4010

TRAVELING-WAVE TUBE

35 db Low-Level Gain

Integral Periodic-Permanent-Magnet Type
2000 - 4000 Mc
Forced-Air Cooled

1.5 watts Saturated Power Output

TENTATIVE DATA

RCA-4010 is an intermediate-power traveling-wave amplifier tube of the helix-transmission-line type designed to operate in the frequency range from 2000 to 4000 Mc. It is intended primarily for use as a driver for a high-power traveling-wave tube. The 4010 may also be used as the output tube when power output requirements are less than about 1.5 watts, as well as in grid-No.1-pulsed applications involving negligible driving power.

When operated in cw applications at 3000 Mc, the 4010 can provide a typical small-signal gain of more than 35 db and a typical saturated power output of 1.8 watts.

Design features of the 4010 include built-in periodic-permanent-magnets to focus the electron beam, operating capability over an ambient temperature range of 0° to 75° C without significant effect on performance, a light-weight sturdy structure capable of withstanding shocks of 30 g for 11 milliseconds, and vibrational acceleration of 5g at frequencies up to 500 cps. These features, together with the ability of the 4010 to operate with full ratings at altitudes up to 50000 feet under high humidity conditions without pressurization commend this type for use in the design of airborne electronic equipment.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 5%	volts
Current at 6.3 volts	1.3	amp
Starting Current	Must never exceed 4.0 amperes, even momentarily	
Minimum Cathode Heating Time	2.5	minutes
Frequency Range	2000 to 4000	Mc
Cold Insertion Loss	60	db
Direct Interelectrode Capacitance:		
Grid No.1 to all other electrodes (Approx.)	12	μμf

Mechanical:

Operating Position	Any
Air Flow	An air stream should be directed into the radiator port at the small-diameter end of the 4010. Adequate flow should be provided so that the temperature of the radiator on the collector does not exceed 150° C under any condition of operation. Typical air-flow requirements are shown in Fig.1.
Maximum Overall Length (Excluding flexible leads)	15-3/8"
Maximum Height	2-5/8"
Maximum Width	2-1/32"
Terminal Leads (Seven)	See *Dimensional Outline*
RF Connectors:	
Input	Type TNC Jack
Output	Type TNC Jack
Weight (Approx.)	2-1/2 pounds

Maximum Ratings, *Absolute Maximum Values for Altitudes up to 50000 feet:*

For CW operation, and pulsed-grid-No.1 operation with duty cycle up to 1

DC COLLECTOR VOLTAGE	1300 max.	volts
DC HELIX VOLTAGE	1200 max.	volts
DC GRID-No.2 VOLTAGE	700 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value	150 max.	volts
Positive peak value	0 max.	volts
DC COLLECTOR CURRENT	25 max.	ma
DC HELIX CURRENT	5 max.	ma
DC GRID-No.2 CURRENT	4 max.	ma
DC GRID-No.1 CURRENT	2 max.	ma
CATHODE CURRENT:		
DC or Peak	25 max.	ma
RF POWER INPUT	1 max.	watt
TEMPERATURE OF METAL SHELL:		
During operation	100 max.	°C
	0 min.	°C
During storage	-62 min.	°C
LOAD VOLTAGE STANDING WAVE RATIO	4 max.	

Typical CW Operation at 3000 Mc:

DC Collector Voltage	1150	volts
DC Helix Voltage	1075	volts
DC Grid-No.2 Voltage	575	volts
DC Grid-No.1 Voltage	0	volts
DC Collector Current	18	ma
DC Helix Current	2.0	ma
DC Grid-No.2 Current	0.5	ma
DC Grid-No.1 Current	0.25	ma
Gain for output up to 0.1 watt	35	db
Gain at 1 watt output	32	db
Power Output (Saturated, approx.)	1.8	watts

Characteristics Range Values for Equipment Design:

	Note	*Min.*	*Max.*	
Heater Current	1	1.0	1.6	amp
DC Helix Voltage	1,2	1000	1150	volts
DC Grid-No.2 Voltage	1,3	475	675	volts
Insertion Loss	1,4	30	-	db
Gain for output up to 0.1 watt	1,3,5	33	-	db
Gain for output of 1 watt	1,3,5	30	-	db
Saturated Power Output	1,3,6	1	-	watt
Modulation (AM) due to Vibration	1,3,7	-	1	db

Note 1: With heater voltage of 6.3 volts.

Note 2: With collector volts = 1150; helix voltage adjusted to value for operation over the frequency range of 2000 to 4000 Mc; grid-No.2 voltage adjusted to

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produce collector-current value specified on tube label; and grid-No.1 volts = 0. It is to be noted that the optimum helix voltage determined in this test is indicated for each tube on the tube label, and that the indicated range is given to show the expected range for tubes of this type.

Note 3: With collector volts = 1150; helix voltage adjusted to value specified on label for operation over the frequency range 2000 to 4000 Mc.; grid-No.2 voltage adjusted to produce collector-current value specified on label; and grid-No.1 volts = 0.

Note 4: Same as Note 3 except grid-No.1 volts = -75.

Note 5: With rf signal input adjusted to produce specified output.

Note 6: With rf signal input adjusted to give maximum power output over the frequency range 2000 to 4000 Mc.

Note 7: With the tube assembly vibrated (1) with a fixed amplitude of 0.005" (travel of 0.010") over a frequency range of 5 to 55 cps, and (2), at an acceleration of 2g over a frequency range of 55 to 500 cps. Tube is vibrated in each of 3 mutually perpendicular planes (specified in MIL-E-1C, par.4.9.20.3).

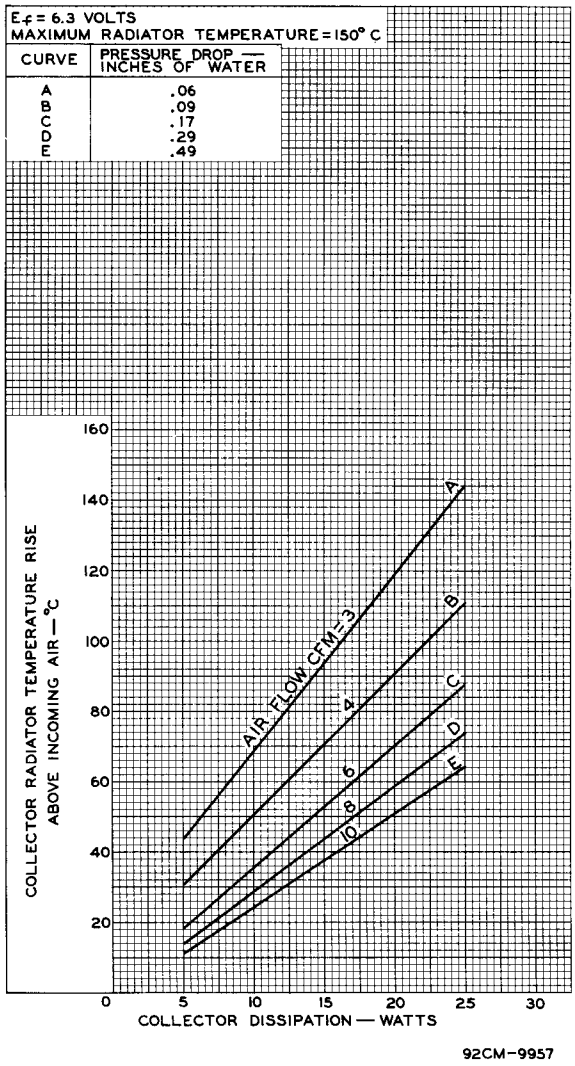


Fig. 1 - Cooling Requirements of Type 4010.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

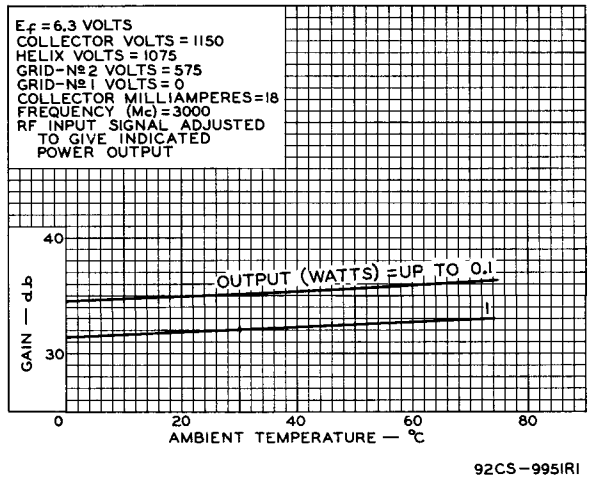


Fig. 2 - Typical Gain Characteristics of Type 4010.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

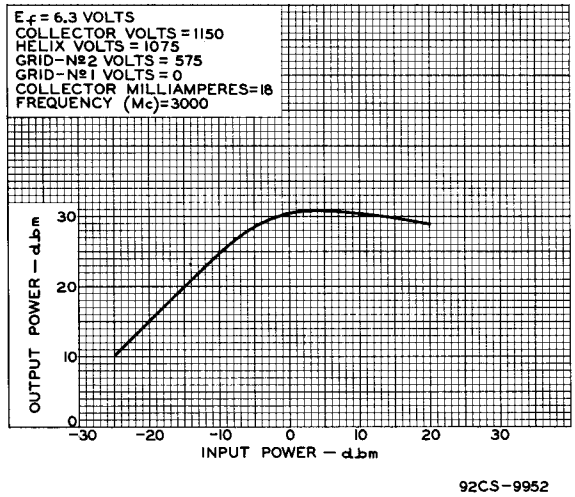


Fig. 3 - Typical Power Output Characteristic of Type 4010.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment-component variation, equipment-control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

The *rated values for collector voltage, helix voltage, and grid-No.2 voltage are high enough to be dangerous to the user.* Care should be taken during adjustment of circuits, especially when exposed circuit parts are at high dc potential.

The *power supply* for the 4010 should be capable of holding ripple voltage sufficiently low to prevent excessive phase or amplitude modulation of the output, and should have adequate regulation to prevent a change in operating conditions which might decrease the gain or power output. Typical values of ripple voltage on different elements which will produce amplitude modulation amounting to ±0.1 db in the tube output are shown below.

Tube Electrode	Typical Operating Volts DC	Typical Ripple Volts* Peak to Peak
Grid No.2	575	2.5
Helix	1075	1
Collector	1100	100

* For ±0.1 db amplitude modulation.

The power supply should incorporate a helix-current overload protective device to prevent damage to the tube in the event of loss of collector voltage. Such a condition would cause the entire electron beam current to flow to the helix and thereby overheat the electrode. If it is desired to remove all voltages by a single control, the time-constant values of the power supply should be so chosen that the helix voltage decays faster than the collector voltage.

The *magnetic field* required to focus the electron beam in the 4010 is supplied by integral periodic permanent magnets. Although the periodic magnet structure is difficult to demagnetize, and has small stray field, care should be taken to prevent the presence of any appreciable external transverse magnetic field which might cause defocusing of the electron beam within the tube. Tubes can be operated as close together as 3" center-to-center without magnetic interaction.

Mounting. The 4010 may be mounted in any position by means of bolts through the holes in the two mounting brackets.

Electrical connections are made to the 4010 by means of the seven color-coded flexible, insulated leads identified on the *Dimensional Outline.* RF Input and output connections require the use of coaxial plugs† which can be connected to 50-ohm coaxial cable and which fit the type TNC jacks on the tube (see *Dimensional Outline).*

Starting Procedure

For pulsed operation. Apply the rated heater voltage to the 4010 for 2.5 minutes to allow the cathode to reach normal operating temperature. Then apply a collector voltage of 1150 volts, helix voltage as specified on the tube label, and grid-No.1 bias voltage of −75 volts.

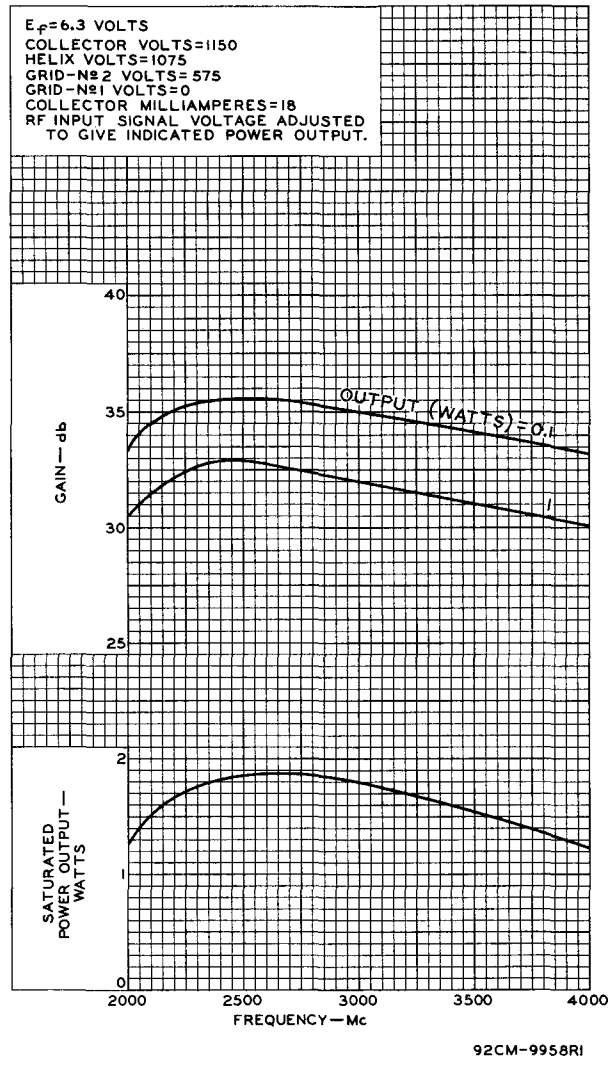


Fig.4 - Typical Characteristics of Type 4010.

Next, apply the value of dc grid-No.2 voltage specified on the tube label, and then the pulsed signal to grid No.1. Increase the amplitude of the signal until the peak collector-current value specified on the tube label is obtained. This current value corresponds to that obtained with an effective grid-No.1 voltage of 0 volts.

† Such as Catalog No. 166A, General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass., or equivalent.

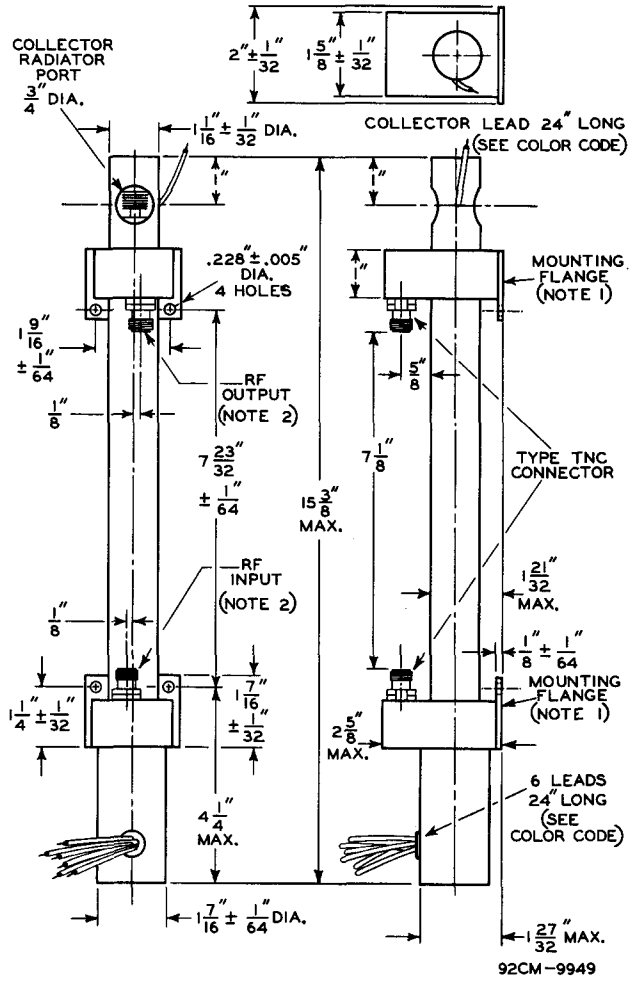
For cw operation. Apply the rated heater voltage to the 4010 for 2.5 minutes to allow the cathode to reach normal operating temperature. Then apply collector voltage of 1150 volts and helix voltage as shown on the tube label, in the order indicated. Next, with zero volts on grid No.1 apply a low value of grid-No.2 voltage. Then increase grid-No.2 voltage gradually until the value of collector current specified on the tube label is reached.

The value of helix voltage specified on the tube label is that necessary to provide broadband operation from 2000 to 4000 Mc. If it is desired to operate at a single frequency or on a narrow band, increased gain may sometimes be obtained by readjustment of the helix voltage.

Turn-Off Procedure

First reduce the collector current by removing the pulsed grid-No.1 signal (when pulsed operation is employed), and then remove grid-No.2 voltage, grid-No.1 bias voltage (when used), helix voltage, and collector voltage in the order indicated.

DIMENSIONAL OUTLINE



COLOR CODE

HEATER (2)	BROWN
COLLECTOR	RED
HELIX	ORANGE
GRID No.2	BLUE
GRID No.1	GREEN
CATHODE	YELLOW

NOTE 1: WITH TUBE MOUNTING FLANGES RESTING ON A SMOOTH, PLANE SURFACE, A 0.015" THICKNESS GAUGE 1/8" WIDE WILL NOT ENTER BETWEEN ANY POINT ON THE MOUNTING FLANGE AND THE PLANE SURFACE.

NOTE 2: THIS JACK REQUIRES COAXIAL PLUG SUCH AS CATALOG No.166A, GENERAL RF FITTINGS, INC., 702 BEACON STREET, BOSTON 15, MASS., OR EQUIVALENT.

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