	33.66	34.54
N	0.205	--	5.21	--
8921/4CX600JA				
B	2.485	2.515	63.00	63.80
ALL ELSE SAME AS ABOVE				



PIN DATA
 PIN 1 &/OR BASE RING-SCREEN GRID
 PINS 2,4,7-CONTROL GRID
 PINS 3,6,8-CATHODE
 PIN 5-HEATER
 CENTER PIN-HEATER

CHASSIS CUTOUT PATTERN REQ'D. FOR ADEQUATE COOLING.
 USE SK 646 CHIMNEY WITH THIS SOCKET.