C6J-A/5685

XENON THYRATRON

Negative-Control Triode Type

TENTATIVE DATA

RCA-C6J-A/5685 is a three-electrode, xenon-filled thyratron with a negative-control characteristic. It is intended for use as a grid-controlled rectifier.

GENERAL DATA

Electrical:

	Min.	*Av.*	*Max.*	
Filamentary Cathode, Coated:				
Voltage (AC or DC)	2.4	2.5	2.6	volts
Current at 2.5 volts	19	21	23	amp
Minimum heating time prior to tube conduction		60		sec
Direct Interelectrode Capacitances (Approx.):				
Grid to anode		4		μμf
Grid to cathode		21		μμf
Maximum Deionization Time		1000		μamp
Maximum Critical Grid Current		10		μamp
Anode Voltage Drop:				
Average at beginning of life		9		volts
Maximum at end of life		12		volts
Maximum Commutation Factor□ averaged over first 350 volts of inverse anode voltage rise		0.66		va/μs²
Grid Control Ratio (Approx.) under conditions: 10000-ohm grid resistor, circuit returns to filament transformer center tap, filament pin 2 negative with respect to filament pin 3 when anode is positive, dc anode voltage, and dc grid voltage		210		

Mechanical:

Mounting Position	Vertical, base down
Maximum Overall Length	9-1/2"
Maximum Diameter	2-1/32"
Bulb	T-16
Cap	Medium (JETEC No.C1-5)
Base	Medium-Metal-Shell Super-Jumbo 4-Pin (JETEC No.A4-81)
Weight (Approx.)	7 oz

GRID-CONTROLLED RECTIFIER SERVICE

Maximum Ratings, *Absolute Values:*

PEAK ANODE VOLTAGE:			
Forward		1000 max.	volts
Inverse		1250 max.	volts
GRID VOLTAGE:			
Peak, before anode conduction		-100 max.	volts
ANODE CURRENT:			
Peak		77 max.	amp
Average●		6.4 max.	amp
Overload:			
Rating I*, for duration of	0.5 sec.	77.0 max.	amp
	1.0 sec.	38.5 max.	amp
	2.0 sec.	19.2 max.	amp
	3.0 sec.	12.8 max.	amp
	4.0 sec.	9.6 max.	amp
	5.0 sec.	7.7 max.	amp
Rating II**, for duration of	3.0 sec.	12.8 max.	amp
	4.0 sec.	11.2 max.	amp
	5.0 sec.	10.3 max.	amp
	6.0 sec.	9.6 max.	amp
Fault,▲ for duration of 0.1 second maximum		770 max.	amp
AMBIENT-TEMPERATURE RANGE		-55 to +75	°C

□ For definition, see page 3.
● Averaged over any period of 6 seconds.
* Averaged over duration of overload occurring no more than once in any period of 6 seconds.
** Averaged over duration of overload occurring no more than once in any period of 30 seconds.
▲ For definition, see page 2.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are limiting values above which the serviceability of the C6J-A/5685 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

The C6J-A/5685 has a *negative-control characteristic* which is essentially independent of ambient temperature over a wide range by virtue of the inert-gas content.

The *filament voltage*, measured directly at the filament terminals, should not vary more than ±5 per cent from the rated value. Less than the rated value may result in a high tube drop with consequent bombardment of the filament and eventual loss of emission. Greater than rated voltage will cause excessive evaporation of the filament coating with resultant increase in grid emission and shortened filament life.

The filament should be allowed to reach operating temperature before tube conduction is permitted to start. The delay period should be not less than 60 seconds after application of filament voltage. Unless this recommendation is followed, the filament will be damaged.

The *anode* of the C6J-A/5685 will show a red color when the tube is operated at full load.

The *anode circuit* should be provided with a time-delay relay to prevent tube conduction until the filament has reached normal operating value.

Sufficient anode-circuit resistance, including the tube load, must be used under any conditions of operation to prevent exceeding the current ratings of the tube.

The C6J-A/5685 has a *critical grid voltage* which will initiate tube conduction for any specific positive value of anode voltage. Careful consideration should be given to the range values of critical grid voltage shown in Fig.1. From them can be determined for specified operating conditions not only the proper value of grid bias necessary to prevent conduction until it is desired, but also the magnitude of the signal (triggering) voltage necessary to initiate conduction. Ample triggering voltage should always be provided to insure anode conduction even under the worst operating conditions to which the equipment will usually be subjected.

As indicated by the curve in Fig.1, there is a range where anode breakdown voltage does not change materially with change of grid voltage. This condition usually occurs near a grid potential of +4 volts. Below this anode voltage, the tube can be started at anode voltages as low as 10 to 15 volts by the application of sufficient positive grid drive.

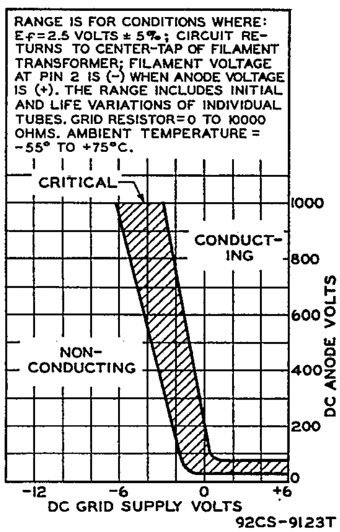


Fig. 1 - Operational Range of Critical Grid Voltage.

Grid control ratio is defined as the slope ($-[\Delta e_b/\Delta e_g]$) of the straight portion of the control characteristic.

The *maximum fault anode current rating* shown in the tabulated data is the highest value of abnormal peak current of short duration (0.1 second maximum) that should pass through the tube under the most adverse conditions of service. This rating is intended to assist the equipment designer in a choice of circuit components such that the tube will not be subjected to disastrous currents under abnormal service conditions approximating a short circuit. It is not intended for use under normal operating conditions because even a single fault current at the maximum value may impair tube life. Repeated fault currents will seriously reduce or even terminate tube life. The equipment designer should also note that if the maximum fault-current rating is exceeded, the thyratron may cease to conduct momentarily with the result that excessive surge voltages are developed in the associated components, thereby causing their failure.

The anode voltages at which the C6J-A/5685 is operated are extremely dangerous to the user. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the anode supply when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

Ion bombardment of the anode may occur in some circuits where high inverse voltage is applied immediately after current conduction ceases during the cycle. If there is insufficient time for the positive ions to re-combine into atoms, the negative anode voltage may attract the ions still present with enough velocity to sputter anode material and cause gas clean-up (gradual disappearance of the gas filling).

In circuits where the inverse voltage after conduction rises slowly in sine-wave fashion at ordinary supply frequencies, the bombardment problem is negligible. Such circuits include grid-controlled rectifiers with resistive loads operating in the discontinuous-current region, rectifiers without firing delay, and grid-controlled rectifiers with back rectifiers.

Slight bombardment with some loss in tube life may occur in circuits where tube current decays at a slow rate and where high inverse voltage with a steep wave front is applied immediately after conduction ceases. Circuits where this condition exists include half-wave rectifiers, relaxation inverters, series transformers, and rectifiers supplying motors or capacitive loads operating in the discontinuous-current region.

Heavy bombardment with serious loss in tube life may result in circuits where the tube conducts full current up to the instant that high inverse anode voltage is applied. Circuits where this condition exists include half-wave back rectifiers with the firing angle of the controlled tube retarded, and full-wave and polyphase rectifier or inverter circuits operating in the continuous-current region with firing delay provided through grid action.

Commutation factor is the product of the rate of current decay in amperes per microsecond just before conduction ceases and the rate of inverse voltage rise in volts per microsecond following current conduction. Expressed as an equation,

$$\text{Commutation Factor} = \text{volts}/\mu\text{sec} \times \text{amperes}/\mu\text{sec} = \text{volts-amperes}/\mu\text{sec}^2 = \text{va}/\mu\text{s}^2$$

If this product for the circuit exceeds the commutation factor rating for the tube, gas clean-up will occur and shorten or terminate tube life.

In determining commutation factor, it is customary to take the average rate of current decay over the last ten microseconds of current conduction and to take the average rate of inverse voltage rise over the specified voltage rise shown in the tabulated data.

Current-decay rate and inverse-voltage-rise rate are best determined by measurement on an oscilloscope. Both the voltage and time scales should be calibrated. A low-resistance non-inductive voltage divider is connected to two anodes that fire in sequence. Then a sample of the waveform is taken from across a portion of the voltage divider and applied to the oscilloscope. The inverse-voltage-rise rate may be derived directly from the calibrated scale readings. The current-decay rate is computed by dividing the load current by the commutation time in microseconds as read on the time scale. *Commutation time* is defined as the time of simultaneous conduction during which current of out-going tube falls and current of on-coming tube rises. Commutation time appears in the waveform as the flat portion of the curve.

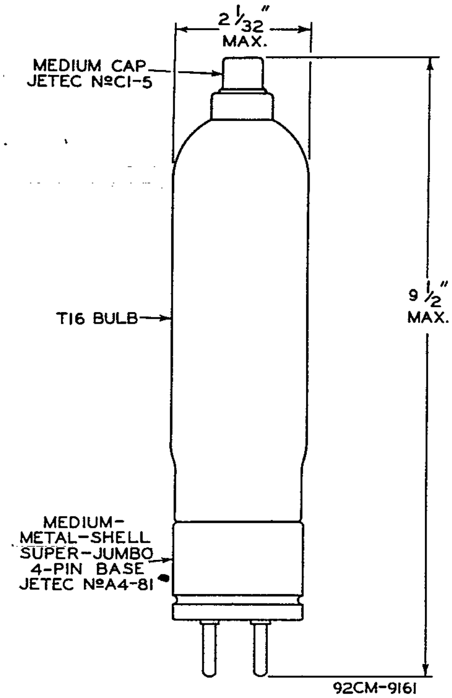
An oscilloscope with a triggered sweep and an internal delay line will facilitate making these measurements. Unless the oscilloscope can pass high frequencies, it is necessary to insert the waveform voltage directly on the deflecting-electrode terminals of the scope from a low-resistance, non-inductive voltage divider. Very high inverse-voltage rise rates are hard to measure but may be estimated very roughly from the resonant frequency of the supply transformer.

Circuit cushioning, which slows down the rate of rise of inverse anode voltage, may be accomplished by connecting a capacitance in series with a small resistance between cathode and anode. Proper cushioning-circuit design can delay the voltage rise by the necessary few microseconds to allow sweeping out the residual ions at relatively low voltage and thus avoid anode sputtering and resultant gas clean-up (See Reference 4).

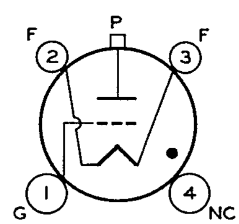
REFERENCES

1. Millman and Seeley, *"Electronics"*, McGraw-Hill Book Company, Inc.
2. M.I.T. Elec. Eng. Staff, *"Applied Electronics"*, John Wiley & Sons, Inc.
3. Wittenberg, H.H., *"Frequency Performance of Thyratrons"*, Trans. of A.I.E.E., Vol.65, No.12, pp. 843-848 (1946).
4. Edwards, D. V. & Smith, E.K., *"Circuit Cushioning of Gas-Filled Grid-Control Rectifiers"*, A.I.E.E. Technical Paper, May 1946, Electrical Engineering, October 1946.
5. Marshall, D.E. & Shackleford, C.L., *"Commutation Factor Rating of Inert Gas Thyratrons and It's Influence on Circuit Design"*, A.I.E.E. Conference Paper, Winter Meeting 1950.

DIMENSIONAL OUTLINE



SOCKET CONNECTIONS
Bottom View



PIN 1: GRID
PIN 2: FILAMENT
PIN 3: FILAMENT
PIN 4: NO CONNECTION
CAP: ANODE