



OPERATING INSTRUCTIONS

MEDIUM-POWER CW HELIX TRAVELING-WAVE TUBES

INTRODUCTION

These Operating Instructions provide basic information for installing and operating CPI MPP's family of medium-power helix vacuum electron devices (traditionally known as helix traveling-wave tubes, or TWTs). Supplementary information is given in the Test Performance Sheet, which is shipped with the product and contains characteristics and operating values for the individual unit. Inquiries for additional information should be made to:

**Manager, Marketing
Communications & Power Industries, Inc. (CPI)
MICROWAVE POWER PRODUCTS DIVISION
811 Hansen Way
Palo Alto, CA 94303
Telephone: (650) 846-3900**

For more detailed product operating procedures in specific equipment, consult the applicable equipment manuals and equipment performance standards. Additional information may be obtained from the equipment manufacturer. Some operational details specified by the equipment manufacturer may vary from those given herein.

WARNING

SERIOUS HAZARDS EXIST IN THE OPERATION OF MICROWAVE DEVICES. BEFORE ATTEMPTING ANY PRODUCT OPERATION, CAREFULLY READ AND UNDERSTAND THE "OPERATING HAZARDS" SECTION FOLLOWING THESE OPERATING INSTRUCTIONS, AS WELL AS THESE INSTALLATION AND OPERATING INSTRUCTIONS. A COPY OF "OPERATING HAZARDS" IS ALSO SHIPPED WITH EACH PRODUCT.

SPECIFIC HAZARDS

CPI as a component supplier can assume no responsibility for any damage or injury resulting from operation of CPI products. These devices must be used with equipment designed to protect personnel against all operating hazards. Installation and operating precautions should be observed, and ratings given in the Test Performance Sheet must not be exceeded.

High Voltage — *Normal operating voltages are deadly.* The equipment must be designed so the operator cannot come into contact with high voltages. High-voltage circuits and terminals must be enclosed, and interlocking switch circuits must be maintained so they open the primary circuits of the power

supply and discharge high-voltage capacitors when access is required.

RF Radiation — *Exposure to rf radiation generated by this device during operation may cause serious bodily injury, possibly resulting in blindness or death.* Cardiac pacemakers may be affected. Exposure of the human body to microwave radiation in excess of 10 milliwatts per square centimeter can be harmful. For this reason, rf energy must be contained by the waveguides and shielding. If voltages are to be applied when the device is not connected into a waveguide system, the rf input and output flanges should be closed tightly with shielded terminations.

These hazards are specifically described in the Operating Hazards section immediately following these operating instructions. Equipment using these devices must be designed to minimize risk to personnel from these hazards. Equipment manufacturers and users must develop and institute procedures suitable for the particular equipment and specific use to guard against all hazards not eliminated through equipment design.

HANDLING

The product is shipped in an approved package that will protect it from moderate handling abuse. If the outer container shows evidence of being dropped or is punctured, open the package and inspect the unit for damage. Inspect the product when it is removed from the container. If any obvious defects appear, a report should be sent to the factory at once. Any damage during shipment should be reported to the carrier. Handle the device with care during unpacking and installation.

PROTECTIVE MEASURES

These devices must be used in equipment that provides automatic protection as described below. In addition, installation and operating precautions must be observed, and ratings shown within the Test Performance Sheet must not be exceeded. Failure to comply fully with the foregoing may result in product failure, damage, or decreased operating life. Any product damage or failure resulting from noncompliance with these requirements or which, in CPI's opinion, could have been avoided by compliance with these requirements will void the CPI warranty.

Heater Voltage — The heater is connected to the cathode internally to make sure the heater and cathode operate at the same dc potential, thereby minimizing noise. Heater voltage is

to be applied between the brown and yellow leads only. For minimum heater modulation, a direct-current heater supply must be used. To ensure TWT reliability, the brown lead must be connected to the negative side of the heater supply; product life will be reduced greatly if the heater polarity is reversed. Heater surge current should not exceed approximately two and one-half times the steady-state value.

Helix (Body) Current — An overcurrent relay should be part of the power supply and should remove the helix voltage (sometimes referred to as beam or cathode voltage) if the helix (body) current exceeds the specified value. The relay trip level should be adjusted to 130 percent of the maximum current encountered in system operation or to a value just below the absolute maximum rating, whichever is lower.

Power-Supply Insulation — The mini-TWT body operates at ground potential; therefore, the heater supply must be insulated to withstand the full beam voltage.

Cathode Current Delay — Beam and collector voltages should never be applied to the device until the cathode has reached full operating temperature. The cathode is raised to operating temperature by applying heater voltage. A time-delay relay in the power supply should prevent the application of other voltages until 2 minutes after the heater is turned on.

Cooling — Conduction cooling is achieved through the base plate. The base plate must be tightly fastened to a heat sink whose maximum temperature does not exceed 95°C. The mounting surface of the heat sink must be machined smooth and flat to ensure maximum contact area with the TWT base plate. The heat transfer to the heat sink is improved by using a thin layer of high-conductivity grease, such as Wakefield Thermal Compound No. 120-8, or equivalent.

Thermal protection may be achieved by attaching a thermal switch to the area at the collector end of the device. The thermal switch should operate at a temperature of 95°C and turn off the beam voltage.

Focusing — Avoid strong external magnetic fields; they will defocus the electron beam, resulting in decreased output power and possible damage to the device.

VSWR — The TWT should be terminated in a 50-ohm load at all times. Voltage standing-wave ratio (VSWR) of the input source and output load must not exceed 4:1 throughout the operating frequency range. Low-pass reactive filters may be used to filter out the second harmonic without damage to the device, provided the rf drive frequency is always within the filter passband.

RF Leakage — External leakage should be prevented by making tight rf input and output connections. Under certain tuning conditions, regeneration or oscillation can occur if rf energy from the output line or radiation from the antenna reaches the input cavity because of faulty rf connections, leaky cable, or inadequate shielding. RF radiation is hazardous. See Operating Hazards section.

OPERATION

Preliminary Check — Check the following conditions before applying voltages to the device:

WARNING

DO NOT ATTEMPT TO OPERATE THIS DEVICE UNTIL IT HAS BEEN DETERMINED THAT ALL PRECAUTIONS HAVE BEEN TAKEN TO PROTECT PERSONNEL FROM ALL HAZARDS. PROTECTIVE DEVICES SUCH AS SHIELDS AND INTERLOCKING SWITCH CIRCUITS MUST BE IN OPERATION. REREAD AND COMPLY WITH ALL PRECAUTIONS AND PROCEDURES SPECIFIED IN THE "OPERATING HAZARDS" SECTION.

WARNING

RF RADIATION — THIS DEVICE IS DESIGNED TO PRODUCE HIGH-ENERGY RF RADIATION. EVEN LOW LEVELS OF RF RADIATION CAN BE HAZARDOUS TO HUMAN HEALTH. PRECAUTIONS MUST BE TAKEN TO PREVENT EXPOSURE OF PERSONNEL TO THE STRONG RF FIELDS GENERATED BY THIS DEVICE. RF RADIATION DUE TO LEAKAGE AT THE WAVEGUIDE FLANGE SHOULD BE PREVENTED BY MAKING TIGHT RF INLET AND OUTPUT CONNECTIONS. NEVER OPERATE THIS DEVICE WITHOUT HAVING AN APPROPRIATE ENERGY-ABSORBING LOAD ATTACHED. NEVER LOOK INTO AN OPEN WAVEGUIDE OR ANTENNA WHILE THIS DEVICE IS ENERGIZED.

1. Heater, cathode, grid, collector, and rf connections are made correctly, and TWT body is grounded. Some TWTs have a blue control anode lead; see Figures 1 and 2 for the typical lead-wire color code. Grid-supply polarity is as shown on the Test Performance Sheet.
2. All protective circuits are operational.
3. Device is secured to an adequately cooled heat sink.

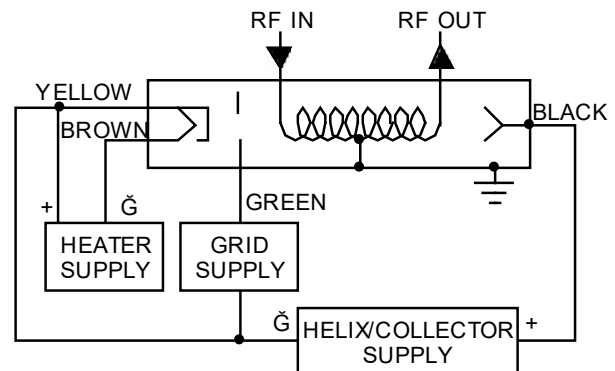


FIGURE 1. NONDEPRESSED COLLECTOR

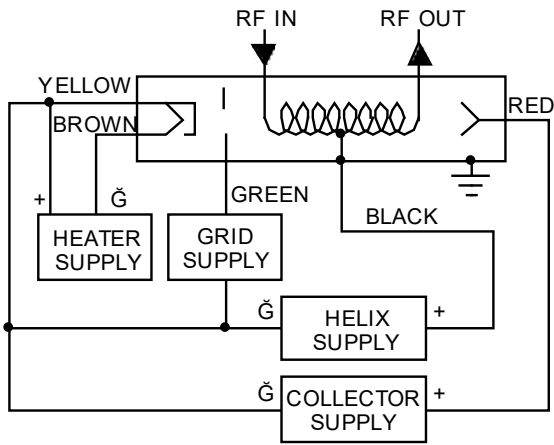


FIGURE 2. DEPRESSED COLLECTOR

Application of Voltages — Recommended operating voltages and currents are given on the product nameplate.

WARNING

HIGH VOLTAGE — VOLTAGES REQUIRED FOR OPERATION OF THIS DEVICE ARE EXTREMELY DANGEROUS TO LIFE; EQUIPMENT MUST BE DESIGNED WITH PROTECTIVE INTERLOCK CIRCUITS TO MAKE PHYSICAL CONTACT WITH THESE VOLTAGES IMPOSSIBLE. SEE "OPERATING HAZARDS" SECTION.

At least 90 percent of the electron beam current must reach the collector when beam voltage and collector voltage are applied. Referring to Figures 1 and 2, the collector is designed to dissipate the beam power. The intermediate elements, control electrode, and helix, cannot withstand high heat dissipation and can be destroyed if full beam current reaches either of them. Periodic-permanent-magnet focused TWTs focus correctly only at voltages near the normal operating voltage. Operating voltages can be applied safely as follows:

1. **Heater Voltage.** Allow 2 minutes for cathode warm-up after the application of heater voltage.
2. **Beam (Helix) Voltage.** The beam voltage (E_w) indicated on the product nameplate is selected for optimum overall rf performance. Beam voltage and collector voltage must be preset to the required nameplate values before they are applied to the TWT.
3. **Collector Voltage.** The collector voltage (E_k) is operated depressed or grounded as shown on the Test Performance Sheet and is measured relative to the cathode.
4. **Grid Voltage.** The grid voltage is measured relative to the cathode. Proper polarity is specified on the Test Performance Sheet.

Removal of Voltages — All voltages should be removed in the reverse order from the application of voltages.

RETURNED PRODUCT FORM

Before any product is returned for repair and/or adjustment, written authorization from CPI for the return and instructions as to how and where the product should be shipped must be obtained. The product type and serial numbers and a full description of the circumstances giving rise to the warranty claim should be included. Such information will help establish the cause of failure and expedite adjustment or repair. For this purpose, a Returned Product Form is shipped with each product.

TRANSPORTATION AND STORAGE

Use the original packing case for both transportation and storage of the product when it is not in service.

CAUTION

PRODUCT STORAGE SHELVES MUST BE MADE OF NONMAGNETIC MATERIALS.