

Amperex

YU204 RADIAL-BEAM PULSE TETRODE • MODULATOR OSCILLATOR AMPLIFIER

The YU204 is a pulse tetrode intended for use in pulse modulator, pulsed-amplifier and pulsed-oscillator service. This compact, high vacuum radial-beam tetrode, incorporating a molybdenum anode and non-emitting grids, is recommended for use in new equipments where high voltage, high current, or high duty factor is encountered.

Cooling of the tube is accomplished by radiation from the anode and by circulation of forced-air through the base and around the envelope. Cooling can be simplified by the use of the SK-510 Air System Socket and the SK-506 Air chimney.

The YU204 is specially designed for medical MRI applications where high noise immunity and high stability are required.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament : Thoriated Tungsten	<u>Min.</u>	<u>Nom.</u>	<u>Max.</u>	
Voltage	—	—	7.5	Volts
Current	20.0	—	22.7	Amps
Amplification Factor (Grid to screen)	—	6.9	—	
Direct Interelectrode Capacitances (Grounded Cathode)				
Grid Plate			0.35	pf
Input	23.8		32.4	pf
Output	6.8		9.4	pf
Transconductance ($I_b = 300$ ma)	10		ma/v	
Highest Frequency for Maximum Ratings	110		MHz	

MECHANICAL

Base	5 Pin metal shell
Basing	See drawing
Recommended Socket	SK-510 Air-System Socket
Operating Position	Vertical base down or up
Maximum Operating Temperatures :	
Base Seals	150°C
Plate Seal	200°C
Cooling	Radiation and forced-air
Recommended Heat-Dissipating Plate Connector	HR-8
Maximum Over-all Dimensions :	
Length	(9.63 inches) 235 mm
Diameter	(5.25 inches) 133 mm
Net Weight (tube only)	(1.5 lbs.) 0,74 kg
Shipping Weight in Shielded Fixture	(12 lbs) 3,70 kg

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PULSE MODULATOR SERVICE**MAXIMUM RATINGS**

DC Plate Voltage	30 max.	kV
DC Screen Voltage	2.5 max.	kV
DC Grid Voltage	- 1.0 max.	kV
Peak Plate Current	8.0 max.	amperes
Plate Dissipation (Ave.)	1000 max.	watts
Screen Dissipation (Ave.)	75 max.	watts
Grid Dissipation (Ave.)	25 max.	watts

TYPICAL OPERATION

DC Plate Voltage	20	25	30	kV
DC Screen Voltage	1.5	1.5	1.5	kV
DC Grid Voltage	- 335	- 360	- 380	V
Pulse Plate Voltage	17.7	22.7	27.7	kV
Peak Plate Current	8.0	8.0	8.0	Amp
Pulse Screen Current	1.25	1.25	1.25	Amp
Pulse Grid Current	0.2	0.2	0.2	Amp
Pulse Pos. Grid Voltage	200	200	200	V
Pulse Drive Power	107	112	116	W
Pulse Plate Input Power	160	200	240	kW
Pulse Plate Output Power	140	180	220	kW
Duty	4.0	4.0	4.0	%

RADIO FREQUENCY PLATE AND SCREEN-PULSED AMPLIFIER AND OSCILLATOR ***MAXIMUM RATINGS**

Peak DC Plate Voltage	20 max.	kV
DC Screen Voltage	2.5 max.	kV
DC Grid Voltage	- 1.0 max.	kV
Peak Cathode Current (Note 1)	12.0 max.	Amp
Plate Dissipation (Ave.)	1000 max.	W
Screen Dissipation (Ave.)	75 max.	W
Grid Dissipation (Ave.)	25 max.	W

* When used as a RF Plate and Screen-Pulsed Amplifier, the grid drive must also be pulsed to avoid overheating this element during the inter-pulse periods.

TYPICAL OPERATION

Pulse Plate Voltage	10	15	20	kV
Pulse Screen Voltage	1.5	1.5	1.5	kV
DC Grid Voltage	-480	-510	-535	V
Pulse Plate Current (Note 1)	1.95	1.95	1.95	A
Pulse Screen Current	0.32	0.32	0.32	A
Pulse Grid Current	0.02	0.02	0.02	A
Peak RF Grid Voltage	735	760	785	V
Pulse Drive Power	14.7	15.2	15.7	W
Pulse Plate Input Power	19.5	29.3	39.0	kW
Pulse Plate Output Power	17.0	23.0	31.5	kW
Duty	15.0	15.0	12.0	%

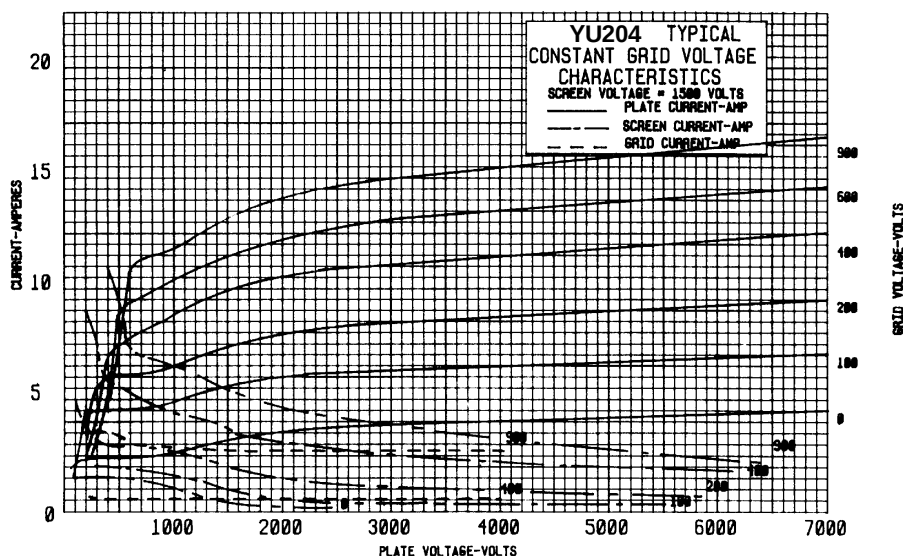
RADIO FREQUENCY GRID-PULSED AMPLIFIER AND OSCILLATOR**MAXIMUM RATINGS**

DC Plate Voltage	15 max.	kV
DC Screen Voltage	2.5 max.	kV
DC Grid Voltage	- 1.0 max.	kV
Peak Cathode Current (Note 1)	12.0 max.	A
Plate Dissipation (Ave.)	1000 max.	W
Screen Dissipation (Ave.)	75 max.	W
Grid Dissipation (Ave.)	25 max.	W

Note 1 : The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on an available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation sections refers to the dc plate current component during the pulse.

TYPICAL OPERATION

DC Plate Voltage	10	12.5	15	kV
DC Screen Voltage	1.5	1.5	1.5	kV
DC Grid Voltage	- 480	- 495	- 510	V
Pulse Plate Current (Note 1)	1.95	1.95	1.95	A
Pulse Screen Current	0.32	0.32	0.32	A
Pulse Grid Current	0.02	0.02	0.02	A
Peak RF Grid Voltage	735	745	760	V
Pulse Drive Power	14.7	15.0	15.2	W
Pulse Plate Input Power	19.5	24.4	29.3	kW
Pulse Plate Output Power	17.0	18.6	23.0	kW
Duty	15.0	15.0	15.0	%



MECHANICAL

Mounting — The YU204 must be operated vertically, base up or base down. When the SK-510 Air-System Socket is used in conjunction with the SK-506 Air Chimney, the socket must be mounted to the under surface of the chassis to maintain proper air space between the plate seal and the chimney opening, otherwise plate seal cooling will be seriously impaired.

In the event the SK-510 Air-System Socket is not used, the socket must provide clearance for the glass tip-off which extends from the center of the tube. The metal tube-base shell should be grounded by means of suitable spring fingers.

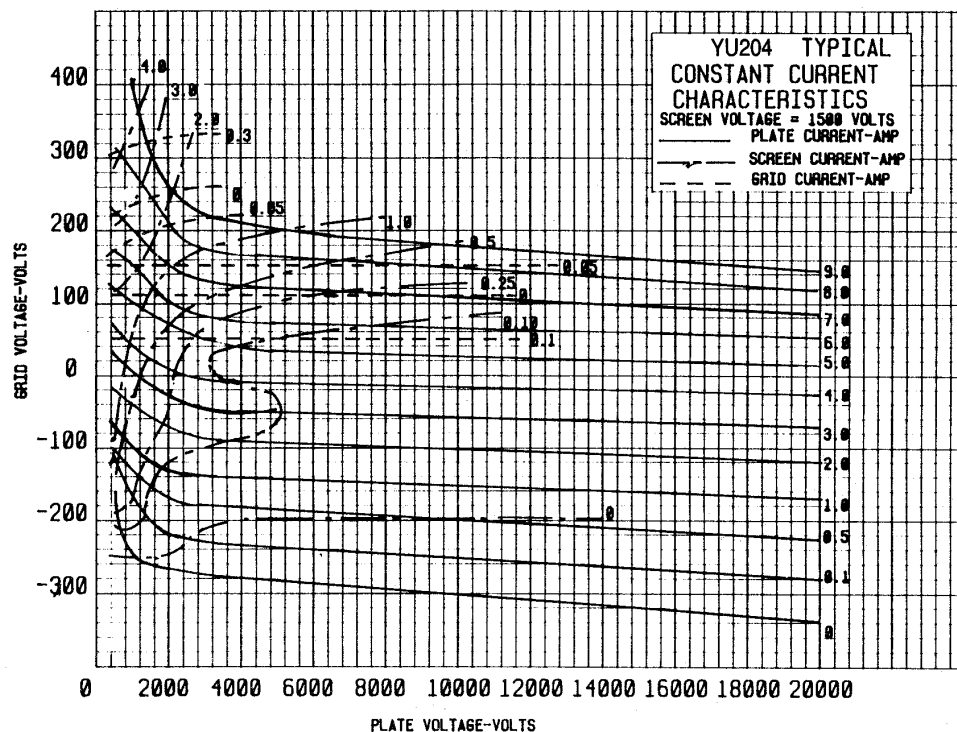
Cooling — Adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 150°C and 200°C, respectively. In all classes of operation, it is recommended that a heat-radiating connector, the HR-8 or equivalent, be installed on the anode terminal and that a socket and chimney be employed which provides for proper seal cooling. When the 4PR1000A is operated at d-c or low frequencies in a SK-510 Air-System Socket, complete with SK-506 Air Chimney and HR-8 Heat Radiator, the minimum airflow requirements to maintain seal temperatures at 150°C in 50°C inlet air are tabulated below:

	Sea Level		10,000 Feet ⁺	
Ave. Plate Dissipation (watts)	Air Flow (CFM) *	Plenum Pressure Drop. (Inches of Water) **	Air Flow (CFM) *	Plenum Pressure Drop. (Inches of Water) **
600	17.0	0.30	24.0	0.45
800	20.0	0.40	28.0	0.56
1000	25.0	0.55	36.0	0.80

- * 1 CFM = 0.47195 Liters/sec
 ** 1 inch of H₂O = 0.002458 ATM
 + Approx 3,000 meters

When the YU204 is used as a pulsed-amplifier or oscillator at frequencies above 30 MHz, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by rf charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured conveniently by using a temperature sensitive paint.



Filament Voltage — For maximum tube life, the filament voltage, as measured directly at the filament pins, should be 7.5 volts. Variations in filament voltage must be kept within the range of 7.13 to 7.87 volts.

When the YU204 is utilized in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value, the normally allowable five per cent variation in this voltage cannot be tolerated if the tubes' peak current capabilities are to be realized.

Element Dissipation — Under normal operating conditions, the average plate dissipation of the YU204 should not be allowed to exceed 1000 watts. Dissipation in excess of this maximum rating is permissible for short periods of time, such as during tuning procedures.

The average power dissipated by the screen-grid and the control-grid must not exceed 75 watts and 25 watts, respectively.

Cut-Off Characteristics — The Plate Current Cut-Off Characteristics of the YU204 are shown in the graph below. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristics closely approximate the mean value in the tube test specification.

Each YU204 is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 30 kV, a screen voltage of 2.5 kV with the grid voltage adjusted to maintain a plate current of 10 microamperes. Under these test conditions, the negative grid bias must not exceed 600 volts. Due to tube-to-tube variation, this cut-off point will vary and the typical range can be expected to be between - 470 volts and - 585 volts.

Pulse-Modulator Service — The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage wave-form, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance etc ...) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate waveform is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

