INSTALLATION
&
OPERATION
MANUAL

CMPA (COMPACT MEDIUM POWER AMPLIFIER)

Model No.

VZC- 6964A4 - C-Band
VZC- 6964AA - Extended C-Band
VZC- 6964AD - Special C-Band
VZX- 6984A4 - X-Band
VZU- 6994A3 - Ku-Band
VZU- 6994AB - Extended Ku-Band
VZU- 6994AP - Special Ku-Band
VZU- 6994AC - Ku-Band

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PROPRIETARY INFORMATION

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SAFETY

In addition to the "High Voltage Equipment Personnel Operating Guidelines" and the "Microwave Radiation Personnel Operating Guidelines" given in this section, included by reference are the following pertinent sections of the International Standard IEC 215, "Safety requirements for radio transmitting equipment":

Appendix D, "GUIDANCE ON ASSESSING THE COMPETENCE OF PERSONNEL FOR DESIGNATION AS SKILLED", and also Sub-clause 3.1 of the Standard.

Appendix E, "GUIDANCE ON SAFETY PRECAUTIONS TO BE OBSERVED BY PERSONNEL WORKING ON RADIO TRANSMITTING EQUIPMENT", and also Sub-clauses 3.2, 3.7, and 22.1 of the Standard.

Symbols

Black lightening bolt in black triangle outline on yellow background.
Description: ***Caution, risk of Electrical Stock.***

Black exclamation point in black triangle outline on yellow background.
Description: ***Caution (Refer to accompanying documents).***

HIGH VOLTAGE EQUIPMENT PERSONNEL OPERATING GUIDELINES

INTRODUCTION

This guideline document presents operating practices for operators and technicians who work with high voltage equipment. In the context of this discussion any voltage that is lethal is viewed as "high voltage". Therefore, even prime power (115 to 440 VAC) is dangerous because prime power potentials have been known to cause death or injury.

Electrical circuits operate quickly and do not allow a careless individual a second chance. When dealing with high voltage, the results are very consistent and predictable and hazards associated with high voltage are always present. THE FACT THAT THE CONTROL SWITCH SAYS OFF DOES NOT MEAN YOU ARE SAFE. Many high voltage circuits are like loaded guns. IN GENERAL, YOU CANNOT SEE A HIGH VOLTAGE HAZARD. You can learn to recognize situations that present a threat and how to avoid them.

NOTE:

The guidelines presented in this guide are not academic. They are based on the experience of engineers and technicians who have years of experience with high voltage circuits.

WHEN IS VOLTAGE "HIGH"?

As stated earlier, any voltage that will kill you should be treated as "high voltage". Voltages associated with prime power generally do not jump the air gap between people and the equipment. Usually exposed circuit elements such as a terminal, bare piece of wire, or some non-insulated surface must be touched. One of the problems associated with prime power is some equipment can be "floating" above ground. In this case, if you place one hand on the equipment chassis and the other on earth ground you can be jolted, injured or killed. 440 VAC can stimulate an involuntary muscle response that will either literally throw you across a room or seize and hold you across the voltage terminals. 600 or more volts can hold you indefinitely. If the potential is sufficient to drive 200 milliamps through your body you will be held indefinitely. Some people consider the 200 to 600 volt range to be worse than potentials of thousands of volts.

GENERAL GUIDELINES

NOTE:

In addition to the above, the following practices have proven effective for personnel who deal with high voltage equipment.

a. **HANDS OFF.** Avoid contact with any potential source of high voltage. Keep hands out of the equipment when it is operating.

b. **AVOID ACCIDENTAL CONTACT.** Make sure that some other part of your body does not come in contact with the high voltage circuits. It is easy to forget the hazards when you are concentrating on a frustrating or interesting task. Pens and badges in shirt pockets could cause contact.

c. **NEVER WORK ON HIGH VOLTAGE CIRCUITS WHEN YOU ARE ALONE.** If anything should happen to you, your only chance may be prompt action by some other person. Be sure someone else is present and knows what to do in an emergency. (e.g.. how to shut equipment off, first aid, who to call, etc.)

d. **USE ONE HAND WHEN WORKING WITH HIGH VOLTAGE CIRCUITS.** Many people recommend that you put one hand in your pocket when you use a probe or other piece of equipment inside a high voltage section.

e. **DO NOT FLOAT MEASURING EQUIPMENT ABOVE GROUND.** Make all measurement with respect to ground. The odds are that if you float the instrument, you may forget and reach inside the equipment. Although it is harder to get the right test setup, it is well worth the effort.

f. **DO NOT ASSUME THAT THE LEVEL OF RISK IS A FUNCTION OF SIZE.** Some large high power voltage equipment looks docile. One reason the equipment is so big is to get the proper separation between high voltage points. On the other hand, just because the equipment is small is no assurance of safety. Dense packaging results in more difficult access and increases the chance that you will accidentally hit the wrong point.

g. **ALWAYS DISCHARGE HIGH VOLTAGE CAPACITORS.** High voltage capacitors store a lot of energy for long periods of time. High voltage capacitors also exhibit a "memory" in that they can recover after discharge and reach lethal levels. In addition to the "memory" problem, there have been instances where the built-in safety features have failed or been miswired. **Each and every time you go to work on a piece of high voltage equipment use a grounding rod with a long handle to discharge every high voltage capacitor.**

h. **DO NOT DEPEND ON THE AUTOMATIC FEATURES OF THE EQUIPMENT TO SAVE YOU.** You never know when someone has left a circuit disabled, or if there has been a wiring error, or if a component has failed.

i. **TAKE PERSONAL RESPONSIBILITY TO ASSURE THAT NO ONE CAN TURN ON THE HIGH VOLTAGE CIRCUITS WHEN YOU ARE WORKING ON THE EQUIPMENT.** Precautions would include taping down (or installing keeper) on controls/circuit breakers and/or disconnecting the power source to the high voltage circuits, activating interlocks that prevent high voltage turn on, etc. Know where the disconnects are and use them. Do not rely on anyone not to turn on the high voltage.

j. **SET UP YOUR TEST EQUIPMENT WITH THE POWER OFF.** Conduct the power-on operations when you have your hands out of the equipment.

k. **DO NOT USE SHORT PROBES FOR HIGH VOLTAGE MEASUREMENTS.** A short probe does not allow any margin for error. If your hand slips you could accidentally come into contact with a danger point. A long probe avoids the whole problem.

l **READ THE INSTRUCTION MANUAL.** The best insurance is foreknowledge of hazards.

m. **CREATE A FAVORABLE ENVIRONMENT FOR SAFE OPERATIONS.** This means that if people are crowding you, stop the operation if it involves high voltage. Pressure can lead to carelessness. In the same way, fatigue is also an enemy. *STAY ALERT AT ALL TIMES WHEN WORKING WITH HIGH VOLTAGE.*

n. **DO NOT BECOME OVER CONFIDENT.** Maintain a healthy respect for high voltage.

o. **A GOOD OPERATING PRACTICE IS TO CHECK THE POTENTIAL BETWEEN THE EQUIPMENT CHASSIS AND EARTH GROUND BEFORE YOU COMPLETE THE CIRCUIT WITH YOUR BODY.** As voltage levels increase, the protection you get from insulation and air gap diminishes. For example, in a piece of equipment that involves beam voltages of about 16 KV, the beam transformers look very safe with massive insulation on the outside of the coils. *Physical contact with the beam coil when the system is operating can be fatal.* Although the equipment is placard to warn people of the presence of high voltage, it is virtually impossible to placard every point of danger in a system.

p. **IF YOU DO NOT KNOW HOW THE EQUIPMENT WORKS AND WHAT THE HAZARDS ASSOCIATED WITH THE EQUIPMENT ARE IN SPECIFIC TERMS, DO NOT HANDLE THE EQUIPMENT.** The greatest protection you can have when dealing with high voltage equipment is specific, detailed knowledge on that particular piece of equipment.

q. **AVOID 'HAYWIRE' TEST SETUPS.** It is easy to get in trouble if the setup you are using has a jumble of wires.

r. **MAKE SURE YOUR CONNECTIONS ARE SECURE.** Do not allow leads to slip off and move about in an uncontrolled fashion. Even if it is not one of the high voltage leads, a free lead could (and generally does) move exactly to where you do not want it. The only safe connection is a mechanically secure one.

s. **WATCH OUT FOR UNTERMINATED HIGH VOLTAGE LEADS.** Some connectors depend on circuit loading to avoid arcing between closely spaced terminals. Unloaded high voltage lines or plugs can lead to arcing situations.

t. **SHUT OFF THE HIGH VOLTAGE WHEN YOU ARE MAKING LOW VOLTAGE MEASUREMENTS.** Its does not make any sense to increase danger needlessly. While there may be times when you cannot shut off the high voltage during a low voltage measurement this is generally not the case.

u. **REMOVE THE TEST EQUIPMENT WHEN YOU HAVE FINISHED A MEASUREMENT PROGRAM.** There have been many instruments destroyed or damaged because a test program was conducted in a haphazard manner rather than in an orderly progression from start to finish. Experience has shown many instances when a little order would have prevented a tragedy or avoided an expensive mistake.

v. **BE EXTREMELY WARY WHEN MAKING FILAMENT VOLTAGE MEASUREMENTS.** The cathode of tubes is elevated above (or below) ground and the filament voltages usually cannot be measured with reference to ground. Do everything you can to assure that the high voltage cannot be turned on when you are making your measurements. This includes disconnecting the high voltage drive source, shorting out appropriate leads, taping down switches and anything else you can think of to protect yourself.

w. **WHEN TROUBLE SHOOTING A UNIT ASSUME THAT THE SWITCHES AND COMPONENTS ARE DEFECTIVE.** You may shut off the high voltage switch in some systems, but if the switch is defective you would still have the high voltage on. Returned units are potential booby traps.

x. **MAKE SURE THAT YOUR WORK STATION IS STABLE.** Flimsy work surfaces or supports for the equipment or the test instruments represent a real threat. Do not use a setup that you know is unstable and/or dangerous.

y. **USE THE 30 SECOND RULE.** Wait 30 seconds after you have shut off the equipment before you work on a unit. Part of the reason for the 30 second rule is that some of the dielectrics (insulators) used for high voltage circuits can store a charge. While the amount of charge stored is a function of the size of the object, the 30 second rule provides an additional margin of safety.

z. **MAINTAIN A HEALTHY RESPECT FOR ANY KIND OF LIVE CIRCUITS. COMPLACENCY CAN HURT YOU OR KILL YOU.** Your continued wariness is your best insurance against injury or death.

MICROWAVE RADIATION PERSONNEL OPERATING GUIDELINES

INTRODUCTION

This guideline document presents operating practices appropriate for operators and technicians who work with equipment involving microwave radiation. Keep in mind that levels of microwave radiation that do not induce immediate physical discomfort in most individuals can be sufficiently high to induce longer term effects. CPI Satcom Division Equipment usually is related to amplification of an RF signal from an external source. Even if a source is not connected to the amplifier you are working with, there are situations where the amplifier can go into a self induced mode and generate high levels of RF energy. This condition can exist if the unit is operated with high voltage on and without proper termination on the input and output of the amplifier.

WARNING:

Protect yourself and those around you from unwanted RF exposure. Always terminate the amplifier input and output with an RF dummy load before you turn the high voltage on. This will reduce the chances of oscillation due to internal amplifier noise.

DISCUSSION

Limit exposure to microwave radiation to prevent unwanted biological effects. There are other effects that can lead to problems if you are careless in operating or servicing microwave equipment. The permissible levels are quite low in comparison to the power levels of the amplifiers built by CPI. (e.g. less than 10 milliwatts vs 20 to 10,000 watts delivered by different units). Local radiation levels can be detected with the proper equipment. The permissible levels are currently being studied by a number of organizations. In the past the U.S. Safety Codes established a dosage rate of 10 mw/cm. sq. Currently there is consideration being given to reducing the permissible level to 1 mw/cm. sq. in the United States as has been the case for several European countries.

GENERAL GUIDELINES

The purpose of these guidelines is to provide practical approaches to control unwanted microwave energy associated with the operation and servicing of CPI Satcom Division equipment. The following approaches are effective in both laboratory or field environments.

a. **ALWAYS TERMINATE THE OUTPUT WAVEGUIDE OR CONNECTOR WITH A DUMMY RF LOAD (CAPABLE OF DISSIPATING FULL CW RF POWER). SIMILARLY, TERMINATE THE INPUT TO AVOID THE POSSIBILITY OF THE AMPLIFIER BEING DRIVEN BY STRAY LEAKAGE SIGNALS.** Incorporate the terminations prior to applying prime power to the amplifier. This procedure prevents self oscillation and irradiation of the local environment.

b. **DO NOT LOOK INTO THE OUTPUT PORT OF THE POWERED RF AMPLIFIER.** Treat the powered amplifier as though it is a loaded gun. Your eyes are particularly vulnerable parts of your body.

c. **SHUT OFF THE UNIT IF YOU ARE TRYING TO LOCATE AN RF LEAK.** As noted earlier, the levels of concern are very low. Examine the physical unit with the high voltage off. If you have to survey the RF runs with the power on to find the leaky joint or component, start by testing the system with low RF input with a radiation meter. If the microwave radiation exceeds 0.5 mw/cm. sq. shut off the high power voltage and consult your supervisor. Work quickly (not at a panic pace) to minimize the dose level. The dose you get is directly proportional to the power level and the time you are exposed. Exposure to microwave radiation can induce both thermal and non-thermal biological effects, especially with the eyes. If you damage the lens of your eyes by exposure to microwave radiation, cataracts can result. Consider that small microwave ovens are very effective in cooking foods. If you follow these guidelines you can minimize exposure of yourself and other people in the operations that you control.

SECTION 1

INTRODUCTION

The new Compact Medium Power Amplifier (CMPA) series is designed for satellite communication earth stations, satellite news gathering vehicles, and fly-away applications operating in the C, X, and Ku frequency bands. RF power of up to 400 watts (for C- and X-band amplifiers) or up to 350 watts (for Ku-band amplifiers) is available in this series.

The Model numbers and frequency ranges of the CMPA series are as follows:

- **Model VZC-6964A4 C-Band 5.85–6.65 GHz**
- **Model VZC-6964AA Extended C-Band 5.85–7.075 GHz**
- **Model VZC-6964AD Special C-Band 5.715-5.765 GHz**
- **Model VZX-6984A4 X-Band 7.90–8.40 GHz**
- **Model VZU-6994A3 Ku-Band 14.0–14.50 GHz**
- **Model VZU-6994AB Extended Ku-Band 12.75-14.50 GHz**
- **Model VZU-6994AP Special Ku-Band 14.7 - 15.2 GHz**
- **Model VZU-6994AC Ku-Band 13.75–14.5 GHz**

The CMPA series has been specifically designed for enhanced performance and ease of operation. In addition, the CMPA incorporates the use of a microprocessor control system thereby simplifying interfacing with remote control and monitor facilities. Implementation of a compact, lightweight, wideband TWT (Traveling Wave Tube) permits continuous, efficient use across the entire frequency band.

Design of the CMPA is also based on the extensive use of LRUs (Line Replaceable Units). Comprehensive diagnostic procedures allow field personnel to quickly isolate a faulty LRU; extensive use of captive hardware on the LRU helps to speed the replacement of this LRU so that the CMPA can be returned to service with a minimum of downtime.

ABOUT THIS MANUAL

This manual contains information that describes installation, operation, and maintenance procedures for the Compact Medium Power Amplifier (CMPA) series. Because specialized training is required for some phases of installation and repair, certain parts of this manual are directed only to trained personnel. Warnings appear at the appropriate points to caution all users of potential RF or high-voltage hazards.

Each section begins with a clearly marked tab; this allows the reader to have rapid access to a particular section. A "Table of Contents", "List of Figures", and "List of Tables" are included at the beginning for reference to each section.

Section 1, "Introduction", contains a brief overall description and a detailed technical description of the CMPA. The design philosophy and a brief description of the optional features are also included in this section.

Section 2, "Unpacking and Installation", contains procedures for preparing the site for installation and unpacking the CMPA. It also describes the steps required to make the necessary power connections.

Section 3, "Interfaces", describes the CMPA's built-in interfaces to external devices; also listed are detailed descriptions for each connection. The communication protocol and command set used for computer control of the CMPA are also included in this section.

Section 4, "Initial Power On and Checkout", describes the TWT (Traveling Wave Tube) preconditioning procedures, use of the Front Panel to start up and check out the CMPA, and instructions for configuring the CMPA for the particular site installation; this includes setting serial port parameters.

Section 5, "Operation", contains procedures for normal start-up, shutdown, and detailed operational modes of the CMPA.

Section 6, "Maintenance", contains procedures for scheduled maintenance; also explained are fault and alarm conditions and their dedicated LEDs.

Section 7, "Drawings and Schematics", contains drawings of the various frequency band CMPAs. It also includes detailed RF schematics and an overall system interconnect drawing.

Section 8, "Supplementary Data", consists of five appendixes; contained are detailed specifications for the CMPA, a listing of control and display functions, and a summary of optional features that are available from CPI. Also contained are service and warranty information and a list of replaceable parts.

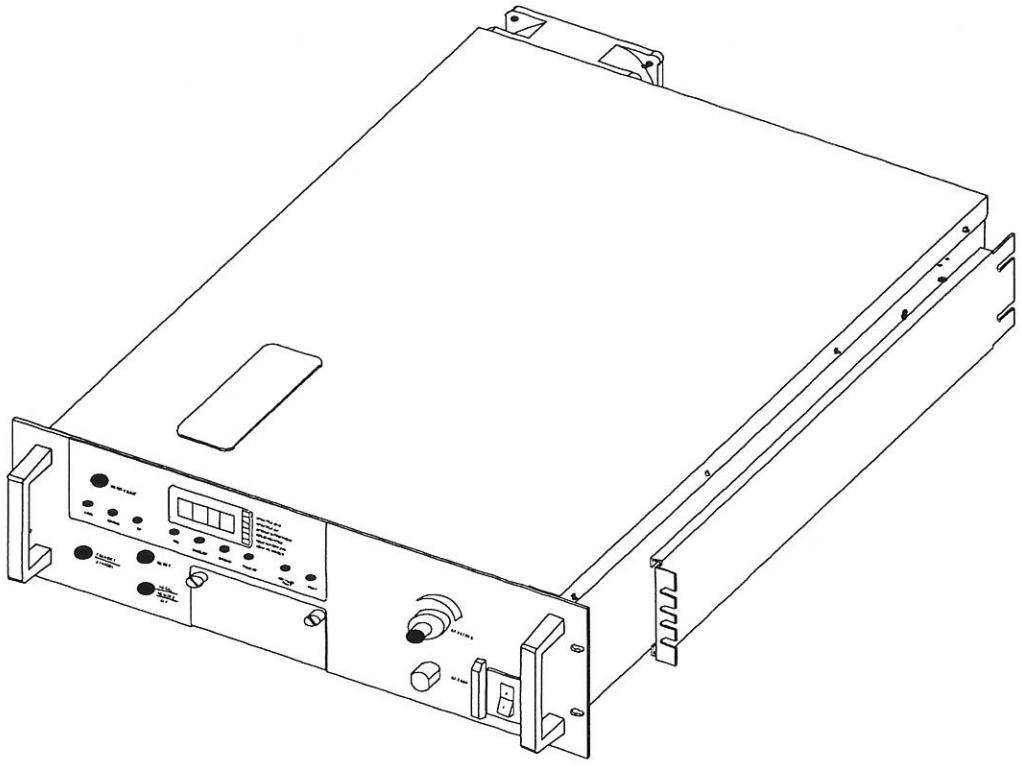
MAJOR SUBSYSTEMS AND THEIR FUNCTIONS

The CMPA (Figure 1-1) is packaged in a 5.25 inch tall slide-mounted drawer suitable for standard 19-inch rack mounting. This enclosed assembly houses both the RF and power supply sections. The overall amplifier enclosure measures approximately 19" (w) x 5.25" (h) x 24" (d), plus fan and external air duct adapters, and weighs approximately 65 lb.

The RF section includes the TWT (Traveling Wave Tube), SSIPA (Solid-State Intermediate Power Amplifier), input/output isolation circuits, input attenuator, RF detectors, and output filter.

The power supply section includes the power factor correction, power processor, and high-voltage regulation circuitry as well as monitor and control circuitry.

Microprocessor circuits provide automatic sequencing to control both CMPA operation and continuous monitoring of critical parameters; monitoring includes LEDs used as status and fault indicators.



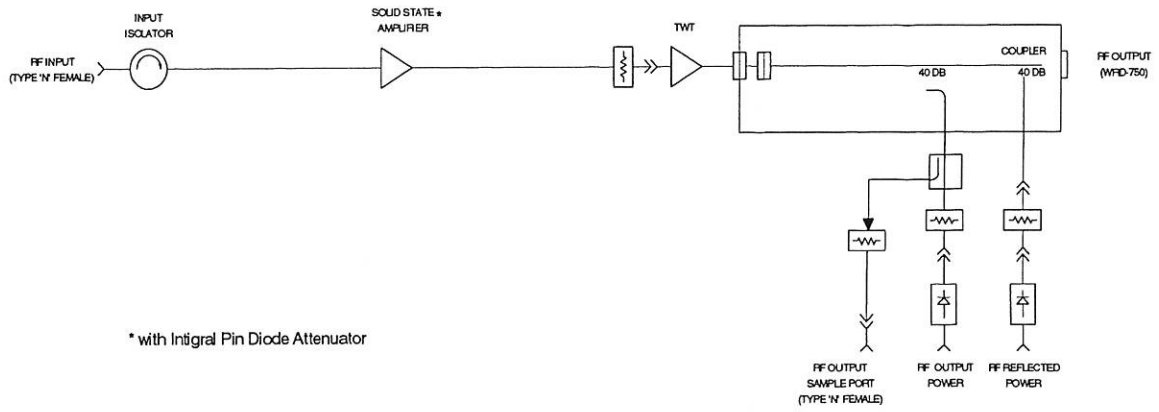
The CMPA

Figure 1-1

The front panel of the unit serves as the primary user interface housing all monitor and control functions including a type "N"
RF connector to sample and measure output RF power.

Protection circuits are included to permit safe, efficient, and reliable operation of the CMPA.

Detailed specifications for the CMPA are provided in Appendix A of Section 8, "Supplementary Data".



CMPA RF Diagram

Figure 1-2

TECHNICAL DESCRIPTION

RF Subsystem

A conservative field-proven approach is utilized in the CMPA RF subsystem. The RF block diagram (Figure 1-2) identifies all major circuit elements for this technical description.

A low-level RF input signal is applied to the CMPA via a type "N" connector (isolator) located at the rear of the enclosure. The isolator limits the input voltage standing wave ratio (VSWR) to a level of 1.3:1 or less back to the source. The RF input is then routed to the attenuator (manual or PIN diode). The attenuator, controlled via the front panel, has a control range of a nominal 25 dB with quick response and excellent linearity. If the PIN diode attenuation option is purchased, built-in memory circuits are provided to return the attenuator to a previously set level in the event prime power outages of up to one hour are experienced.

The output of the attenuator is connected to the input port of the SSIPA (Solid-State Intermediate Power Amplifier). The SSIPA is designed to be transparent to final amplifier RF parameters and is temperature compensated to minimize drift. As a result, the overall TWT CMPA gain is specified to be stable within ± 0.25 dB/24 hours with 10 percent line voltage variations. The output of the SSIPA is connected to an isolator that protects the SSIPA from TWT failure. The SSIPA and TWT provide a combined subsystem gain of at least 75 dB at maximum rated power for C and X-bands and 73 dB for the Ku-band.

The primary TWTs employed in this power amplifier are the CPI VTC-6265M1, VTX-6385M1, and VTU-6395M1 TWTs featuring compact conduction cooling, dual depressed collectors for efficient operation, and Periodic Permanent Magnet (PPM) focused helix design. They are designed especially for compact, lightweight applications involving satellite uplink service.

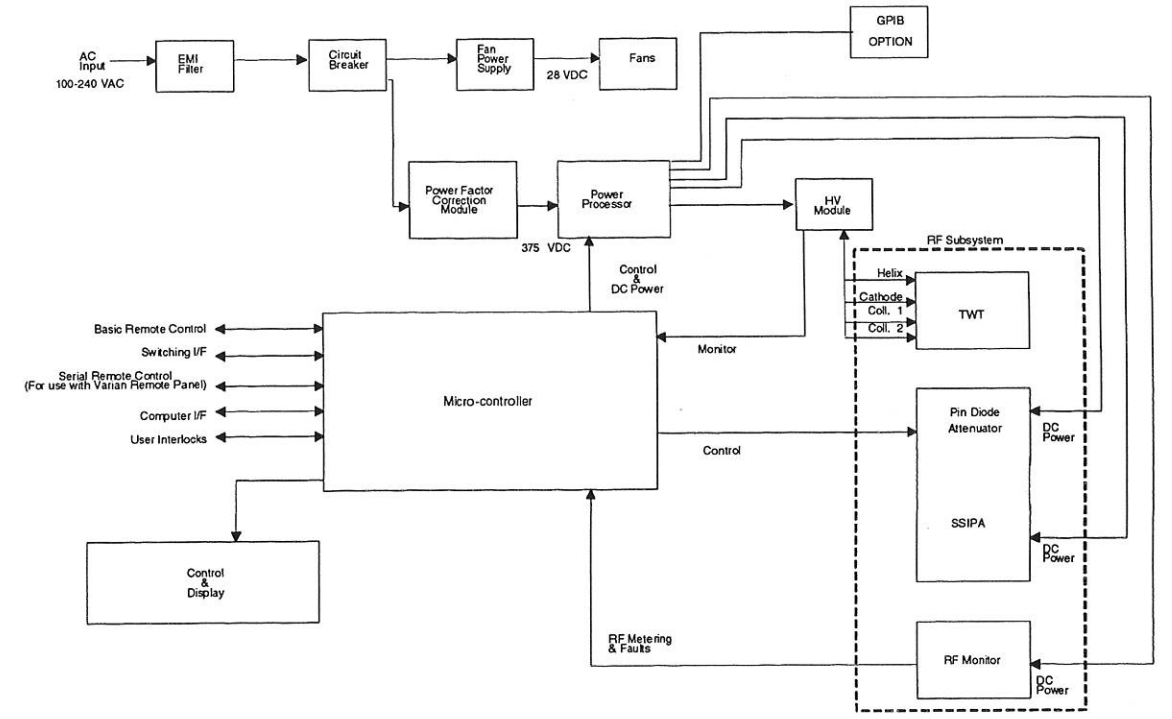
The output waveguide assembly interfaces to the TWT and protects the tube from abnormal or transient conditions that could permanently damage the TWT. This assembly consists of an isolator, harmonic filter, receive reject filter, and three-port directional coupler (see below). The high power isolator provides a low VSWR to the external waveguide run and antenna feed. The isolator assists in protecting the TWT from excessive reflected power due to damaged/broken waveguides or antenna components. The isolator is rated such that it will safely dissipate all reflected power equal to the full rated output of the CMPA for the duration of time until the protection circuits shut off the high-voltage power supplies. In addition, the isolator is designed such that it can safely dissipate a VSWR mismatch of 2.0:1 (12 percent of forward RF power) indefinitely.

The harmonic filter contained in the output waveguide assembly (C-band and Ku-band only) provides a minimum of 60 dB attenuation to all harmonic products other than the fundamental signal. The receive reject filter (Ku-band only) serves as a high pass filter cutting off below band signals. Finally, the three-port directional coupler provides one reflected power port coupled via a detector to the RF power monitor assembly for reverse power protection, and two for forward power, one for the user to monitor forward RF power via a type "N" connector on the front panel and one for use by the optional forward power metering circuit which uses a similar detector to process the RF signal. The RF sample port, calibrated in coupling ratio versus frequency, permits independent monitoring of CMPA output power levels through the use of an external spectrum analyzer or portable power meter. High reflected RF protection circuitry is standard and reflected power information is sent to the front panel for display. With the forward power metering option comes user settable low and high RF power alarms settable via the front panel access door.

The output and reflected power level readouts are also available for remote monitoring via the optional CPI remote control panel or via the computer interface (CIF) port located at the rear of the enclosure. Should the PIN Diode attenuation option be purchased, RF drive is adjustable via the Serial Remote, Discrete Remote, or CIF port. Also, the RF sample port, calibrated in coupling ratio versus frequency, permits independent monitoring of CMPA output power levels through the use of an external spectrum analyzer or portable power meter. The standard RF output interface, provided by the user, to connect the CMPA to the external waveguide run is a CPR-137F (flange) termination for C-band, CPR-112F for X-band and WR-75F for Ku-band.

Power Supply Subsystem

The power supply portion of the CMPA provides all of the internal voltages necessary to operate the TWT, RF driver (SSIPA), the forced air cooling system, and auxiliary circuits for control, monitoring, and protection of the CMPA. Other than the AC input power, no other external power supplies or voltages are required for operation. A simplified block diagram of the power supply is shown in Figure 1-3.



Power Supply Block Diagram

Figure 1-3

The traveling wave tube derives its operation from four DC power supplies: a low-voltage filament (heater) supply, a high-voltage helix supply, and two high-voltage collector supplies. The power supply design utilized in the CMPA is of the SMPC (Switch Mode Power Conditioner) type which has an excellent reputation for reliability and stability. An added advantage of the SMPC approach over outdated linear power supplies is its intrinsic high efficiency and safe operation. By limiting the amount of the instantaneous stored energy in the power supply, the risk of permanent damage to the CMPA due to abnormal or transient conditions is avoided. The momentary level of stored energy (measured in joules) is well below the maximum limit of energy that the tube can safely dissipate during normal operation. The principal circuit modules are discussed in the following paragraphs.

Power Factor Correction Module

Input primary power--single phase, 110 - 240 VAC, 47-63 Hz--flows via an EMI filter and the main circuit breaker to both the cooling system power supply and the Power Factor Correction Module. This module provides a regulated 375 VDC to the power Processor and allows the CMPA to meet the requirements of IEC-555 regarding total harmonic distortion.

Power Processor Module

The power processor circuits provide the necessary line and load regulation of the input 375 VDC bus which is converted via the switch regulator and bridge circuit to a nominal 200 VAC, 21 kHz to drive the high-voltage module. A sample of the helix high-voltage output is returned to the switch regulator for error feedback correction and sends a pulse-width modulated signal through an optical isolator to the switching transistors. This approach allows careful regulation of the TWT helix and collector voltages and protects both supplies from overvoltage/ undervoltage or short circuit conditions. Low voltage outputs produced by the power processor (+/- 15 VDC and 16 VAC) are used to operate various internal circuit functions as well as provide power for the RF monitor circuit, front panel display, and SSIPA. Internal sensors provide the necessary overcurrent protection functions.

High-Voltage Module

The high-voltage module provides the following key power supply functions: regulated TWT heater supply, regulated TWT high-voltage helix and collector supplies, helix supply current/voltage monitoring, and fault protection. The high-voltage module contains the transformers, rectifiers, filters, and voltage/current sense circuits for all critical TWT voltages and currents. The incoming 200 VAC, 21 kHz signal is applied to the primary of a multi-section high-voltage transformer which provides all of the high-voltage levels necessary to operate the traveling wave tube. Since the helix and collectors share the same transformer and regulator, the high-voltage circuit design establishes the collector voltages at 50 percent (collector #1) and 32 percent (collector #2) depression below the helix voltage. This relationship permits optimum efficiency and substantial energy savings while extending the useful life of the TWT. A separate step-down transformer with rectifier and filter network is employed to provide the regulated low voltage to power the TWT heater.

RF Power Monitor Module

The RF power monitor assembly receives signals from the reflected and forward power RF detectors for use in fault/alarm sensing and power metering. This monitor assembly feeds voltages to the microprocessor controller; it is the controller that monitors the RF levels to determine RF high/low faults or high/low alarms. This assembly also contains software for peak measurements.

The reflected RF fault sensor protects the TWT against excessive reflected power due to abnormal waveguide or antenna conditions.

If the metering option is purchased, the forward power low RF alarm circuit is included, which compares the output power with a low RF set point (set by the user) and triggers an alarm should output power fall below this level. Also, if this option is purchased, this circuit provides the necessary input to the display circuit to route these readings to the CMPA Front Panel.

CONTROL AND DISPLAY MODULES

The Control and Display modules are designed to assure correct operation of the power amplifier with minimal operator training. These microprocessor-based modules provide automatic sequencing of CMPA operation and monitoring and control of all critical parameters via both the front and rear panel interfaces.

The Display Module communicates to the user all necessary information required to monitor and control the amplifier. Measured readings such as reflected RF power, helix voltage, helix current, attenuator setting (w/ optional PIN attenuator) and forward RF power (w/optional forward power metering) can all be displayed using the Meter Select Button. Status LEDs are also included on the panel and communicate to the user the current control point (Local, Remote, or CIF--Computer Interface Port), and the amplifier state (HTD (Heater Time Delay), Transmit, Standby, or Fault). Detail fault information and user settable interface parameters are available to the user by accessing the detail LEDs and DIP switches via the front panel access door. By examining the detail LEDs behind this door, the user can ascertain the exact fault or alarm that has occurred. Also, through manipulation of the DIP switches and up/down buttons, the user is able to set all remaining system parameters such as trip points and serial port communication parameters.

The Control Module is central to the CMPA. All control, input/output, and decision making, with the exception of critical module level decisions, is done by the Control Module. All rear panel user interfaces are also communicated to via the Control Module. To survive AC power loss, all user settings and operating parameters such as RF trips, TWT operating voltages, serial port baud rate, and PIN diode attenuation setting, etc. are stored in the battery backed random access memory (RAM).

LRU Philosophy

The maintenance concept employed in the CMPA series is to localize a malfunction or circuit failure down to the level of an LRU (Line Replaceable Unit), extract the LRU, and replace it with an equivalent part provided in the spares kit. This procedure can be completed in the field without resorting to the costly practice of returning the entire CMPA to the depot for servicing. The philosophy is to configure the LRUs as building blocks with a specific function that can be monitored by sensors and fault indicators on a real-time basis.

The CMPA contains circuitry to protect itself from operational damage caused by abnormal AC, DC, RF faults, or insufficient cooling.

Personnel safety is of utmost importance and is safeguarded by proper grounding and also by access interlocks and covers that prevent physical entry into the high-voltage sections.

Optional Features

To customize and enhance the functioning of the CMPA, CPI provides a range of options. These include the following:

- A separate Remote Control panel with identical functions and configuration as the one supplied with the CMPA.
- Redundant and Power Combined Subsystems. The TWT Amplifier can be configured in a 1:1, 1:2, or 1:3 auto switching or power combined configuration as required by the end user.

SECTION 2

UNPACKING AND INSTALLATION

This section contains instructions for site preparation, unpacking, and installation of the Compact Medium Power Amplifier (CMPA). Instructions for the optional CMPA Remote Control and Switching/Power Combined subsystems are supplied separately with those items. The CMPA's built-in interface connections for optional equipment are described in Section 3, "Interfaces", of this manual.

PRE-INSPECTION

Inspect the exterior of each for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the equipment and submit a damage report. Failure to do so could invalidate future claims.

UNPACKING

Carefully unpack and remove all items (inspect the interior of the container for damage). Save all packing material until all inspections are complete. It is recommended that all packing material be saved for potential future use. Verify that all items listed on the packing slips have been received.

Inspect all items for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the equipment and file a claim. Failure to do so could invalidate future claims. Check the unit thoroughly for damaged or loose parts. To remove the top cover of the unit, remove the screws around the sides of the cover and lift the cover off. After visual inspection is complete, reinstall the cover and carefully tighten all screws.

PREPARING FOR INSTALLATION

It is recommended that an electrical inspection for verification of customer interface connections be performed before and after the installation of the equipment in its final operational location; the following basic steps must be completed:

1. Verify proper CMPA RF input and output terminations. (See Warning.)
2. Verify that all CMPA user interface connectors to be used match pin-out data in Section 3, "Interfaces."
3. Verify proper prime power connection to the CMPA. See Appendix A in Section 8 for AC voltage specifications.

ATTENTION

WARNING:

Operating the Compact Medium Power Amplifier (CMPA) without proper termination or under excessive load voltage standing wave ratio (VSWR) could cause destruction of the traveling wave tube (TWT) and will void the warranty. (See specification in Appendix A in Section 8.)

Installation

Installation of the CMPA includes four phases:

- **Mechanical installation**
- **Electrical connections**
- **RF connections**
- **Cooling considerations**

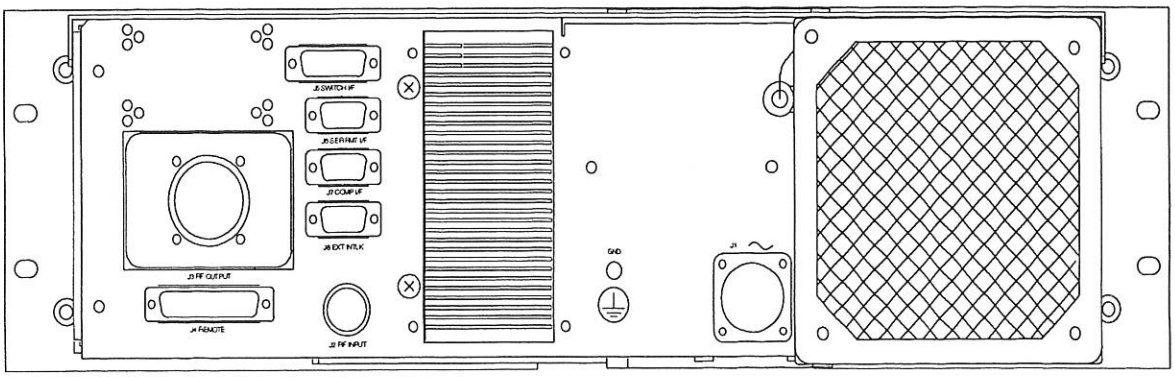
MECHANICAL INSTALLATION

The CMPA is designed for rack slide mounting in a standard 19-inch (48.3 cm) wide rack cabinet. Use the following procedure for this installation:

1. Determine the required front panel arrangement and exact panel locations for the CMPA on the rack cabinet.
2. Mount the mating slides (supplied) to the rack cabinet using the supplied hardware.
3. Install the CMPA on the mating slides and securely fasten the front panel to the rack cabinet rails.
4. Once the unit is installed on the slides and fastened to the cabinet, the balance of the installation procedures can be completed.

ELECTRICAL CONNECTIONS

The locations of the connectors referred to in this section are shown in Figure 2-1. Electrical interconnections to the system consist of prime power, ground strap, and external connections including computer interface (CIF), remote control, switch interface, and user interlocks, if applicable.



Rear Panel of CMPA

Figure 2-1

Prime Power

The prime power requirement for the equipment is nominal 110 - 240 (C, X, and Ku-bands) VAC, 47-63 Hz, single-phase. The wiring used for applying prime power to the system should be sized in accordance with National Electrical Code considering the total input power required. (See Specifications in Appendix A in Section 8.)

Prime power is applied to connector J1 located on the rear panel of the CMPA via the connector provided. The wiring used should be HAR type. The pins of the prime power connector should be wired as follows:

Pin A—line
Pin B—neutral
Pin C—ground

ATTENTION

WARNING:

AC prime power must be removed via an external circuit breaker before disconnecting or connecting the prime power connector on the CMPA. Do not apply power to the CMPA until completion of the installation.

Grounding

ATTENTION

WARNING:

Proper grounding of the CMPA amplifier to the station ground bus or to earth ground is necessary for personnel and equipment safety. The ground screw on the CMPA rear panel must be used for this purpose.

I/O Interfaces

I/O interface connections are made at the rear panel of the CMPA via J4-J8, which are all standard D-shell connectors. All of the D-shell connectors on the rear panel of the CMPA are female or "socket", meaning that interface cables constructed by the user must utilize male or "pin" gender D-shell connectors. Additionally, they are equipped with bale-lock hardware to ease integration. Standard prudent connection procedures should be adhered to when making these connections. (Refer to Section 3, "Interfaces", for pin-out information.)

- Discrete Remote Control (J4) 25 pin
- Switch Port (J5) 15 pin
- Serial Remote Control (J6) 9 pin
- Computer I/F (J7) 9 pin
- User Interlock (J8) 9 pin

NOTE

Connectors J5 and J8 are shipped with jumper interlock connectors attached. These jumpers are explained in Section 3; do not remove them until you have read this section.

RF Connections

The following two RF connections are made at the rear of the CMPA:

- **RF Input (J2)**–Type "N" Female provided. User needs Type "N" Male on interface connection.
- **RF Output (J3)**–Either a CPR-137 (C-band), CPR-112 (X-band), or WR-75 (Ku-band) waveguide flange. See details below.

The following (optional) RF connection is made on the front panel of the CMPA:

- **RF Output (sample) Monitor**—Type "N" Female provided. User needs type "N" male on interface connection.

RF Output (Waveguide Connection) (J3)

The output waveguide flange of the CMPA is located on the rear panel of the CMPA. The standard RF Output interface, provided by the user, to connect the CMPA to the external waveguide run is a flange termination. Use the following waveguide flange depending on the CMPA band:

- **CPR-137 for C-band**
- **CPR-112 for X-band**
- **WR-75 for Ku-band**

The CMPA comes equipped with a grooved, threaded rear connector. An O-ring gasket is supplied in the ship kit.

To install the waveguide flange, proceed as follows:

1. Install the O-ring gasket (supplied) in the output flange of the CMPA.
2. Position the interconnecting waveguide so that it aligns precisely with the waveguide flange at the rear of the CMPA.
3. If alignment is not precise, or if the installation is subject to motion or severe vibration, a flexible waveguide section should be installed between the output of the CMPA and the interconnecting waveguide.
4. After alignment is verified in all three planes, loosely attach the interconnecting waveguide to the output waveguide flange of the CMPA. Start all bolts and verify proper alignment before uniformly tightening the bolts.
5. Carefully tighten all bolts (in opposite pairs rather than sequentially around the perimeter of the flange) so that the connection is firm. Do not over-tighten because this can strip the threads or distort the mating flange. Recommended torque is 30 in-lbs for #10-32 (C-band), 20 in-lbs for #8-32 (X-band) and 10 in-lbs for #6-32 (Ku-band).

COOLING CONSIDERATIONS

The CMPA is forced-air cooled. The exhaust air from the CMPA may be at a relatively high temperature (approximately 35°C above ambient temperature) and heat dissipation may be as high as 1200 watts. To prevent excessive heat buildup in the rack cabinet, it is recommended that the exhaust air be ducted away from the CMPA; an air duct is provided for this purpose.

The external ducting must have a cross-sectional area at least equal to that of the exhaust opening. Minimum airflow required for proper cooling of the CMPA is 90 CFM at sea level. To meet this airflow requirement, external back pressure must be limited to 0.10 inch of water column (0.25 cm). Exhaust duct bends and transitions must be smooth and bend radii should be as large as possible to promote proper cooling.

Generally speaking, a 0.10 inch H_20 pressure drop in a 5 inch diameter flex type hose corresponds to approximately 10 ft in length. It is therefore recommended that for longer duct runs, a transition be made to perhaps 8 inch duct as near the CMPA exhaust as possible; 8 inch plumbing will significantly reduce pressure drop and permit much longer duct runs. Use of 4 inch diameter ducting should be strictly avoided.

It is, highly recommended that a heating, ventilation and air-conditioning (HVAC) engineer be consulted before ducting is installed as insufficient cooling will significantly impact TWT (Traveling Wave Tube) longevity.

SECTION 3

INTERFACES

Each CMPA is provided with interfaces that can be used to connect it with several optional external devices. All remote and computer interface cables must be foil or braid-foil shielded to meet EMC/EMI standards. The shields must be connected 360^0 to metallic D-sub connectors. Pig-tail wiring must not be used. These interfaces are listed below:

- **Discrete Remote interface**— This opto-isolated remote offers essential CMPA control and monitoring via individual signals per CMPA command or status.
- **Serial Remote interface**— This interface allows remote control via RS-422/485 (4-wire multi-drop) serial communication.
- **RF switch system interface**— This interface enables switch system controllers, such as 1:1 or 1:*n*, and combiner system controllers to interface with the CMPA.
- **External interlocks interface**— These interlocks enable the user to interlock the CMPA with external safety devices.
- **Computer interface**— This interface enables the user's computer equipment to control the CMPA via RS-422/485 or RS-232 serial communication. Users must write all necessary software for their computers.

Interface connectors for these devices are located at the rear panel of the CMPA, and are described in the sections that follow.

CMPA CONTROL MODE HIERARCHY

The Compact Medium Power Amplifier (CMPA) may be controlled from six points: RF Switch Port, Interlock Interface, Local, Serial Remote, Discrete Remote, and Computer Interface (CIF). The RF switch port and interlock interface connect to switching systems and user-defined interlocks. The RF switch port and interlock interface have the highest level of control. They are active at all times; all commands that are issued by the user through these ports must be acknowledged and acted upon if the CMPA may physically do so.

The Local, Remote, and Computer modes are the main user interface modes; only one remote port, either discrete or serial, may be assigned via a DIP switch to the Remote mode.

- All control points will always provide status.
- Front panel push-button labeled LOC/REMOTE/CIF will toggle between all control points. The front panel is the "super-user" and may transfer the control point at any time.
- If the control point is transferred from the front panel (LOCAL) to the remote panel (REMOTE) or the CIF, the remote panel may transfer control between itself and CIF.
- No control transfer may be commanded via the CIF port or Discrete Remote.

DISCRETE REMOTE INTERFACE

The Discrete Remote interface is typically used by those who desire to operate the unit remotely using switches for command and LEDs for status. It is recommended, however, that when possible users should use the serial remote port or CIF port as they are better suited to longer cable runs, integration with a computer, use with a CPI remote control unit, and more consistent with the direction CPI is taking in providing uplink amplifiers for the future.

The Discrete Remote interface is located at connector J4 on the rear panel of the CMPA. J4 is a 25-pin type "D" connector with pin assignments as shown in Table 3-1. All control and status signals are opto-isolated. Refer to Figure 3-1 for a schematic of Discrete Remote interface command/status pins.

TABLE 3-1
Discrete Remote Interface Pin Assignment (J4)

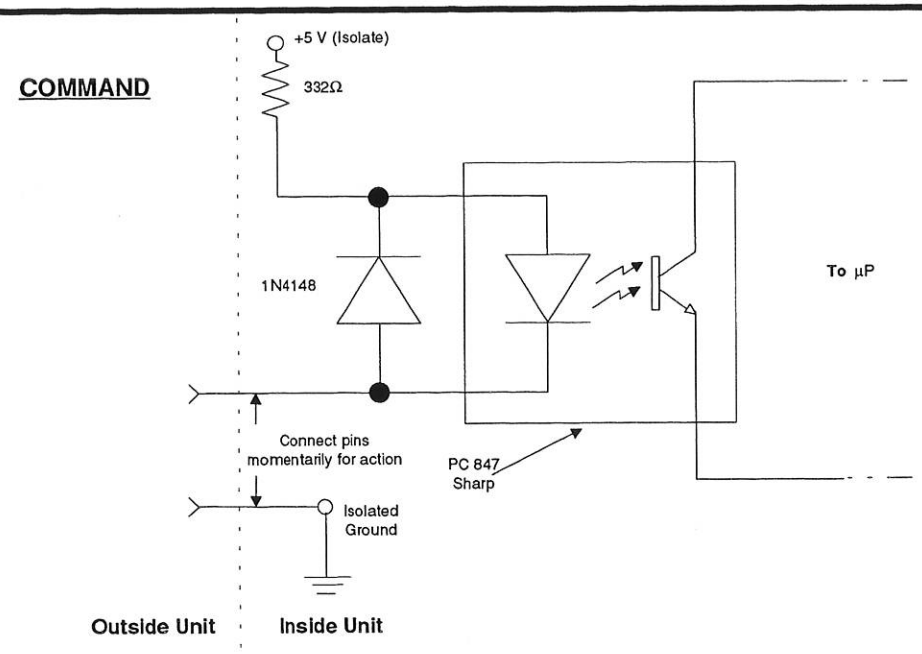
Pin #	Signal Name	Remarks
1	HTD Status	Low=HTD Status
2	Standby Status	Low=Standby Status
3	Recycled Fault Status	Low=Recycled Fault Status
4	Loc/Rem/CIF Status0	Low=Loc/Rem/CIF Status(see note 4)
5	Loc/Rem/CIF Status1	Low=Loc/Rem/CIF Status(see note 4)
6	Transmit Command	Connect to Command Common for action
7	Reset Command	Connect to Command Common for action
8	RF Down Command	Connect to Command Common (see note 5) for action
9-13		Not used
14	TX Select Status	Low=TX Select Status
15	Transmit Status	Low=Transmit Status
16	Fault Status	Low=Fault Status
17	Prime Power On Status	Low=Prime Power On Status
18	Status Common	Common for status lines
19	Standby Command	Connect to Command Common for action
20	RF Up Command	Connect to Command Common(see note 5) for action
21	Command	Common

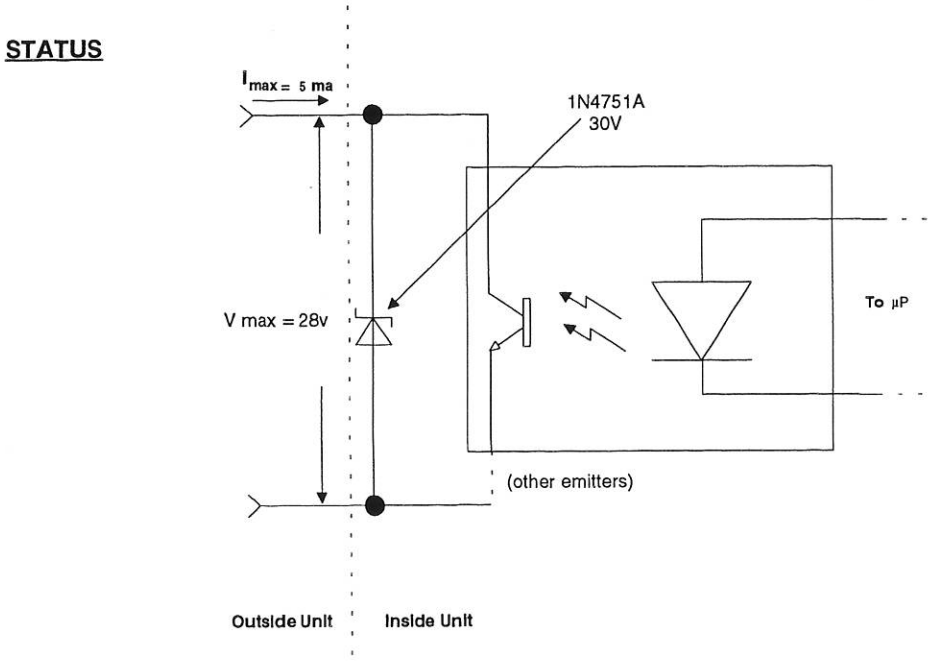
TABLE 3-1 NOTES:

1. Commands are executed by shorting the desired signal command pin to the command common pin (21). See figure 3-1.
2. Status is indicated on opto-isolated open collectors. All status emitters are tied to status common. See figure 3- 1.
3. Maximum pull-up voltage recommended on status lines is 28 V; these lines are zener clamped to status common at 30 V (nominal). Maximum current on status lines is 5 mA. See figure 3- 1.
4. Combinations of Loc/Rem/CIF Status are shown in Table 3-1A.

TABLE 3-1A
Loc/Rem/CIF Status

Signal	Local	Remote	CIF
Loc/Rem/CIF Status0	Low	High	Low
Loc/Rem/CIF Status1	High	Low	Low





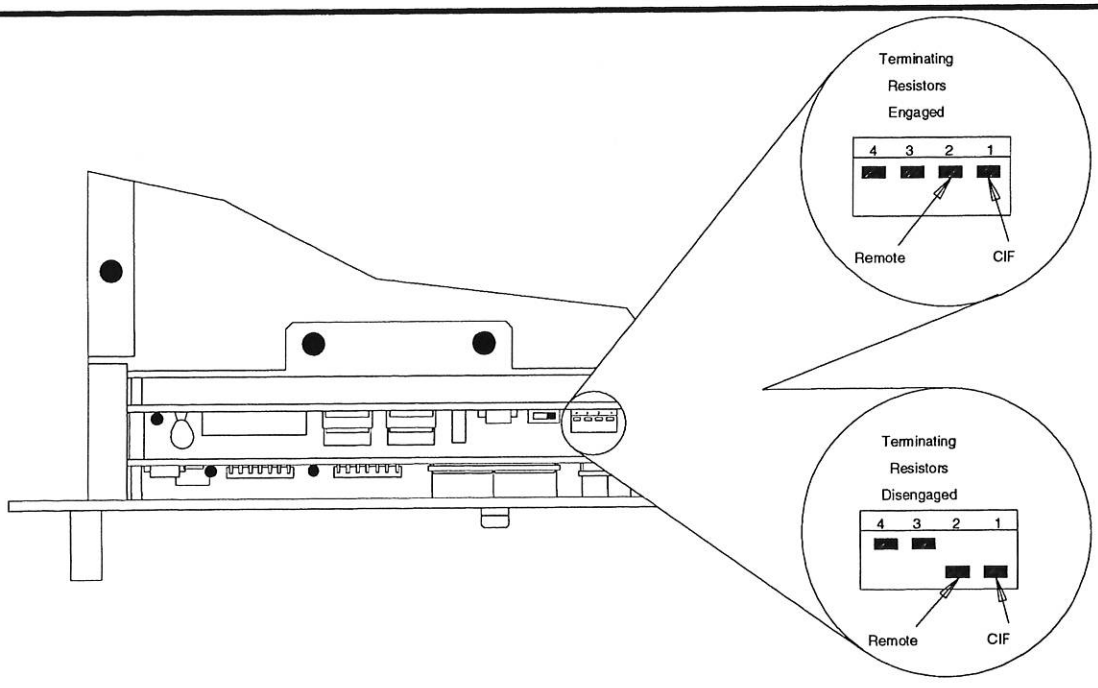
Typical Schematic of Discrete Remote Interface Command/Status Pins

Figure 3-1

SERIAL REMOTE INTERFACE

The CMPA Serial Remote interface is typically used to support serial communications with a remote control unit, such as the CPI CMPA Remote unit. This port does support multi-drop RS-422/485 (4-wire) serial communications; even at high baud rates (such as 9600 baud) this port will support communications over a 4000-ft (1200 m) serial cable. The Serial Remote interface uses a protocol and command set very similar to the Computer Interface(CIF) port .

The CMPA Serial Remote interface is located at connector J6 on the rear panel of the CMPA. It is a 9-pin D-type connector, with pin assignments as shown in Table 3-2. The serial port parameters are set up using DIP switches on the front panel; an internal DIP switch is used to control the RX terminating resistor. The CMPA comes from the factory with the termination resistor engaged. To disengage, ensure that prime power is not being applied to the CMPA; then remove the top cover of the unit and move switch 2 on the internal DIP switch bank to the forward position (OPEN). See Figure 3-2. If this port is used for multi-drop applications, disengage the terminating resistor on all but the last CMPA on any serial cable. Refer to Section 4, "Initial Power-On and Checkout", for detailed procedures regarding serial port setup.



Setting Termination Resistors

Figure 3-2

TABLE 3-2
Serial Remote Interface Pin Assignment (J6)

Pin #	Signal Name	Remarks
1	Shield Ground	
2		Not used
3	Send Data (-)	Data sent out of CMPA (RS-422/485)
4	Receive Data (-)	Data received by CMPA (RS-422/485)
5	Signal Ground	
6	Receive Data (+)	Data received by CMPA (RS-422/485)
7		Not used
8		Not used
9	Send Data (+)	Data sent out of CMPA (RS-422/485)

TABLE 3-2 NOTE:

The Serial Remote interface uses a protocol and command set very similar to the Computer Interface port. Refer to that portion of this section for programming reference. Additionally, the Serial Remote port includes the following command:

ASCII	Decimal	Command Byte	Definition
	\	92	**Set Control Mode**—If the CMPA is in either Remote or CIF mode and the Serial Remote port is the valid Remote port (as opposed to the Discrete Remote port), the Serial Remote port may shift control between Remote and CIF. To specify Remote, follow the command with the letter R (ASCII 52hex 82dec); to specify CIF, use the letter C (ASCII 43 hex 67 dec).

Rf Switch System Interface

The RF Switch System interface provides the relay-reported CMPA status and RF Inhibit command required by a waveguide switch controller. Three relays provide CMPA status: Low RF, Fault, and Sum Fault. The relay coil is de-energized to indicate a condition; this fail-safe mode means that a loss of power will provide condition indications on all relays. The only command on this interface, RF Inhibit, is active at all times and is not subject to the control mode hierarchy. If an RF Switch Port RF Inhibit is issued while the Low RF Relay indicates a Low RF condition, the Low RF Relay will continue to indicate Low RF. Once the RF Switch Port RF Inhibit disappears, the Low RF Relay will report existing conditions.

Relay Definitions

The Low RF Relay indicates that the CMPA's RF output is below the Low RF Alarm level or that the CMPA is in the Fault state; a waveguide switch system usually uses this information to trigger automated switching action. The Low RF Relay may be toggled to either Flexible mode or Rigid mode via front panel DIP Switch Bank 2, switch 8, and the Up and Down buttons (See Figure 4-1). A "1" on the Front Panel display indicates Flexible mode; "2" indicates Rigid mode. (Refer to Section 4 for instructions for setting CMPA features using the DIP switches.)

In Rigid mode, the Low RF Relay will indicate that the CMPA's RF output is below the Low RF Alarm level any time this condition occurs, except during an RF Switch Port RF Inhibit command. The Rigid mode can be thought of as the strictest operation of the Low RF Relay.

In Flexible mode, the Low RF Relay will indicate that the CMPA's RF output is below the Low RF Alarm level any time this condition occurs *during the Transmit state*, except during any RF Inhibit, and during Fault state. The Flexible mode allows the user to operate a switch controller in Automated Switching mode without triggering waveguide switch action while operating the CMPA in any normal operating state or issuing RF Inhibit commands. Table 3-3 describes the two modes in more precise detail.

The Fault relay indicates that the CMPA is in the Fault state—the CMPA features Auto Fault Recycle capabilities and is capable under some circumstances of cycling back to a normal operating state. This relay may be re-assigned to indicate other conditions—use DIP Switch Bank 2, switch 7, and the Up and Down buttons to toggle through the available options:

1—Fault
2—Low RF-relay mimics the Low RF Relay
3—Sum Fault-relay mimics the Sum Fault Relay
4—Reports the result of the logical equation: (High Voltage On) and (NOT(RF Inhibit))
5—High Voltage ON

The Sum Fault relay indicates that the CMPA is latched into the Fault state. When the CMPA is latched in the Fault state, the user must clear the fault source and issue a Reset command to the CMPA to return it to a normal operating condition.

TABLE 3-3
Low RF Relay Function

	Compact MPA Operational State				
	HTD	**Standby**	**BONS**	**Transmit** *(see note 4)*	**Fault** *(see note 5)*
Flexible	No LoRF	No LoRF	No LoRF	Yes/No LoRF	Yes LoRF
Rigid	Yes LoRF	Yes LoRF	Yes LoRF	Yes/No LoRF	Yes LoRF(see note 3)

TABLE 3-4 NOTES:

1. Yes LoRF= relay de-energized; pin 1 connected to pin 2, pin 3 disconnected from pin 2.
2. No LoRF= relay energized; pin 1 disconnected from pin 2, pin 3 connected to pin 2.
3. If an RF Inhibit is issued from any source except RF Switch Port, Low RF relay=Yes LoRF.
4. BONS is the Beam On Sequence, the time during which the High Voltage turn-on sequence is performed.
5. Fault refers to the Fault state. See section 5 for detail description.

The RF switch system interface is located at connector J5 on the rear panel of the CMPA. J5 is a 15-pin D-type connector with pin assignments as shown in Table 3-4.

TABLE 3-4
RF Switch Pin Assignment (J5)

Pin #	Signal Name	Remarks
1	Low RF NC	**Relay NC 1** (Normally closed when coil is de-energized; closed to pin 2 during Low RF Alarm or the Fault state.)
2	Low RF Common	**Relay Common 1**
3	Low RF NO	**Relay NO 1** (Normally Open when coil is de-energized; open from pin 2 during Low RF Alarm or the Fault state.)
4	Fault NC	**Relay NC 2** (Normally closed when coil is de-energized; closed to pin 5 during the Fault state or whatever condition chosen for this relay.)
5	Fault Common	**Relay Common 2**
6	Fault NO	**Relay NO 2** (Normally open when coil is de-energized; open from pin 5 during the Fault state or whatever condition chosen for this relay.)
7		**Not used**
8		**Not used**
9	Sum Fault NC	**Relay NC 3** (Normally closed when coil is de-energized; closed to pin 10 when the CMPA is latched into the Fault state.)
10	Sum Fault Common	**Relay Common 3**
11	Sum Fault NO	**Relay NO 3** (Normally open when coil is de-energized; open from pin 10 when the CMPA is latched into the Fault state.)
12		**Not used**
13		**Not used**
14	RF Inhibit	**Closed to pin 15 for "No RF Inhibit."**
15	RF Inhibit Return	**Input Return**

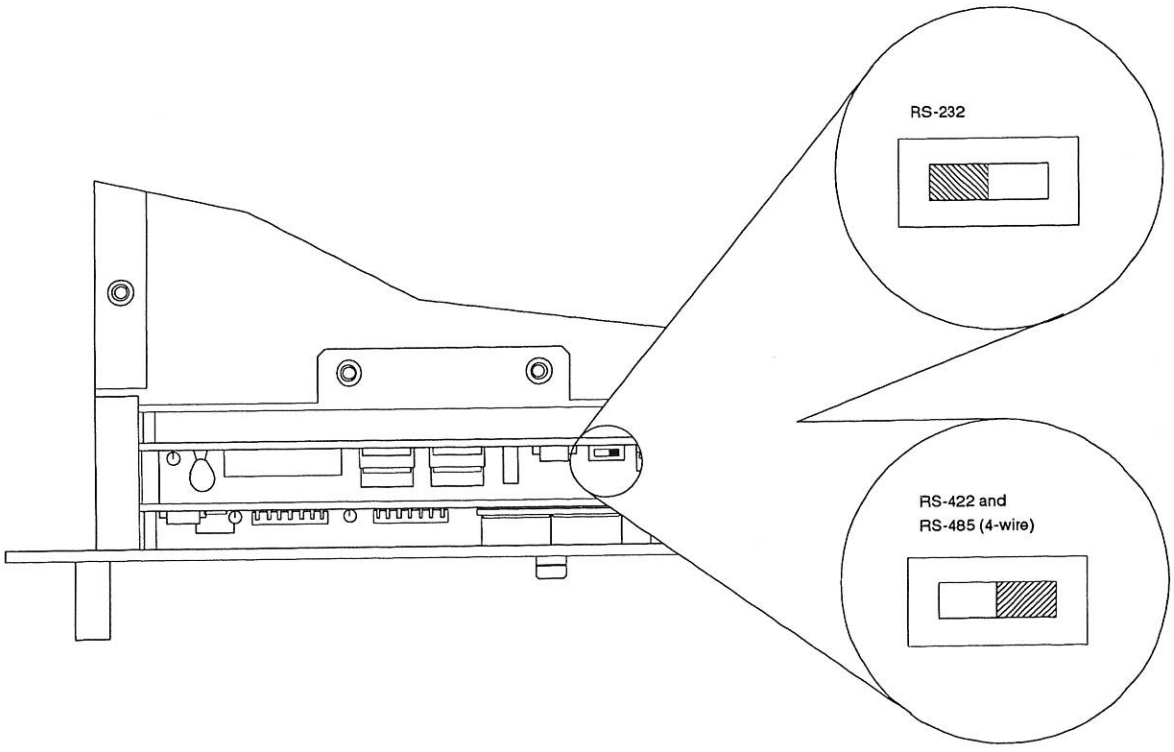
TABLE 3-4 NOTES:

1. Outputs are dry relay contacts rated up to 50 VDC, 50 mA and are connected in fail-safe mode.
2. The RF Inhibit requires a maintained closed-contact with RF Inhibit return and an open circuit for RF Inhibit. For this reason, a jumper connector is installed and shipped with the unit. When the CMPA is used in a switching system, this jumper is not required. This RF Inhibit command is executed regardless of the current control mode.

EXTERNAL INTERLOCKS INTERFACE

The External Interlocks interface allows the user to connect the CMPA to external safety interlocks; this interface features two signals: External Interlock Non-Latching and External Interlock Latching. External Interlock Non-Latching is RF Inhibit; this command is always executed. External Interlock Latching is a user-induced fault and is treated like all other faults, that is, Interlock Open Fault. These commands are executed by opening the command pin from its return.

The CMPA External Interlocks interface is located at connector J8 on the rear panel of the CMPA. It is a 9-pin D-type connector, with pin assignments as shown in Table 3-5.



Setting Serial Format

Figure 3-3

TABLE 3-5
Interlocks Interface Pin Assignment (J8)

Pin #	Signal Name	Remarks
1	External Interlock	Open from Return (pin 2) for Latching Beam Off
2	External Interlock	Latching Return
3	External Interlock	Open from Return (pin 4) for RF Non-Latching Inhibit
4	External Interlock	Non-Latching Return

NOTE:

A jumper is factory-installed on this port. When using the External Interlock interface, this jumper is not required.

COMPUTER INTERFACE

The Computer Interface (CIF) port is used to control and monitor the CMPA from an external data terminal or computer with software provided by the user. The CIF port can be configured to either RS-232 or RS-422/485 (4-wire) serial hardware format. Using the RS-422/485 serial hardware format allows an addressable multipoint bus to be implemented, providing serial communications between a computer and up to sixteen other RS-422/485 equipped devices.

Serial format selection is made via a slide switch located inside the unit. To change serial format, first ensure that prime power is not being applied to the CMPA. Next, remove the CMPA cover and move the internal slide switch to select the desired format. Refer to Figure 3-3.

The software aspect of the CIF port encompasses two standard protocol formats and a thorough command set. Protocol format and other serial port parameters, such as baud rate, are configured through the front panel via DIP switch banks. The command set includes all commands and status essential for operating the CMPA. Using the protocol and command set described later in this section, users can write software for their own computers.

CIF HARDWARE CONFIGURATION

The serial interface can be configured to one of two serial hardware formats: RS-232 or RS-422/485 (4-wire). A slide switch mounted inside the unit is used to select the hardware format. The RS-232 serial hardware format is suitable for point-to-point communications over short distances (50 ft or 15 m). The RS-422/485 (4-wire) serial hardware format is suitable for either point-to-point or multi-drop applications over long distances (4000 ft or 1200 m) provided that a suitable serial cable is used. Several cable manufacturers offer serial cables specifically designed for long distance serial communications applications.

In the multi-drop configuration, up to sixteen other addressable RS-422/485 equipped devices may share the same serial bus. Termination resistors should be installed on the last device on the bus. If the bus has multiple runs, the terminating resistor should be engaged on the last device at the end of each run. On the CMPA, the CIF port terminating resistor is installed by turning "ON" switch 4. Instructions for changing this switch can be found earlier in this section under "Serial Remote Interface". Refer to Figure 3-2 as well.

The CMPA CIF (Computer Interface) is located at connector J7 at the rear panel of the CMPA. It is a 9-pin D-type connector, with pin assignments as shown in Table 3-6. A computer may be connected to the connector using the standard RS-422/485 configuration.

The CIF Serial port parameters are set up using DIP switches on the Front Panel. Refer to Section 4, "Initial Power-On and Checkout", for detailed procedures regarding CIF serial port setup.

TABLE 3-6
CIF (Computer Interface) Pin Assignment (J7)

Rear Panel Signal Name	Remarks	D-shell Pin Number
1	SHIELD	
2	TX (RS-232)	Data sent out of CMPA
3	RX- (RS-422/485)	Data received by CMPA or RX (RS-232)
4	TX- (RS-422/485)	Data sent out of CMPA
5	GND	
6	TX+ (RS-422/485)	Data sent out of CMPA
7	Not connected	
8	Not connected	
9	RX+ (RS-422/485)	Data received by CMPA

COMPUTER INTERFACE (CIF) PROTOCOL

The following information describes the structure and content of the Computer Interface (CIF) protocol for the CMPA. The CIF protocol uses ASCII characters in a packet message structure to provide serial asynchronous communications between a computer and the CMPA. The CIF protocol includes commands for controlling and monitoring the CMPA. CMPA control commands are executed by the CMPA if the CIF port has been chosen as the valid control point. CMPA monitoring commands are valid at all times unless otherwise stated. Use the DIP switches accessible via the front panel access door to set the desired CIF parameters.

Unless otherwise specified, all numbers in this document are base 10.

PROTOCOL MESSAGE STRUCTURE

The CIF protocol uses a packet style message structure. Each packet typically includes a header byte, address byte, command byte, any necessary parameter byte(s), an ending byte, and a checkbyte. In this context, "byte" refers to a message constituent that is composed of 1 start bit, a 7-bit ASCII character, 1 parity bit (optional), and 1 stop bit. The parity bit will exist if either Even, Odd, or Mark parity is chosen. No parity bit will be included if None is chosen. Since 7 data bits are used, ASCII characters 0 through 127 are the "alphabet" for all valid messages. To avoid incompatibilities with existing controllers, the actual alphabet used avoids most control characters. The protocol provides choices for header/ending byte format and checksum format, which are described later in this section.

The user's computer generates and sends packets to the CMPA that can contain only one command and associated parameters. The CMPA can process only one received packet at a time; packets are not queued for processing. If a command is sent to the CMPA CIF port, a response will be returned usually within 100 ms. Commands requiring long execution times, such as changing power level, generate an immediate response indicating if the command was accepted and whether or not execution has begun.

If the CMPA was able to execute a command received via the CIF, the response message will indicate what command was executed and return any necessary parameters. In the case of a query command, the returned parameters are referred to as Status Bytes and are described in detail later in this section.

If the CMPA was not able to execute a command received via the CIF, a reject code (or codes) is included in the response message. If the STX/ETX header/ending byte message format was used, the header byte is NAK, thus indicating a rejection.

COMMAND AND RESPONSE FORMAT

Command Received by CMPA

HEADER	ADDRESS	COMMAND	PARAMETERS	ENDING	CHECK
BYTE	BYTE	BYTE	AS REQUIRED	BYTE	BYTE

Response Returned When Command Is Accepted

HEADER	ADDRESS	COMMAND	RESPONSE	ENDING	CHECK
BYTE	BYTE	BYTE	BYTE(S)	BYTE	BYTE

Response Returned When Command Is Rejected

HEADER	ADDRESS	COMMAND	REJECT	ENDING	CHECK
BYTE	BYTE	BYTE	CODE(S)	BYTE	BYTE

To avoid problems with control characters, and so on, device addresses, commands, parameters, and responses are limited to standard ASCII values 32 through 126.

Header and Ending Bytes

Two message formats are supported—STX/ETX header/ending bytes and printable ASCII header/ending bytes.

STX/ETX option (Front panel DIP switch bank 4, switch 4, display reads "off".)

Commands:

Header byte = STX (ASCII 02)
Ending byte = ETX (ASCII 03)

Responses:

Header byte = ACK (ASCII 06) is used if the CMPA accepted the command.
Header byte = NAK (ASCII 21) is used if the CMPA rejected the command. A reject code (or codes) indicates why the command was rejected.
Ending byte = ETX (ASCII 03)

ASCII option (Front panel DIP switch bank 4, switch 4, display reads "on".)

All commands and responses:

Header byte = { (ASCII 123)
Ending byte = } (ASCII 125)

Address Byte

The address byte provides the computer port with an address. It may be set from 48 to 111 using front panel DIP switch bank 4, switch 1, and the up/down pushbuttons.

Command Byte

The range of command bytes is from 32 to 111.

Response Byte(s)

The response byte(s) range from 32 to 95.

Reject Byte(s)

If a command is not accepted, a reject code (or codes) is returned.

ASCII Character	Decimal	Meaning
a	97	Command byte not recognized.
b	98	Illegal parameter or parameter out of range.
c	99	CIF is not enabled and the command can't be executed.
f	102	The command was not executed; high voltage is off.
g	103	The command was not executed; RF is inhibited.

Check Byte

Two options are available:

Longitudinal Parity—The check byte is the exclusive OR of all message bytes including the header and ending bytes and excluding CR or LF if chosen. (Front panel DIP switch bank 4, switch 5, display reads "on".)

Checksum—This formula provides a printable ASCII checksum. (Front panel DIP switch bank 4, switch 5, display reads "sum".)

$$\text{Checksum} = 32 + \text{MOD}_{95}[(\Sigma \text{ message byte}_i) - (32 * N)]$$

where:

MOD_{95} is the operation modulo 95.

N is the total number of bytes in the message including header and ending bytes and excluding CR or LF if chosen.

message byte_i is the ith message byte where $1 \leq i \leq N$.

Example: Calculate the check byte for the message {A1} using the checksum rule.

Character:	{	A	1	}
ASCII:	123	65	49	125
i	1	2	3	4

Check Byte = $32 + MOD_{95}[(123+65+49+125) - (32*4)]$
= $32 + MOD_{95}[234]$
= 32 + 44
= 76 which translates to the ASCII character L

NOTES:

1. Parity errors will cause the command to be ignored and no response message to be issued.
2. If any character is received before or during the transmission of a response message, the response message will be deleted. This will not interfere with the execution of a command.
3. The CIF port can be set to accept bad check bytes (it will expect a character in the check byte's place). Use front panel DIP switch bank 4, switch 6. When the display reads "on", the CMPA will accept bad check bytes; when it reads "off", the CMPA won't accept bad check bytes.

Carriage Returns and Line Feeds

The user may choose to use carriage returns (CR) and line feeds (LF); they are appended to the command/response. If both CR and LF are chosen, they will be appended in the order CR LF. Be sure that the CIF port's setting matches the user's monitor and control computer settings—mismatches in settings may result in the CMPA providing partial or unexpected responses. To select these suffix bytes, use front panel DIP switch bank 4, switch 7. Use the UP/DOWN buttons to change selection.

Display	Selection
0	Nothing
1	CR
2	LF
3	CR LF

COMMANDS

Commands are sent from a computer to the CMPA. Refer to information given earlier in this section for the proper formats for commands. There are four types of commands:

- **Query commands.** These commands cause the CMPA to return information. The returned bytes are called status bytes; they are described in detail later in this section. Refer to Table 3-7.
- **CMPA commands.** These commands cause the CMPA to take some action. Refer to Table 3-8.
- **Slow commands.** A subset of CMPA commands, these commands may require several seconds to complete. Refer to Table 3-9.
- **Interface commands.** These commands invoke special interface features. Refer to Table 3-10.

A table for each command type is provided. The table includes the command name, the ASCII code associated with the command and its base 10 representation, and a description of the command.

TABLE 3-7
Query Commands

ASCII Byte	Decimal	Commands
0	48	**ID/Version Query.** An eight-character string will be returned that identifies the CMPA model and computer interface version.
1	49	**Summary Status Query.** Two bytes of status are returned.
2	50	**Secondary Status Query.** Two bytes of status are returned.
3	51	**Fault/Miscellaneous Status Query.** Four bytes of fault conditions and general information are returned. The information returned mimics the front panel report. This query will store faults until a Cancel or Reset from any source clears all bits.
4	52	**Info/Error Data Query.** Two bytes are returned that indicate activity since the last Info/Error Data Query.
5	53	**Not used**
6	54	**RF Output Power in dBm Query.** Four ASCII characters in the form NN.N are returned. Leading zero is replaced with a blank.

TABLE 3-7

Query Commands (Continued)

ASCII Byte	Decimal	Commands	
7		55	**RF Output Power in Watts Query**. Four ASCII characters in the form NNNN are returned. Leading zeros are blanked.
8		56	**Attenuator Setting Query**. Four ASCII characters in the form NN.N are returned. Leading zero is blanked.
9		57	**Not used**
:		58	**Low RF Alarm Trip-point Query** (Watts). (see notes 1)
;		59	**High RF Alarm Trip-point Query** (Watts). (see notes 1)
<		60	**Low RF Fault Trip-point Query** (Watts). (see notes 1)
=		61	**High RF Fault Trip-point Query** (Watts). (see notes 1)
>		62	**Meter Query**. This command returns meter readings (without the units) according to the following formats. Leading zeros are replaced with blanks. Each reading is delimited by a space (ASCII 20 hex 32 dec). **RF Output (dBm)** NN.N dBm **RF Output (Watts)** NNNN W **Attenuator Setting** NN.NN V **Helix Voltage** NN.NN kV **Helix Current** NN.N mA **Reflected RF** NNN W
?		63	**Not used**

TABLE 3-7 NOTES:

1. These commands return four ASCII characters in the form NNNN. Leading zeros are blanked.

TABLE 3-8
CMPA Commands

ASCII Byte Decimal	Command	Definition
@	64	**Transmit.** This command turns the beam on.
A	65	**Standby.** This command turns the beam off.
B	66	**Reset.** This command is the equivalent of pushing the RESET button on the Front Panel.
C	67	**Set Attenuator.** Provide the attenuator setting in the form NN.NN. The CMPA interface will accept leading spaces (ASCII 20 hex 32 dec).
D	68	**Set RF O/P power in dBm.** Provide the setting in the form NN.N. Leading zeros may be replaced with spaces (ASCII 20 hex 32 dec).
E	69	**Set RF O/P power in watts.** Provide the setting in the form NNNN. Leading zeros may be replaced with spaces (ASCII 20 hex 32 dec).
F	70	**Not used**
G	71	**Not used**
H	72	**Not used**
I	73	**Enable RF Inhibit**
J	74	**Clear RF Inhibit**
K	75	**Not used**
L	76	**Set Low RF Alarm Trip-point** (Watts). (see notes 1)
M	77	**Set High RF Alarm Trip-point** (Watts). (see notes 1)
N	78	**Set Low RF Fault Trip-point** (Watts). (see notes 1)
O	79	**Set High RF Fault Trip-point** (Watts). (see notes 1)
P	80	**Not used**
Q	81	**Not used**

TABLE 3-8 NOTES:

1. These commands return four ASCII characters in the form NNNN. Leading zeros are blanked.

Slow Commands

A subset of CMPA Commands, these commands may require several seconds to complete. These commands are listed in the CMPA Commands table above.

TABLE 3-9
Slow Commands

ASCII Byte	Decimal	Commands (for description and notes, see Table 3-8)
D	68	**Set RF O/P power in dBm** (see notes 1 and 2)
E	69	**Set RF O/P power in Watts** (see notes 1 and 2)

TABLE 3-10
Interface Commands

ASCII	Decimal Bytes	Command Definition (See Table 3-8 notes)
R	82	**Enable RF Limits**—RF O/P power commands will be rejected (reject code 'b') if they exceed the Low RF Fault or High RF Fault trip settings. (see notes 1 and 2)
S	83	**Disable RF Limits**—Cancels the previous command. (see notes 1 and 2)
T	84	**Not used**
U	85	**Not used**

Status Byte Definitions

Status bytes are the responses to Query commands. Each bit represents some piece of information; the bit definitions are provided in the following tables. Bit 0 corresponds to the least significant bit (LSB) and bit 7 corresponds to the most significant bit (MSB). Bit 7 will contain the parity bit, if chosen. To make all status bytes printable ASCII characters, bit 6 is always equal to the complement of bit 5.

TABLE 3-11
Summary Status Bytes

Byte	Bit	Bit	Definition
	1	7 (MSB)	**Parity**
	6		**Complement of bit 5**
	5		**Change bit** — This bit is set if the current power level differs by more than 0.1 dB from the value returned by the last successful RF power query. This bit is zero if RF is inhibited or if the CMPA is in Standby. The value of this bit is determined each time a Summary Status Query is requested. (see note)
	4		**Info/Error Message Data Check** — This bit is set when a selected information or error condition has occurred. This bit is cleared by an Info/Error Message Query command. Refer to Interface commands, Activate Info/Error Message command, and Deactivate Info/Error Message command.
	3		**Secondary Status Data Check** — This bit is set when any change in a Secondary Status byte occurs. This bit is cleared by a Secondary Status query.
	2		**Fault/Misc Status Data Check** — This bit is set when any change in a Fault/Misc status byte occurs. This bit is cleared by a Fault/Misc Status Query.
	1		**Not used**
	0 (LSB)		**Slow Command in Execution** — This bit is set during the execution of a Slow command. Refer to Table 3-9.
2	7 (MSB)		**Parity**
	6		**Complement of bit 5**
	5		**RF Inhibited**—Bit is set if RF is inhibited.
	4		**Transmit Selected**—Bit is set if Transmit is selected during Heater Time Delay.

TABLE 3-11
Summary Status Bytes (Continued)

Byte	Bit	Bit Definition
	3	**Summary Fault**—Bit is set if CMPA is latched into the Fault state.
	2	CMPA Operating State
	1	CMPA Operating State
	0 (LSB)	CMPA Operating State
		CMPA Operating State is indicated as follows:

2	1	0	CMPA State
0	0	0	Not used
0	0	1	Heater Time Delay
0	1	0	Standby
0	1	1	Beam On Sequence
1	0	0	Beam On
1	0	1	Beam On and RF Inhibited
1	1	0	Beam Off Sequence
1	1	1	Fault

TABLE 3-12
Secondary Status Bytes

Byte	Bit	Bit	Definition
1		7 (MSB)	Parity
		6	Complement of bit 5
		5	Valid control point
		4	Valid control point
			Valid control point is indicated as follows:
			Bit 5 / **Bit 4** / **Control Point** 0 / 0 / Local 1 / 0 / Remote 1 / 1 / Computer Interface (CIF)
	3		Not used
	2		Not used
	1		**High RF Alarm**—This bit is set during High RF Alarm (see note)
	0 (LSB)		**Low RF Alarm**—This bit is set during Low RF Alarm. (see note)
2	7 (MSB)		Parity
	6		Complement of bit 5
	5		**RF Peak Output Power**—This bit is set if power meter is detecting peak power. (see note)
	4		Not used
	3		**Power Fail Signal Timeout**—This bit is set if the AC Power Fail signal is detected true for more than 10 seconds and corresponds to the front panel "PFAL" report.
	2		Not used
	1		Not used
	0		Not used

TABLE 3-13
Fault and Miscellaneous Status

Bit is set for the fault condition.

Byte	Bit	Bit Definition
1	7 (MSB)	Parity
	6	Complement of bit 5
	5	Helix Over Voltage
	4	Helix Under Voltage
	3	Helix Average Over Current
	2	Power Supply Arc Trip
	1	DC Bus Under Voltage
	0	Helix Voltage detected in Standby
2	7 (MSB)	Parity
	6	Complement of bit 5
	5	Reflected RF
	4	Interlocks Open
	3	TWT Thermal Fault
	2	High RF Fault (see note)
	1	Low RF Fault (see note)
	0	External Interlock Fault
3	7 (MSB)	Parity
	6	Complement of bit 5
	5	Not used
	4	Not used
	3	Not used
	2	Not used
	1	Not used
	0	SSIPA Over Current Fault

TABLE 3-13
Fault and Miscellaneous Status (Continued)

4	7 (MSB)	Parity
	6	Complement of bit 5
	5	**RF Inhibit**–Switch Port
	4	**RF Inhibit**–External Interlock
	3	**RF Inhibit**–CIF
	2	**RF Inhibit**–Local
	1	**RF Inhibit**–Remote Panel
	0	Not used

TABLE 3-14
Information/Error Messages

Byte	Bit	Definition (set if condition exists since last query)
1	7 (MSB)	Parity
	6	Complement of bit 5
	5	Control of the CMPA has been given to the computer interface.
	4	Control of the CMPA has been lost by the computer interface.
	3	An illegal or bad character has been received by CIF.
	2	A CIF response message was interrupted because activity was detected on the CIF port.
	1	Not used
	0	Not used
2	7 (MSB)	Parity
	6	Complement of bit 5
	5	RF O/P power setting command terminated due to the cessation of high voltage. (see notes 1 and 2)
	4	RF O/P power setting command terminated before reaching requested value. (see notes 1 and 2)
	3	Not used
	2	Not used
	1	Not used
	0	Not used

TABLE 3-14 NOTES:

1. Forward power related commands are valid only if the unit is equipped with the forward power metering option.
2. Valid only if unit is equipped with PIN Diode attenuator.

SECTION 4

INITIAL POWER ON AND CHECKOUT

This section describes the procedures for turning on the CMPA for the first time. It also describes the steps for initial checkout of the system, and for setup of the Remote and Computer Interface (CIF) serial ports.

Before proceeding with the steps in this section, read it completely. Also read the next section, "Operation", to become familiar with normal operation of the CMPA.

ATTENTION WARNING:

The information presented in this section is addressed to technicians who have specific training in, and knowledge of, high-power amplifiers. Inappropriate use of the CMPA can cause harm to the operator or equipment. Do not attempt the procedures outlined in this section before becoming thoroughly familiar with its contents.

PRE-POWER PROCEDURES

Before applying prime AC power to the CMPA, verify that the following conditions are met:

- The voltage of the station's AC prime power matches those marked on the back label.
- A ground strap is connected from the station's ground buss to the ground screw located on the CMPA's back panel.
- All connections are tight, no wires are pinched, and no other hardware or circuit-card assemblies have been loosened during shipment or handling.
- The main power switch on the CMPA front panel is turned off.
- The RF Input and RF Output are connected to a matched source and test load.

NOTE:

Failure to verify these pre-power conditions may damage the CMPA or cause it to malfunction. Operating the equipment before verifying these items may also void the warranty.

DANGEROUS VOLTAGE WARNING:

Lethal voltages of up to 9 kVDC are present inside the CMPA when power is applied to the system. Always turn power off before servicing the CMPA. Do not attempt to repair the CMPA unless experienced in servicing both microwave and high-voltage systems. Should the CMPA fail during or after initial power-up, refer to the Maintenance section of this manual. If necessary, also see Appendix D, "Warranty and Support Information", in Section 8, "Supplementary Data".

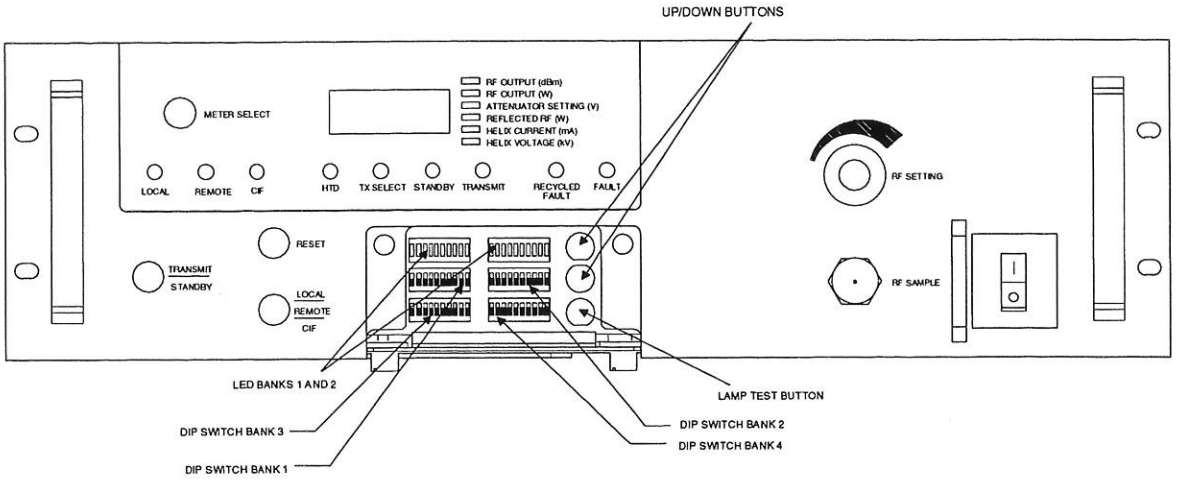
ATTENTION WARNING:

Before switching on power for the first time, become familiar with all CMPA controls and indicators, and with the procedures in this section.

USING THE FRONT PANEL

The CMPA is fully controlled using the front panel; this panel is also used to display (and in some cases to change) the CMPA's RF power-level settings, protection settings, and computer interface and configuration settings. (Refer to Figure 4-1, which shows the front panel layout.)

Because the front panel is used to perform initial power-up and checkout of the CMPA, familiarity with its functioning is essential. This section provides a brief overview sufficient for normal start-up tasks. For more complete information, see Section 5, "Operation"; also see Appendix B, "Front Panel Controls," in Section 8, "Supplementary Data".



The CMPA Front Panel with hidden controls exposed

Figure 4-1

INITIAL POWER-ON PROCEDURES

Initial power-on procedures for the CMPA should not be attempted until all pre-power procedures have been completed. This task should be performed by a qualified operator only; this is not a normal power-on sequence.

Should a fault or misadjustment be discovered during initial power-on, turn to Section 5, "Operation", for help in diagnosis; or contact CPI customer support (for telephone number see Appendix D).

Initial power on and checkout are to be performed in the following order:

- POST (power on self test) and HTD (heater time delay) countdown
- Verification of operational settings, which include fault and alarm trip settings
- Verification of serial port settings
- Verification of RF output level

Each phase of checkout is described in the paragraphs that follow.

POST (POWER ON SELF TEST) AND HTD (HEATER TIME DELAY)

Each time the CMPA power is switched on, the microprocessor controller performs a series of self tests to ensure that it has the ability to control and monitor the CMPA. The HTD (heater time delay) then counts down for a predetermined time to allow the
TWT (traveling wave tube) heater to warm up.

The following steps are to be performed in the order indicated. Verify the response of the CMPA during each step:

1. Switch on AC power to the CMPA; the AC power switch is located on the front panel on the front of the unit. (Self tests begin at this time.)

   "PoSt" will be displayed on the front panel display.

   a. If a self test fails, the error is reported on the front panel display. (Refer to Section 5, "Operation", for further steps if this occurs.)

2. The HTD (Heater Time Delay) LED will then light to indicate that the self tests passed. (HTD countdown is occurring at this time.)

   a. HTD countdown starts at 3:00 minutes and counts down to 0 minutes as observed on the Digital LED Display on the front panel.

   b. During countdown, verify that the LOCAL LED is lit. If it is not, press the LOCAL/REMOTE/CIF pushbutton until it does light. (This indicates that the front panel has complete control of the CMPA.)

   c. If the TX SELECT LED is lit, press the TRANSMIT/STANDBY pushbutton until the TX SELECT LED is extinguished. (This action will prevent the CMPA from transitioning to the Transmit state at the conclusion of HTD.)

   d. If a fault occurs during this countdown period, the HTD LED will go off and the FAULT LED will light.
   (Refer to Section 5, "Operation", subsection "CMPA states", if this occurs.)

3. When HTD countdown reaches 0:00, verify that the HTD LED goes off and that the STANDBY LED lights. Reaching this point in the procedure indicates that the following conditions have been met:

   a. Self tests were successful.

   b. The TWT (traveling wave tube) heater is warmed up.

   c. No faults have occurred up to this point.

   d. The CMPA is ready for the next normal step: Transmission. (**Do not** press the TRANSMIT/STANDBY pushbutton switch at this time.)

Verifying Operational Settings

The CMPA is delivered with all of its operational values factory preset to meet the requirements of a typical installation. Before the CMPA is used at the installation site, the user-configurable settings must be checked and, if necessary, set to meet the user's requirements.

Setting the Fault and Alarm Trip Points

The following Fault and Alarm Trip Point settings can be displayed and changed. (Note that the CMPA must be equipped with the Forward Power Metering option for any of the following RF Fault or Alarm trips to function.)

- **HELIX** Over and Under voltage and current settings.
- **LOW RF Alarm set**–A visual alarm for warning operators and for triggering the RF switch system (refer to RF Switch System Interfaces in Section 3).
- **HI RF Alarm set**–A visual alarm for warning operators.
- **LOW RF Fault set**–This fault occurs if the RF output power falls below the Low RF trip point.
- **HI RF Fault set**–This fault setting protects the CMPA against using it beyond its rated output power by causing a trip.
- **RF INHIBIT**–A manual way to inhibit RF output. (Useful in testing.)

Use the following procedure to verify or change the trip points:

1. Refer to Figure 4-1 for identification of DIP switches, LED banks, LAMP TEST switch, and up and down pushbuttons; these are located behind the access door on the front panel. Also refer to the changeable trip points contained in Table 4-1 (DIP switch bank 1) and Table 4-2 (DIP switch bank 2).

    a. Before starting, locate the LAMP TEST pushbutton and while pressing it, verify that all front panel LED lights including the ones behind the access panel are functioning.

2. Locate DIP using a narrow dull instrument, such as a small screwdriver, push switch #1 to the "on" position. Note that the "Helix Over Voltage" value is displayed on the Digital LED Display located on the Control Panel and that the "Helix Over Voltage" LED #1 in LED bank 1 is blinking.

a. If the "Helix Over Voltage" value needs to be changed, press the up or down pushbutton switch to change the displayed value to the desired value. (Refer to Table 4-3 for minimum, nominal, and maximum settings.)

b. Turn off switch #1 to save this new value (LED stops blinking).

3. Repeat step 2 for switches #2 through #8 to verify the remaining Helix settings and to set the RF Fault and Alarm settings as shown in Table 4-1; then continue with switches #1, 7, and 8 in DIP switch bank 2 as shown in Table 4-2 to set the remaining trip points. (Verification of operation will be performed later.)

TABLE 4-1
DIP Switch Bank 1

Switch#	Name	Remarks/Factory Presets
1	Helix Over Voltage Setting	8.9 kV
2	Helix Under Voltage Setting	8.2 kV
3	Helix Average Over Current	10 mA
4	High Reflected RF	25 W
5	High RF Fault	475W
6	High RF Alarm	425W
7	Low RF Fault	0 W
8	Low RF Alarm	0 W

TABLE 4-1 NOTES:

1. Use switches 1-8 in conjunction with the up/down switches and the digital LED display.
2. Refer to Table 4-3 for a list of minimum, nominal, and maximum settings for the Helix and the RF.

TABLE 4-2
DIP Switch Bank 2

Switch #	Name	Remarks/Factory Presets
1	Helix Voltage detected in Standby	4 kV
2		Not used
3		Not used
4		Not used
5	Features/Special TestMenu	Flip this switch to the up position, then use the Meter Select button to scroll through menu. See full description of menu contents below.
6	Reset to defaults	Flip this switch to the up position, then press the up button to reset the unit to factory-preset defaults.
7	Set Fault Relay (see note)	The Fault Relay may be re-assigned to these different signals. Use the up/down buttons to toggle through the selections. **1 - Fault** **2 - Low RF Alarm (mimics Low RF Alarm relay)** **3 - Sum Fault (mimics the Sum Fault relay)** **4 - [(HV ON) AND (NOT RF Inhibit)]**
8	Set Low RF Relay setting (see note)	1 - Flexible (Refer to Table 3-4 in Section 3.) 2 - Rigid

TABLE 4-2 NOTE:

Use switches 1, 7, and 8 in conjunction with the up/down switches and the digital LED display.

FEATURES/SPECIAL TESTS MENU

The Features/Special Tests menu contains special operating features, unit configuration information, and special test modes. The test modes are described in the CMPA Service Manual; they are for factory and field service personnel use only.

To enter the Features/Special Tests Menu, switch on DIP Switch Bank 2, switch 5. Use the Meter Select button to scroll through menu items. If this menu has not been accessed since power to the CMPA was last turned on, scrolling will begin at the first menu item. If this menu has been accessed multiple times since last turning the power on, the scrolling will begin at the last entry accessed. Example display contents below are shown in **bold** type. The menu items, in the order that they scroll, are:

1. **Beam On Meter** - The display will indicate the elapsed time that the CMPA was "on the air" (as measured from a Standby to Transmit transition to a Transmit to Standby transition). This display appears after the Transmit to Standby transition; the display toggles between **bEon** and the elapsed time (format is H.MM where H=Hour and MM=Minute). To clear the display of this information, press the Meter Select button.

This menu entry determines whether this feature is on or off. While viewing this menu entry, the display alternates between **bEon** and the current setting, **on** or **oFF**. Use the Up/Down buttons to select **on** or **oFF**.

2. **Fault Log** - The CMPA can store five fault sets. Set 1 is the most recent; Set 5 is the oldest. If the Fault Log becomes full, Set 5 gets discarded, Sets 1 through 4 become Sets 2 through 5, and the newest entry becomes Set 1. The display will indicate which fault set is displayed on the detail fault LEDs located behind the front panel access door. Use the Up/Down buttons to cycle through the fault sets. To clear all of the Fault Log entries, press the Reset button while viewing the Fault log.

3. **Beeper** - The beeper provides an audible alarm for fault events. This menu entry determines whether this feature is turned on or off. When viewing this menu entry, the display alternates between **bEEP** and the current setting, **on** or **oFF**. Use the Up/Down buttons to select **on** or **oFF**.

4. **Beam On Elapsed Meter** - This elapsed time meter indicates how long the CMPA has been in the Transmit state. The display alternates between **bOEL** and the elapsed time in hours. If the value is greater than 9999 hours, the right-most decimal point will light to indicate that the digits displayed are the (from left to right) 10000's, 1000's, 100's, and 10's. To reset this meter to zero, press and hold the Up, Down, and Reset buttons.

5. **Heater Elapsed Meter** - This elapsed time meter indicates how long the CMPA has been turned on. The display alternates between **HtEL** and the elapsed time in hours. If the value is greater than 9999 hours, the right-most decimal point will light to indicate that the digits displayed are the (from left to right) 10000's, 1000's, 100's, and 10's. To reset this meter to zero, press and hold the Up, Down, and Reset buttons.

6. **Revision** - The software revision is displayed in the form **r**x.xx.

7. **Controller Configuration** - The setting of the front panel configuration DIP switch bank is displayed in the form **c**xxx. This is a factory setting.

8. **High Voltage Test Mode** - (appears as **HtSt**) This is a special test mode that is described in the *CMPA Service Manual*.

9. **Power Supply Test Mode** - (appears as **PtSt**) This is a special test mode and does not apply to the CMPA.

10. **External Interfaces Test Mode** - (appears as **UtSt**) This is a special test mode for factory use only.

TABLE 4-3
Helix and RF Settings Ranges

Fault Name	Minimum	Nominal Factory Preset Defaults	Maximum
Helix Over Voltage	8.20 kV	8.90 kV	9.20 kV
Helix Under Voltage	0.00 kV	8.20 kV	8.90 kV
Helix Over Current	5.0 mA	10.0 mA	12.0 mA
Low RF Alarm	0 W	0 W	500W
Low RF Fault	0 W	0 W	500W
High RF Alarm	0 W	425W	500W
High RF Fault	0 W	475W	500W
High Reflected RF	0 W	25 W	40 W
Helix Voltage Off	1.00 kV	4.00 kV	7.50 kV

SETTING SERIAL REMOTE AND CIF PORT PARAMETERS

The Serial Port parameters for both the REMOTE port and the CIF (Computer Interface) port are set using the controls that are located behind the access door on the front panel. (Refer to Figure 4-1.)

The hidden controls used consist of up/down pushbutton switches and DIP switch banks 3 and 4. The up/down pushbutton switches are used in conjunction with the DIP switches to set serial port parameters.

Some of the factory settings may need changing to match the computer system that will be used. Use the following procedure to display or change settings:

1. Refer to Figure 4-1 for identification of DIP switches and up and down switches. Also refer to the changeable parameters contained in Table 4-4 (DIP bank 3, REMOTE) and Table 4-5 (DIP bank 4, CIF).
2. Locate DIP bank 3, to set the REMOTE port, and push switch #1 to the "on" position. Note that the Address value is displayed on the Digital LED Display located on the front panel.
    a. If the Address needs to be changed, press the up or down pushbutton switch to change the displayed value to the desired value.
    b. Turn off switch #1 to save this new address.
3. Repeat step 2 for the remaining switches #2 through #7 to set the Baud, Parity, Protocol, etc. as shown in Table 4-4.
4. Repeat steps 1 through 3, if required, for DIP bank 4; this sets the Computer Interface (CIF) parameters. (Refer to Table 4-5 for this step.)
5. Note that the above steps do not include a means of setting the CIF port to either RS-232 or RS-422/485 (4-wire). For a descrip-tion of how to make such an adjustment see section 3, "Interfaces".

TABLE 4-4
DIP Switch Bank 3 (Remote)

Switch #	Parameter	Remarks
1	Set Address	**Factory set to 49 dec.** Can be optionally set to addresses from 48 dec to 111 dec.
2	Set Baud rate	**Factory set to 9600.** Can be optionally set to 300, 600, 1200, 2400, or 4800 baud.
3	Set Parity	**Factory set to EVEN.** Can be optionally set to ODD(o), MARK (nn), SPACE (S), or NONE (n).
4	Set Protocol	**Factory set to OFF.** (STX/ETX Start/Stop bytes) Can be optionally set to ON (ASCII Start/Stop bytes).
5	Set Check Byte Type	**Factory set to Lon** (exclusive OR checkbyte). Can be optionally set to SUM.
6	Accept Bad Check Byte	**Factory set to ON** (will accept bad check bytes). Can be optionally set to OFF.
7	Set CR/LF	**Factory set to 0** (NO CR or LF). Can be optionally set to 1=CR, 2=LF, 3=CR LF.
8	Discrete Remote or Serial Remote.	Keep this switch "on" for Discrete Remote and "off" for Serial Remote.

TABLE 4-5
DIP Switch Bank 4 (CIF and RF)

Switch #	Parameter	Remarks
1	Set Address	Factory set to 65 dec. Can be optionally set to addresses from 48 dec to 111 dec.
2	Set Baud rate	Factory set to 9600. Can be optionally set to 300, 600, 1200, 2400, or 4800 baud.
3	Set Parity	Factory set to NONE. Can be optionally set to ODD (o), MARK (nn), Space (S) or EVEN (E).
4	Set Protocol	Factory set to ON (ASCII Start/Stop bytes). Can be optionally set to OFF (STX/ETX Start/Stop bytes).
5	Set Check Byte Type	Factory set to SUM. Can be optionally set to LON (exclusive OR checkbyte).
6	Accept Bad Check Byte	Factory set to ON (will accept bad check bytes). Can be optionally set to OFF.
7	Set CR/LF	Factory set to 3 (CR AND LF). Can be optionally set to 0= No CR or LF, 1=CR, 2=LF, 3=CR LF.
8	RF Inhibit	Factory set to OFF. This control works if the CMPA is in local control mode (LOCAL LED is lit). Use the up/down pushbuttons to turn the RF Inhibit on and off. The attenuator setting LED will flash to indicate RF Inhibit.

VERIFYING RF OUTPUT LEVEL

After verifying the factory settings and test functions of the CMPA in Standby state, the next step will be to place the CMPA in the Transmit state to verify the RF Output operation. (Refer to Table 5-1 in Section 5.)

Perform the following steps:

1. Verify that the STANDBY LED and the LOCAL LED are both lit; repeat steps 1-3 under "Self Tests and HTD" if they are not.

2. Verify that the RF Input and the RF Output are connected to a matched source and test load.

3. If equipped with the optional Forward Power Metering, press the METER SELECT pushbutton repeatedly until the LED lights next to an RF meter setting to be displayed. In this procedure, select RF OUTPUT (W): watts position.

   If not equipped with the metering option, connect a separate RF power meter (not supplied) to the type "N" sample port on the front panel of the CMPA noting the calibration label on the front of the unit.

4. Ensure that the attenuator is set to maximum attenuation.

   Manual Attenuator: Rotate the RF SETTING knob counter-clockwise until it reaches the end-stop.

   PIN Diode Attenuator: Press the Meter Select button until the attenuator setting is displayed on the meter. Rotate the RF SETTING knob to the left and hold until the display stops changing. Afterwards, press the Meter Select button until RF Output (W) is displayed.

5. Press the TRANSMIT/STANDBY pushbutton. The CMPA will transition from the Standby state (the STANDBY LED extin-guishes), through the Beam On Sequence (BONS) state (TRANSMIT LED flashes), to the Transmit state (TRANSMIT LED is solidly lit).

NOTE:

At this point of the procedure, if equipped with the optional Forward Power Metering, the Low RF Alarm may have tripped. The RF Output LED flashes, and the letter L appears on the left side of the display when either RF Output meter is displayed.

6. Slowly increase the RF output to 275 W or 54.4 dBm (Ku-band) or 350 W 55.4 dBm (C- or X-band).

   Manual attenuator: Rotate the RF SETTING knob clockwise until the correct RF output power is displayed. Write down the RF SETTING dial setting; this information will be used in a later step.

   PIN Diode Attenuator: Rotate the RF SETTING knob clockwise and hold until the correct RF output power is displayed. Use the Meter Select pushbutton to display the attenuator setting. Write down the attenuator setting; this information will be used in a later step.

   a. The FAULT LED should remain off.

   b. The RF OUTPUT LED should not be flashing; the flashing LED indicates an RF Alarm and the display will indicate H for High RF Alarm or L for Low RF Alarm. Also, the LEDs behind the front panel door will indicate which alarm is present. Recheck the alarm settings for this model if necessary.

VERIFYING RF ALARM AND RF FAULT TRIP POINTS

This part of the procedure verifies that the RF alarm and RF fault operation is functioning normally. These settings were verified in a previous procedure. (Refer back to that procedure if necessary.)

NOTE

This section (steps 7-12) can be skipped if the CMPA is not equipped with the optional Forward Power Metering.

7. Continue to adjust the RF SETTING control to just over 300 W for Ku-band (350 W for C- or X-band). The High RF alarm should come on; this is indicated by the RF OUTPUT (W) LED flashing and the letter H appearing on the Digital LED Display. (The letter L will appear during the Low RF alarm tests later in this procedure.)

8. If possible, continue to adjust the RF SETTING control to just over 325 W for Ku-band (375 W for C- or X-band.) The user will observe Auto Fault Recycle operation during this step. The following sequence will occur within approximately 3 seconds:

   a. The TRANSMIT LED will extinguish and the FAULT LED will be lit briefly (this time period is so quick that the FAULT LED may not light).

   b. The RECYCLED FAULT LED will flash and the High RF Fault LED will light.

   c. The TRANSMIT LED will flash as the CMPA recycles through the Beam On Sequence state back to the Transmit state.

   d. Once the CMPA is in the Transmit state, the High RF Fault will be detected and steps a through d will occur two more times before the CMPA latches into the Fault state.

   e. Once the CMPA is latched into the Fault state, the RECYCLED FAULT LED will extinguish and the FAULT LED will flash.

9. Decrease the RF SETTING to the setting noted in step 6.

10. Press the RESET pushbutton. The FAULT LED will go off and the High RF Fault LED will also go off. The CMPA will then transition to the Standby state and the STANDBY LED will light.

11. If no options are to be tested, switch off the main power to the CMPA, remove the RF Input and Output test loads, and make the normal RF Input and RF Output connections.

This completes the initial power-on and checkout procedure.
If the CMPA is to be computer controlled, use the following procedure. Also, check any optional equipment at this time such as the Remote Control Panel and the PIN Diode attenuator.

THE CMPA IS NOW READY FOR NORMAL OPERATION. (Refer to Section 5 for normal operating procedures.)

TESTING THE CMPA VIA COMPUTER CONTROL

If the CMPA is to be controlled by a computer, perform the following steps:

1. Verify that the customer computer contains the software to drive the CMPA.
2. Verify that the customer computer is connected to the serial Computer I/F (CIF) connector located on the CMPA back panel.
3. Verify that the CMPA is powered on and in Standby as indicated by the STANDBY LED being lit.
4. Verify that the CMPA CIF serial port parameters have been set to match the computer system to be used. These parameters are listed in Table 4-5. (Refer to "Setting the Serial Port Param-eters" for procedure.)
5. Press the LOCAL/REMOTE/CIF pushbutton until the CIF LED is lit. (This indicates that the computer can now control the CMPA.)
6. Perform tests at the computer to confirm that it not only has complete control of the CMPA but that it has complete monitor-ing capabilities of all of the metering available on the CMPA front panel.
7. If no options are to be tested, switch off the main power to the CMPA, remove the RF Input and Output test loads, and make the normal RF Input and RF Output connections.

Testing Optional Equipment

At this time, any optional equipment should be tested to verify its operation. Check the following equipment as described.

REMOTE CONTROL INTERFACE

The CMPA features two remote interfaces: Discrete and Serial. CMPA status is available at all times through either port; however, for command purposes, only one remote port may be assigned to the Remote mode. This selection is made using front panel DIP switch bank 3, switch 8. (This switch is on for Discrete Remote and off for Serial Remote.) Refer to "Setting the Serial Remote/CIF Port Parameters" earlier in this section for more details, if necessary.

For the purposes of the following test, the Remote unit should be used within sight of the CMPA to assure that the Remote unit's appearance is consistent with the CMPA's front panel report.

1. Verify that the Remote is attached to the correct port. The Discrete Remote is a 25-pin D-shell connector (J4); the Serial Remote is a 9-pin D-shell connector (J6).
2. If the Serial Remote is used, verify that the Serial Remote port parameters are set to match the serial port properties of the Remote unit. (Refer to "Setting the Serial Port Parameters" for that procedure.)
3. Verify that the CMPA is powered on and in the Standby state as indicated by the STANDBY LED being lit.
4. Press the LOCAL/REMOTE/CIF pushbutton on the front panel until the REMOTE LED is lit. (This indicates that the Remote Control Panel can now control the CMPA.)
5. Perform tests at the Remote Control Panel to confirm that it not only has complete control of the CMPA but that it has complete monitoring capabilities of all of the metering available on the front panel.

   Note that the PIN Diode Attenuator option must be installed for remote attenuation capability.
6. If no more options are to be tested, switch off the main power to the CMPA, remove the RF Input and Output test loads, and make the normal RF Input and RF Output connections.

SECTION 5

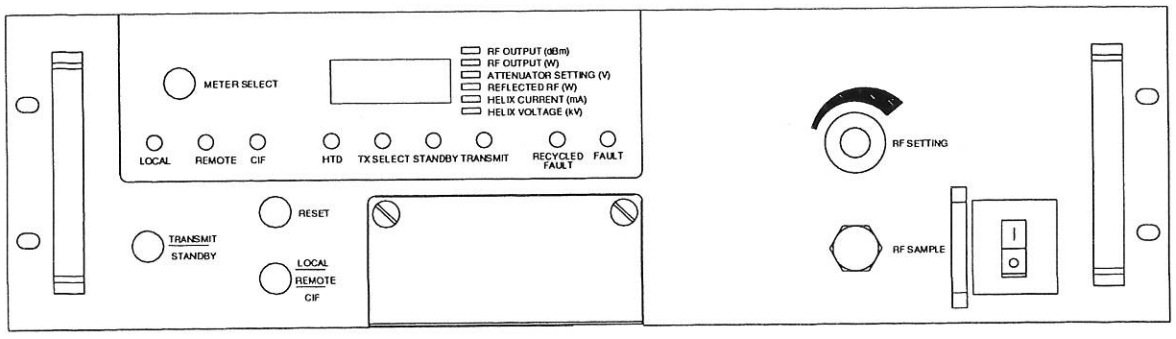
OPERATION

INTRODUCTION

This section describes the normal operation of the CMPA (Compact Medium Power Amplifier); it presents a brief overview of operation and explains how the front panel is used to monitor and control the CMPA. All front panel pushbuttons, LEDs, and other controls are defined in this section.

The CMPA features a microprocessor-based control system that accepts control input and provides CMPA status and metering.
This section describes CMPA operation via a front panel; for CMPA operation via other ports, refer to Section 3.

The front panel, as shown in Figure 5-1, accepts input from pushbuttons and switches and provides CMPA status and metering via the display and LEDs. Individual pushbuttons control essential CMPA functions, such as transmitting and selection of the Control mode. DIP switches, LEDs, and pushbuttons located behind the front panel access door are used to configure the Remote serial port and the Computer Interface port (CIF).



CMPA Front Panel

Figure 5-1

OVERVIEW OF OPERATION

The CMPA is controlled and monitored using the front panel; located here are a digital LED display, pushbutton switches, monitoring LEDs, RF setting control, and the main power switch.

Operation of the CMPA is performed in the following sequence starting from turning the main power ON:

1. **POST (Power On Self Test)**—Self tests are performed at this time. (Front panel displays "PoSt".)
2. **HTD (heater time delay)**—Up to 3 minutes delay until operating temperature of the TWT (traveling wave tube) cathode is reached. (HTD countdown is displayed on the front panel display.)
3. Standby LED lights after HTD countdown is complete.
4. **TRANSMIT/STANDBY** pushbutton is depressed to initiate beam on sequence (BONS). (During BONS, the Transmit LED blinks.)
5. Transmit LED lights solid to indicate that the CMPA is capable of transmitting RF.

Two different fault conditions may occur during operation:

1. **Fault (Non-latched)**-Beam-off malfunction state; CMPA will recycle to the state prior to the fault.
2. **Fault (Latched)**-Beam-off malfunction state; only operator intervention will return the CMPA to a normal operating state. Clear the fault source as indicated by the LED detail behind the front panel door, then press Reset to return the CMPA to Standby.

FRONT PANEL DESCRIPTION

The following front panel components—pushbuttons, LEDs, and other controls—are described in detail below. Refer to Figure 5-1 for their physical location.

PUSHBUTTONS

- **TRANSMIT/STANDBY**—Toggles beam state between beam on and beam off. When beam is on, as indicated by a solidly lit Transmit LED, the CMPA will provide RF output.
- **RESET**—Resets the unit after Fault conditions. (Extinguishes all captured fault LEDs and the Recycled Fault LED.)
- **LOCAL/REMOTE/CIF**—Toggles between the three control points. (Refer to "Changing Control Modes" in this section.)
- **METER SELECT**—Toggles through all valid meter selections.
- **LAMP TEST** (hidden switch)—Lights all front panel indicators (LEDs). (Located behind the front panel access door.)

STATUS LEDS

- **LOCAL**—Lit when valid control point is the front panel.
- **REMOTE**—Lit when valid control point is the Remote port. (If DIP switch bank 3, switch 8 is off, the Serial Remote port will accept commands. If that switch is on, the Discrete Remote will accept commands.)
- **CIF**—Lit when valid control point is the CIF port.
- **HTD**—Lit during Heater Time Delay (HTD). (If unit transitions to Fault during HTD, the HTD countdown will continue.)
- **TX SELECT**—Lit when TRANSMIT pushbutton is pressed during HTD; CMPA will transition to Transmit at the conclusion of HTD.
- **STANDBY**—Lit during Standby state.
- **TRANSMIT**—Flashes during beam on sequence (BONS); lit during Transmit state.
- **RECYCLED FAULT**—Flashes after unit successfully recycles from Fault.
- **FAULT**—Flashes anytime unit is in Fault condition.

DISPLAYING METER READINGS

Up to six different meter readings can be selected for viewing on the digital LED display located on the front panel, depending on options purchased. To view a meter reading, press the METER SELECT pushbutton repeatedly until the LED lights next to the desired item to be displayed.

The following metering items can be displayed as indicated by a lit LED:

- **RF OUTPUT (dBm)**—Indicates RF output power in dBm, if CMPA is equipped with Forward Power Metering option. (LED flashes for either Low or High RF Alarm.)
- **RF OUTPUT (Watts)**—Indicates RF output power in Watts, if CMPA is equipped with Forward Power Metering option. (LED flashes for either Low or High RF Alarm.)
- **ATTENUATOR SETTING (Volts)**—Indicates attenuator control voltage setting. Valid only when unit is equipped with PIN Diode Attenuator option. (LED flashes for RF Inhibit.)
- **REFLECTED RF (Watts)**—Indicates reflected RF power in Watts.
- **HELIX I (mA)**—Indicates helix current in milliamps.
- **HELIX V (kV)**—Indicates helix voltage in kilovolts.

ESSENTIAL OPERATING PROCEDURES

NOTE

Before starting or operating the CMPA for the first time, be sure that "Initial Power On And Checkout" procedures described in Section 4 have been performed. Important alarm and fault trip points were set in that section.

Perform the CMPA normal operating procedure in the following order:

1. Switch on the main power switch located on the CMPA's front panel. (Power on self tests will start at this time as indicated by the Front Panel display "PoSt". The CMPA should be in Local mode as indicated by the LOCAL LED being lit.)
2. Verify that no fault message is displayed on the numeric LED display and that the FAULT LED is not flashing. (Refer to the "CMPA States" subsection later within this section any time that the FAULT LED flashes; this indicates an abnormal condition.)
3. Verify that HTD (Heater Time Delay) counts down from 3:00 to 0:00 minutes. (This countdown is displayed on the digital LED display; the HTD LED will be lit during this period.)
4. Verify that the STANDBY LED lights and that the HTD LED goes off after HTD is complete. (This takes 3 minutes or less.)
5. Press the TRANSMIT/STANDBY pushbutton; the TRANSMIT LED flashes during the beam on sequence (BONS), then lights continuously. The CMPA is now capable of transmitting.

   Alternate method: Press the TRANSMIT/STANDBY pushbutton during HTD (step 3); this causes the TX SELECT LED to light. (BONS and Transmission of RF will then occur automatically at the completion of HTD.)
6. Ensure that an RF input is being applied to the CMPA.
7. Confirm that RF OUTPUT power has been set to the desired level. (Refer to the "Setting the RF Output Level" procedure below.)
8. To end transmission, press the TRANSMIT/STANDBY pushbutton. (The TRANSMIT LED will go off and the STANDBY LED will light.)

SETTING THE RF OUTPUT LEVEL

The following procedure is used to set or confirm that the RF Output has been set to the correct level. This level was initially set in Section 4, "Initial Power on and Checkout", but can be changed here if necessary.

1. If equipped with optional Forward Power Metering, press the METER SELECT pushbutton repeatedly until the LED lights next to the desired setting to be displayed.

   If not equipped with optional Forward Power Metering, connect a separate RF power meter (not supplied) to the type "N" sample port on the front panel of the CMPA noting the calibration label on the front of the unit.

2. To change the value of the setting, rotate the Control Panel RF SETTING adjustment control until the desired level is displayed on the digital LED display or separate user-provided power meter. (Refer to Table 5-1 for an explanation of the data that appears on the digital LED display.)

The following RF settings can be displayed and changed when equipped with optional Forward Power Metering and/or PIN Diode Attenuator:

- **RF OUTPUT**–Can be displayed in Watts (W) or in dBm.
- **ATTENUATOR SETTING**–The attenuator may be set at any time. If the PIN Diode Attenuator is used, the attenuator setting will indicate the control voltage applied to the attenuator. If the standard manual attenuator is used, use the dial counter and record the desired attenuation settings.

TABLE 5-1
Digital LED Display

Meter Name	Format	Remarks (Right Justified)
RF Output (dBm)	XX.X	Any reading below 1 W will read 00.0 dBm. (Forward Power Metering required.)
RF Output (Watts)	XXX	Forward Power Metering required.
Attenuator Setting (Volts)	XX.XX	PIN Diode option required for this setting.
Reflected RF (Watts)	XXX	
Helix I (mA)	XX.X	Current reading is displayed in milliamps.
Helix V (kV)	XX.XX	Voltage reading is displayed in kilovolts.

TABLE 5-1 NOTES: (APPLICABLE WHEN EQUIPPED WITH OPTIONAL FORWARD POWER METERING)

1. When the meter is displaying any RF parameter and peak detected exists, the first character displayed will be an "P".
2. When the meter is displaying either RF Output and the "Low RF Alarm" exists, the first character displayed will be an "L".
3. When the meter is displaying either RF Output and the "High RF Alarm" exists, the first character displayed will be an "H".

CMPA SHUTDOWN

When transmission is completed and no other transmission is planned for an hour or two, the CMPA's AC power should be switched off to conserve electricity and prolong the life of the TWT (traveling wave tube). Follow these steps:

1. Press the TRANSMIT/STANDBY pushbutton to place the CMPA in "Standby" mode. Verify STANDBY LED is lit.
2. Wait approximately 5 minutes to allow the TWT to cool off.
3. Switch off the Main Power switch located on the front panel.

The microprocessor-based controller receives an AC Power Fail signal that prevents the controller from reporting faults that result from normal conditions encountered during power down (either by turning the main power breaker off or by losing AC power). When this signal indicates loss of AC power, the controller turns the beam off, masks the report of all faults, and blanks the display (except for dashes on the digital display). If this signal is detected by the controller to be off for more than 10 seconds, it is assumed that the signal is not correctly reporting the state of the AC power and the CMPA is returned to the operational state prior to the detected loss of AC power. At this point, the front panel display will indicate PFAL as will the Secondary Status on the Serial Remote and CIF ports. When PFAL is displayed, the CMPA is fully operational; however, upon loss of AC power, faults may appear (such as DC Buss Fault and Helix Overcurrent Fault or Helix Undervoltage Fault) that are the result of normal power down conditions. The PFAL message will disappear when the AC Power Fail signal has been restored to the controller.

MAKING ROUTINE SAFETY CHECKS

It is very important that the user regularly confirm the accuracy of the CMPA's trip settings. These have been set for this CMPA at the factory and verified earlier in Section 4, "Initial Power On and Checkout".

Verification of the trip settings should be made (from the front panel) at least once a week, or more often if the equipment has been used by several operators. **Failure to operate the CMPA with the correct settings can result in damage that is not covered by the warranty.** For this reason, the procedure that changes the trip settings should be given only to authorized personnel.

CMPA CONTROL MODES AND HIERARCHY

The CMPA may be controlled from five points:

- **RF Switch port**
- **Interlock interface**
- **Local** — All control occurs on the front panel.
- **Remote** — All control occurs on either the Serial Remote or Discrete Remote; monitoring is valid on both Discrete Remote port and Serial Remote port.
- **Computer** — All control and monitoring occurs on the remote computer.

The RF Switch port and Interlock interface connect to switching systems and user-defined interlocks. The RF Switch port and Interlock interface have the highest level of control. They are active at all times; all commands that are issued by the user through these ports must be acknowledged and acted upon if the CMPA may physically do so.

The Local, Remote, and Computer modes are user interface modes; only one Remote port may be assigned via DIP switches on the controller to the Remote mode. On the front panel, press the LOCAL/REMOTE/CIF button to toggle through all of the valid control modes (LOCAL, REMOTE, CIF). If the CMPA is in the Remote mode, the Serial Remote port may toggle control between the Remote panel and the Computer interface (REM, CIF).

- All control points will always provide status. Commands that modify either the CMPA's operating state or RF output will be accepted only from the valid control point.
- The front panel button labeled LOCAL/REMOTE/CIF will toggle between all control points. The front panel is the "super user" and may transfer the control point at any time.
- If the control point is transferred to the Serial Remote port or the CIF, the Serial Remote port may transfer control between itself and the CIF.
- No control transfer may be commanded via the CIF port or the Discrete Remote.

CMPA STATES AND DESCRIPTION

The operation of the CMPA may be divided into several states and sequences. They are as follows:

- **POST (Power On Self Test)**—Initial power on.
- **HTD (Heater Time Delay)**—Beam off state while cathode heats to operating temperature.
- **Standby**—Normal beam off state.
- **BONS (Beam On Sequence)**—Transition from Standby (beam off) to Transmit (beam on).
- **Transmit**—Beam on state (in this state, the CMPA may transmit).
- **BOFS (Beam Off Sequence)**—Transition from Transmit to any beam off state.
- **Fault (Non-latched)**—Beam off malfunction state; the CMPA will recycle to the state prior to the fault.
- **Fault (Latched)**—Beam off malfunction state. Only user intervention will return the CMPA to a normal operating state.

Each state is described in greater detail in the following text.

POST

The microprocessor based controller performs a list of tests that establish its ability to control and monitor the CMPA. Some areas covered by POST include checking validity of information in the battery-backed RAM, EPROM checksum, and other controller-specific aspects. During this test, the CMPA will accept no user inputs that affect the beam state.

If there is no POST failure, proceed to HTD.

If there is a POST failure, halt at failed test and report error on numeric LED display. The exception is the battery-backed RAM error; this error is reported on LED bank 2, LED 8. The CMPA continues with normal operation using firmware-based defaults.

HTD

During HTD (Heater Time Delay), the heater warms the cathode to its operating point. HTD is of variable length (based on power off time) to provide optimum cathode temperature in the minimum time.

In the tube during the Transmit state (Beam On), a beam of electrons is accelerated from an electron cloud around the cathode, past the anode, through the helix structure, and finally coming to rest in the collector structure. To create the cloud of free electrons, the cathode is heated by the heater. Ideally, the cathode should be maintained at a specific temperature. Cathode temperature is difficult to measure; however, there is a relationship between heater time after prime power on and cathode temperature. HTD, therefore, is of variable length (based on prime power off time) to provide optimum cathode temperature in minimum time after power is applied to the CMPA.

HTD proportional time delay:

If time off $\leq$5 seconds, no HTD.

If 5 seconds<time off<1.5 minutes,
HTD = 1.5 x time off

If time off $\geq$1.5minutes,
HTD = 3 minutes

Heater Reduce is off during this time. The beam is off and may not be commanded on during HTD.

If the beam was on during the previous power on period, the beam is selected. Also, if a Transmit request is received during this time, the beam is selected. If the beam is selected, the TX Select LED is lit. The TX Select LED can be lit only during HTD.

After a successful conclusion of HTD, the unit will transition to Standby or Transmit, if transitioning with Transmit selected
(TX Select).

If a fault occurs during HTD, the unit will transition to the Fault state. The HTD countdown clock will continue during Fault.

Standby State

The Standby state is the normal beam off state. During Standby, the high voltage is off and the unit may not transmit.

While the unit is in the Standby state, the Standby LED is lit. After one minute of beam off, the Heater Reduce command is issued to the power supply.

If the beam is selected such as in TX Select during HTD, in a fault recycle attempt where the fault originated during BONS or in Transmit, the unit will enter the beam on sequence.

If a Transmit request is received, the unit should enter the beam on sequence.

If a fault occurs, the unit will transition to the Fault state.

Beam On Sequence

Beam on sequence covers the transition from Standby (beam off) to Transmit (beam on). During BONS the green Transmit light will flash on the front panel.

Transmit State

Transmit is the normal beam on state. During this state, the high voltage is on and the CMPA may transmit.

High Voltage is always on. Heater Reduce is always off. RF Inhibit may be on or off.

If the prime power recovers after a power failure, a suitable HTD should be executed with the beam selected. Ultimately, the CMPA should return to Transmit unless commanded otherwise.

If a fault occurs, the unit will transition via the BOFS (Beam Off Sequence) to the Fault state. A fault recycle attempt will return CMPA operation to Transmit via Standby (beam selected).

Beam Off Sequence

The BOFS (Beam off sequence) describes the transition from Transmit or BONS to any beam off state.

Fault State

If a fault condition is detected, the unit transitions to Fault (a beam off state). In the Fault state, a decision is made to latch the unit into Fault or to recycle back to the prior operational state.

The fault system is always in auto recycle mode. Auto recycle mode allows the controller to return the unit to normal operating states after some transient faults (or series of transient faults).

An LED is assigned to each fault; these LEDs are located behind the access door on the front panel. The individual LEDs are assigned according to the label on the inside of the front panel access door. When a fault occurs, its LED will light and stay lit until a Reset request is issued. Once in the Fault mode, no additional faults will be acknowledged.

All fault detection and fault reporting will be frozen if the AC Power Fail signal is detected; also, the beam is turned off. If the AC Power Fail signal is detected to be true for more than 10 seconds, fault detection and fault reporting will be resumed. If this occurs, the digital display alternates between selected meter and the message "PFAL" and fault detection and fault reporting resume.

Auto Fault Recycle Mode Rules

Latch into Fault state:

If three faults occur within a 20-second period, the unit latches in the Fault state.

Recycle to prior state:

If fewer than three faults occur within 20 seconds, then recycle back to the appropriate operational state.

During Fault:

High Voltage is off. Heater Reduce is on after one minute of Fault. RF Inhibit is on.

Since all faults are ignored during Fault, a hard fault (such as a stuck Interlocks Open) will be seen three times as the unit cycles between Fault and another operational state. This guarantees that a hard fault will ultimately latch the unit into Fault. If a recycle decision is made, the unit remains in the Fault state for an additional 0.5 second before cycling back to the original state.

If the unit enters Fault from HTD, the HTD countdown will continue.

While the unit is in the Fault state, the Fault LED flashes. Once the unit leaves the Fault state, the Recycled Fault LED will flash and the Fault LED will extinguish. At this point, the user may issue a Reset request to extinguish the Recycled Fault LED.

If the unit is latched into the Fault state, the Recycled Fault LED extinguishes and the Fault LED flashes. To exit the latched Fault state, the user must clear the fault cause, then issue a Reset request. The CMPA returns to Standby.

Dedicated Fault and Alarm LEDs

The front panel contains an access door behind which are the Lamp Test pushbutton, Up and Down pushbutton switches, four banks of DIP switches, and two banks of LEDs. The Up and Down pushbutton switches are used in conjunction with the DIP switches to set fault trip points and serial port parameters.

The two LED banks are used to indicate individual fault and alarm conditions. Refer to Tables 5-2 and 5-3.

TABLE 5-2
Detail Fault and Alarm LEDs

LED Bank 1	Fault Indication (When LED Is Lit)
1	Helix Over Voltage
2	Helix Under Voltage
3	Helix Average Over Current
4	High Reflected RF
5	High RF Fault
6	High RF Alarm
7	Low RF Fault
8	Low RF Alarm
9	Interlocks Open Fault
10	TWT Over Temperature Fault

TABLE 5-3
Detail Fault and Alarm LEDs

LED Bank 2	Fault Indication (When LED Is Lit)
1	Helix Voltage Is Off
2	SSIPA Over Current Fault
3	Not used
4	Not used
5	Not used
6	Not used
7	External Interlock Open Fault
8	Battery-backed RAM Error Detected
9	DC Buss Fault
10	PS Arc Fault

SELF TEST INTERPRETATION

Self tests of the CMPA are performed each time that the main power is turned on. Should one of these tests fail, the FAULT LED will flash to indicate that a fault has occurred; the number of the self test that failed will be displayed on the digital LED display located on the front panel.

The following information shows the test numbers—one of these numbers will be displayed in the event of a failure—and a description of the test that was performed.

POST Error Codes

00 **A to D Calibration Error**
01 **A to D Initialization Error**
02 **Battery Backed Up RAM Error (checksum test)**
03 **EPROM Error**
04 **Real Time Clock not running**
05 **Real Time Clock stuck in update**
06 **Static RAM Error**
07 **Incorrect Configuration Dip-Switches**

The display will show ErNN, where NN is the POST error code. Some of these errors could occur while the unit is operating if either the A/D or RTC fails.

Software Error Codes

There are also some Software Error codes that the user should never ever see; call CPI if they do. The display would show SENN.

00— Bad Sequence Counter: The monitor sequence counter is invalid.

01— Bad System State: The monitor system state is invalid.

02— Data Type Not Found: An attempt was made to use a conversion function with an invalid data type.

03— Unused Interrupt: An interrupt occurred that is not currently defined.

SECTION 6

MAINTENANCE

INTRODUCTION

This section describes scheduled maintenance procedures for the CMPA (Compact Medium Power Amplifier). It covers procedures and test equipment for scheduled preventive maintenance tasks and performance testing.

NOTE:

Improper maintenance of the CMPA may void the warranty. For details, see "Warranty and Support Information", in Appendix D.

SCHEDULED PREVENTIVE MAINTENANCE

To function safely and effectively, the CMPA requires periodic maintenance. This consists of inspection, cleaning, testing, and calibration of the CMPA's subsystems at monthly to 6-month intervals. In addition, a daily log should be kept of all the CMPA meter readings. This can be helpful in identifying problems that are emerging or continuing.

Preventive maintenance is divided into mechanical calibration, electrical calibration, and performance testing. Also provided is a description of how to care for spare TWTs and start-up procedures to be followed when the CMPA is turned off for extended periods. Refer to Table 6-1 for the Preventive Maintenance Schedule.

ATTENTION

WARNING:

The person performing maintenance of this equipment must have training and knowledge of both the product and safety requirements and safety issues related to the equipment. Read and practice the safety guidelines at the front of this manual.

ATTENTION

WARNING:

It may sometimes be necessary for work to be performed on the CMPA equipment when voltages greater than 50 V are exposed. Only personnel trained in RF amplifiers and high-voltage equipment are authorized to work on the CMPA under these conditions. The person exposed to live voltages must be observed by at least one other person who is able to immediately switch off the CMPA power without delay; the power switch is located on the CMPA front panel. Also, the observer should be trained to render first aid by means of cardiopulmonary resuscitation (CPR). Work safely!

TABLE 6-1
Preventive Maintenance Schedule

Mechanical Tasks	Daily	1 Mo	3 Mo	6 Mo
Log meter readings	X			
Clean air filters		X (see note 1)		
Check LEDs and digital display		X		
Perform visual inspection		X (see note 1)		
Collector air system maintenance		X		
Assembly cooling fans			X (see note 2)	
Perform misellaneous cleaning			X (see note 1)	
Electrical Tasks	**Daily**	**1 Mo**	**3 Mo**	**6 Mo**
Perform initial power on check			X	
Verify limit settings				X
Verify heater setting			X	
Verify Helix setting and metering		X		
Verify RF metering				X
Run performance tests				X
Test any spare tubes				X

TABLE 6-1 NOTES:

1. Cleaning may be required more or less frequently than shown (depending on the site).
2. Replace blowers after 50,000 hours of operation.

MECHANICAL PREVENTIVE MAINTENANCE

Mechanical preventive maintenance consists of all of the mechanical tasks listed in Table 6-1. Most of them are performed with the AC power switched off. Details are listed in the following paragraphs.

Inspecting and Cleaning Air Filter

The air filter at the rear of the amplifier should be checked monthly and cleaned or replaced.

Checking Front Panel LEDs

At least once a month, check that all front panel status indicators (LEDs) are working properly. To perform this test, do the following:

1. Ensure that the main power switch is turned on.
2. Open the front panel access door and while depressing the LAMP TEST pushbutton, confirm that all LEDs on the front panel and also those behind the access door are lit.

Visual Inspection

At one-month intervals, the CMPA should be visually inspected for physical defects. If the equipment is subject to severe environmental conditions, inspections should be performed more frequently.

WARNING:

Before attempting any inspection or cleaning, switch off all power, wait 30 seconds, then ensure that there is no buss voltage present from the power factor assembly (normally 375 VDC). When using solvents, provide adequate ventilation and avoid breathing fumes. When cleaning with air, wear safety goggles and use clean, dry compressed air not exceeding 25 psi (1.75 kg/cm).

The daily equipment readings log is a good source for clues that could indicate an intermittent or marginal condition. Any increase in reflected power or unexplained fault conditions could point to a deteriorating condition and may be found during a thorough visual inspection.

Perform the following general visual inspection:

1. With the AC power disconnected or switched off, check that all connector plugs are properly seated in their mating connectors and have not been damaged. Replace any bad connector plugs and reseat any that are dislodged.
2. Inspect electrical wiring for signs of discolored, broken, or bad insulation. Repair or replace as needed.
3. Inspect all soldered connections for any signs of corrosion, cracking, or dirt. Clean and resolder as needed.
4. Look for signs of dirt or moisture contamination, which can cause short-circuiting, arcing, corrosion, or overheating. Clean contaminated areas with a lint-free cloth, a small vacuum cleaner, or a compressed-air blower at low pressure. Beware of electrostatic discharge (ESD) when using compressed air.
5. Inspect all waveguides for discoloration, cracks, loose connectors, and improper sealing. Tighten or replace waveguides as required.
6. Check for other defects. These include, but are not limited to, wear, breakage, deterioration, fungus, excess moisture, and mounting integrity.

COLLECTOR AIR SYSTEM MAINTENANCE

The TWT collector air flow system must be checked to ensure it is properly transferring the heat into the air stream and away from the TWT. This means that verification of air flow and inspection and elimination of any contaminants restricting the air flow must be performed periodically. The recommended cycle is three months but may be required more often if local air pollution warrants it.

Follow these steps to verify proper TWT cooling:

1. Put the CMPA in Standby and allow the TWT to cool; then switch off the main power located on the front panel. Extend the CMPA if mounted in a rack and remove the top cover. (The front panel display should be dark to indicate that the power is indeed off.)
2. Place a light at the collector fan and look at the heat sink assembly from the rear exhaust. Check for buildup of foreign material that creates a reduction in air flow. Remove the TWT cooling plenum assembly and clean it if it is not clean and clear of material.

Checking Rear Cooling Fan and Collector Fan

The cooling fan is located at the rear of the CMPA. A second fan that cools the collector assembly is located inside the CMPA. Follow these steps monthly to inspect these fans:

1. With the CMPA in Standby state, verify that the fan is operating smoothly. If a mechanic's stethoscope is available, check for bearing rumble, which indicates wear. If a fan is faulty, replace it. See Fan Troubleshooting and Replacement in the "Service Manual" Vol. II.)
2. The internal collector fan can be checked by removing the top cover and monitoring the operation of the fan with power on.

WARNING:

Do not come in contact with any electrical assembly while power is applied.

3. Check for dust in the fans. An accumulation of dust is a sign that air filter needs more frequent cleaning.

Miscellaneous Cleaning

The following parts of the CMPA require routine cleaning every three months, or more frequently in unusually dirty environments. Ensure that the main power has been switched off any time it is necessary to clean inside the CMPA.

- Clean all transformers, inductors, and coils, using a small vacuum cleaner, a compressed-air blower at low pressure, or a lint-free cloth.
- Clean the front panel using a dry, clean cloth.

ELECTRICAL PREVENTIVE MAINTENANCE

Verification of CMPA operating voltages and also the metering accuracy must be performed yearly. For instructions on how to do this, refer to the "Service Manual" Vol. II CPI Part # 01019355. If any voltage is not within the range stated in the "Service Manual" for the assembly, it should be adjusted and a note in the daily log for the equipment should state the indication before and after adjustment.

In addition, perform the entire initial power on and checkout as described in Section 4, "Initial Power On and Checkout".

The assemblies to be checked and adjusted are A2 Power Factor, A1 Power Processor (heater voltage and helix voltage), and A6 Display Module (forward power, reflected power, helix monitor). Refer to the "Service Manual" Vol. II for adjustment and troubleshooting procedures.

After performance testing (described later in this section), when the characteristics of the CMPA are verified, it may be necessary to consider replacement of the TWT if the results are not within specification.

SPARE TWT MAINTENANCE

The following is a recommended conditioning procedure for spare TWTs. It is also applicable for a CMPA that has occasional use or is turned off for prolonged periods (several weeks or months).

If TWT tubes are stored for extended periods, they should be operated at least every six months using the following procedure.

NOTE

If a spare TWT is to be tested, follow the TWT installation instructions in the "Service" Manual.

1. Apply power to the CMPA; do not apply RF drive at this time. (Rotate the RF Setting control fully counterclockwise until the attenuator voltage setting reaches the end of the dynamic range—if equipped with the optional PIN Diode Attenuator.)
2. Allow the TWT to warm up for a minimum of 5 minutes, but not longer than 15 minutes; step 3 will apply operating voltages to the TWT.
3. Put the CMPA in Transmit mode by pressing the TRANSMIT/STANDBY pushbutton; the TRANSMIT LED will light.
4. Allow the CMPA to remain in the Transmit state for 5 minutes.
5. If this is successful (no arcs), the TWT should be run without RF until the Helix current has stabilized. (Helix current can be monitored on the front panel.)
6. Apply RF slowly by rotating the RF Setting control on the front panel until rated power is reached: 275 W for Ku-band and 350 W for C/X- bands.
7. Operate with and without RF input for a minimum of 30 minutes after the helix current has stabilized. The time required to stabilize varies with the age of the tube, storage time, and storage conditions.
8. Perform normal shutdown: Press TRANSMIT/STANDBY pushbutton to place CMPA in Standby mode; STANDBY LED will be lit. Allow TWT to cool before switching off main power to the CMPA.

Once the TWT is in service, it is important that the tube is operated correctly. There are three guidelines to follow:

- In Redundant Mode (1:n configuration), the amplifier should be left in Transmit state. Leaving the TWT in Standby with the heater on, for several hours, can cause accelerated aging of the cathode. This reduces the life of the TWT (even with heater backoff) and may create gas that will poison the cathode and reduce the emission.
- The collector heat sink must be kept clean. If the heat sink becomes clogged, the collector can overheat and over a long period can produce gassing of the TWT; this can poison the cathode and affect the performance. Cleaning the external cooling air filter(s) is similarly important.
- The heater must be operated at the nameplate voltage for the particular TWT. A voltage setting too high or too low can cause premature failure. However, when the TWT is old and the beam current drops due to cathode depletion, the heater voltage can be raised 5 percent without causing any harm.

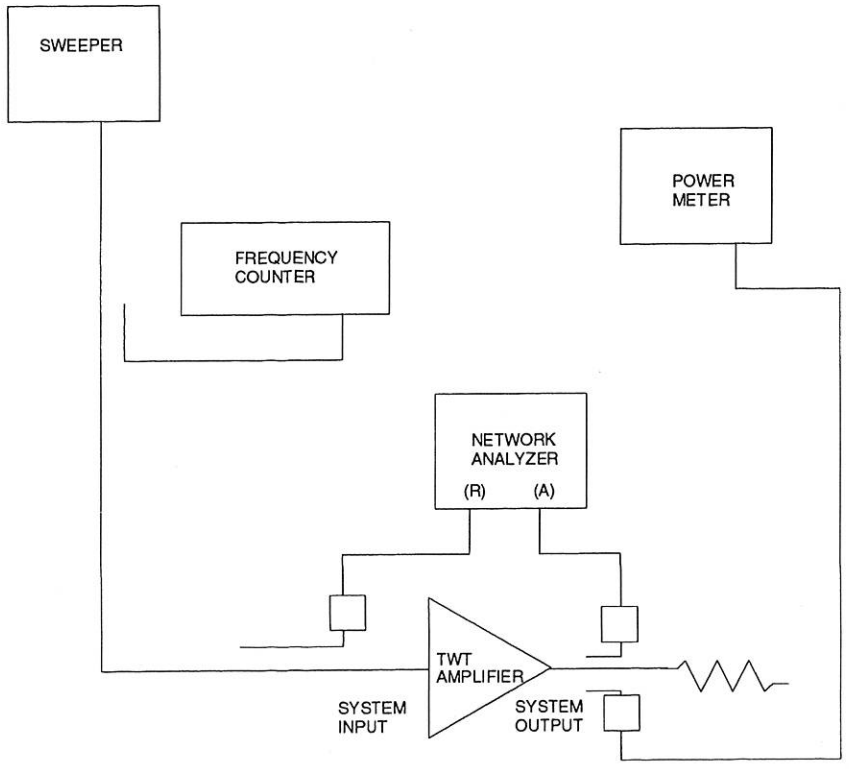
PERFORMANCE TESTING

At 6-month intervals, perform the tests for power and gain and record their results. If the results are not satisfactory then troubleshooting of the RF system and possible replacement of assemblies may be required. (Refer to the "Service" Manual if required.)

Certain test equipment is required for the performance testing procedures. Table 6-2 lists the recommended equipment; equipment with equivalent accuracy or capacity may be substituted.

TABLE 6-2
Recommended Test Equipment

MODEL #	TYPE AND DESCRIPTION
	Sweep Signal Generator
	Frequency Counter
	Scalar Analyzer
	Power Meter
	Power Sensor



TWT Amplifier Test Setup

Figure 6-1

POWER AND GAIN

Follow these steps to test the CMPA power and gain. Record the results on the chart provided in Table 6-3, "CMPA Performance Data Log".

1. Connect equipment as shown in Figure 6-1.
2. Set drive level to minimum and CMPA gain to maximum.
3. Set sweeper to CW so that frequencies selected will be used every time preventive maintenance is performed and a trend can be developed.
4. Increase drive level until CMPA has reached saturation. Record level on the test data sheet.
5. Reduce drive level until CMPA is at rated power out (if step 4 is greater).
6. Calculate gain and record on test data sheet. Gain = Po (dbm) - Pi (dbm).
7. Reduce drive level until CMPA is at rated power—10 dB. It may be necessary to use a 10 dB fixed attenuator at the CMPA input to achieve a reliable input power measurement.
8. Calculate gain and record on the test data sheet.
9. Repeat for all required frequencies.

TABLE 6-3
CMPA Performance Data Log

Date_____

CMPA Model_____ S/N_____

TWT Model_____S/N_____

Heater Voltage (see note)_____ V

Heater Current (see note)_____ A

Helix Voltage _____ kV

Collector 1 Voltage (see note)_____ kV

Collector 2 Voltage (see note)_____ kV

Beam Current (see note)_____ A

Helix Current (No RF)_____ mA

NOTE

Measured using optional "Break-out Box" available from CPI.

Freq	Power Out–Maximum (Do not exceed Rated)	Gain @ Rated/Max Power
F1_____	_____	_____
F2_____	_____	_____
F3_____	_____	_____
F4_____	_____	_____

Min Power Spec_____ dBm

Min Gain Spec_____ dB @ Rated

Tested By_____

SECTION 7

DRAWINGS AND SCHEMATICS

This section contains drawings and schematics for the Compact Medium Power Amplifier (CMPA). Table 7-1 contains a list of drawings and their drawing numbers.

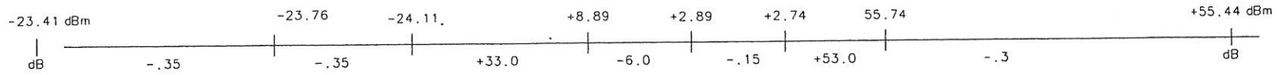
TABLE 7-1
Compact MPA Drawings

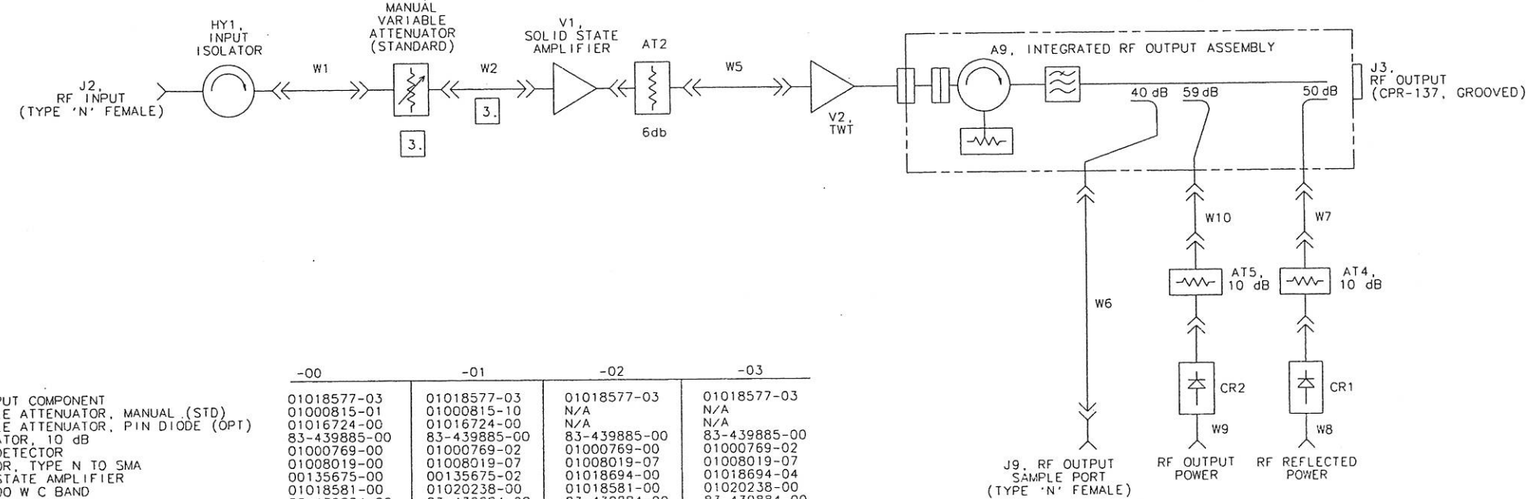
Title	Drawing Number
Outline, C-band Compact MPA	01018593
Outline, X-band Compact MPA	01018596
Outline, Ku-band Compact MPA	01018602
RF Diagram, C-band Compact MPA	01018591
RF Diagram, X-band Compact MPA	01019458
RF Diagram, Ku-band Compact MPA	01018614
Interconnect, Compact MPA	01018601

Drawings are in numerical order.

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	1	PRE-RELEASE		5/31/94	
	-	ENG. RELEASE		7/11/94	WCJ
	2	INC ECO	37563	10/14/94	WCJ/WCJ
	3	INC ECO	D0193	05/08/95	DC/
	4	INC ECO	D1359	4-27-96	VC/TH
	5	INC ECO	D2607	4/19/97	JD/
	6	INC ECO	D4041	3/31/98	ON/

TYPICAL LEVEL DIAGRAM





		-00	-01	-02	-03
A9	RF OUTPUT COMPONENT	01018577-03	01018577-03	01018577-03	01018577-03
AT1	VARIABLE ATTENUATOR, MANUAL (STD)	01000815-01	01000815-10	N/A	N/A
AT1	VARIABLE ATTENUATOR, PIN DIODE (OPT)	01016724-00	01016724-00	N/A	N/A
AT4, AT5	ATTENUATOR, 10 dB	83-439885-00	83-439885-00	83-439885-00	83-439885-00
CR1, CR2	DIODE DETECTOR	01000769-00	01000769-02	01000769-00	01000769-02
HY1	ISOLATOR, TYPE N TO SMA	01008019-00	01008019-07	01008019-07	01008019-07
V1	SOLID STATE AMPLIFIER	00135675-00	00135675-02	01018694-00	01018694-04
V2	TWT, 400 W C BAND	01018581-00	01020238-00	01018581-00	01020238-00
AT2	ATTENUATOR, 6db	83-439884-00	83-439884-00	83-439884-00	83-439884-00

3. COMPONENTS USED IN -00 + -01 VERSIONS ONLY.

2. ALL REFERENCE DESIGNATORS REFER TO BASIC C BAND AMPLIFIER LM # 01018591.

1. ACTUAL COMPONENT VALUES DETERMINED IN TEST. COMPONENTS SHOW TYPICAL VALUES.

NOTES: UNLESS OTHERWISE SPECIFIED.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

DASH NO.	NEXT ASSEMBLY	USED ON
-02	01018590	VZC-6964AA
-01	01018590	VZC-6964AA
-00	01018590	VZC-6964A4
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC. 1PL ± .1 2PL ± .02
FRAC ± 1/64
ANG ± 1° SURFACE FINISH √
MATERIAL
SPEC NO.

DR	B. JAZBEC	5/31/94
CHK		
APPD		
APPD		
DESIGN ACTIVITY APPROVAL		
CUSTOMER APPROVAL		

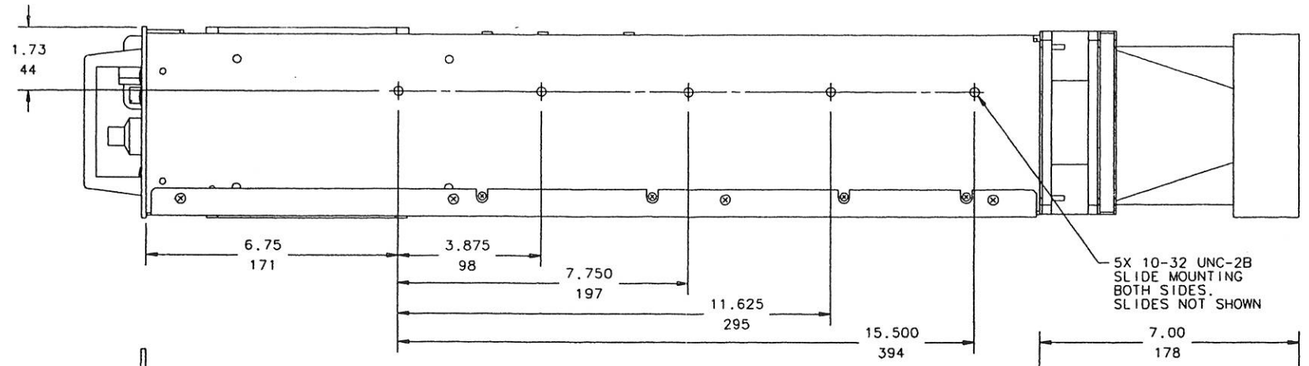
Communications & Power Industries
SATCOM DIVISION

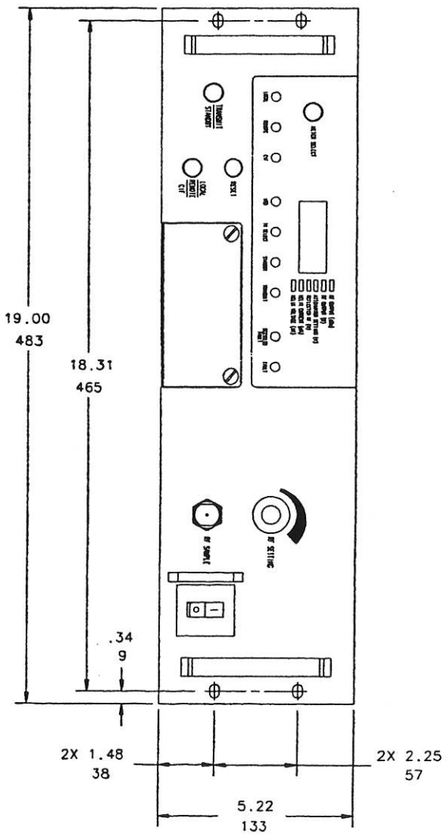
RF DIAGRAM, COMPACT MPA, C BAND

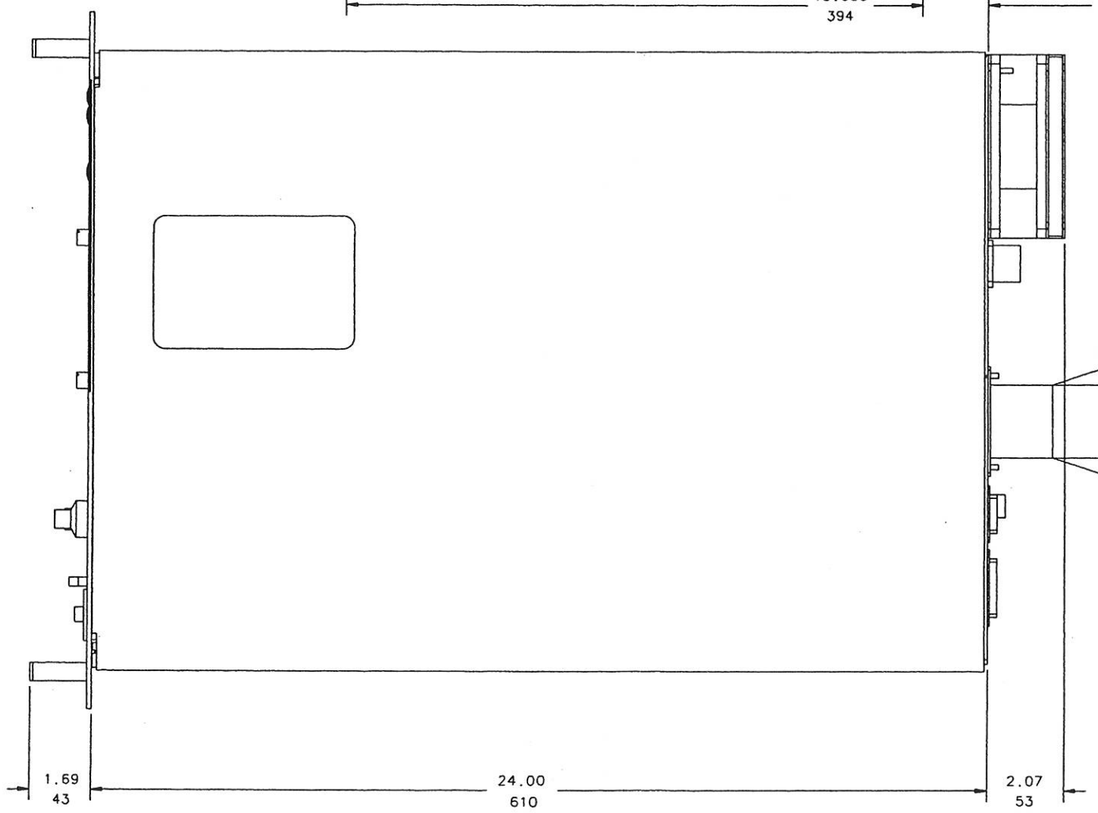
SIZE	FSCM NO.		
D	59782	01018591	6
SCALE: NONE	CLASS B	SHEET 1 OF 1	

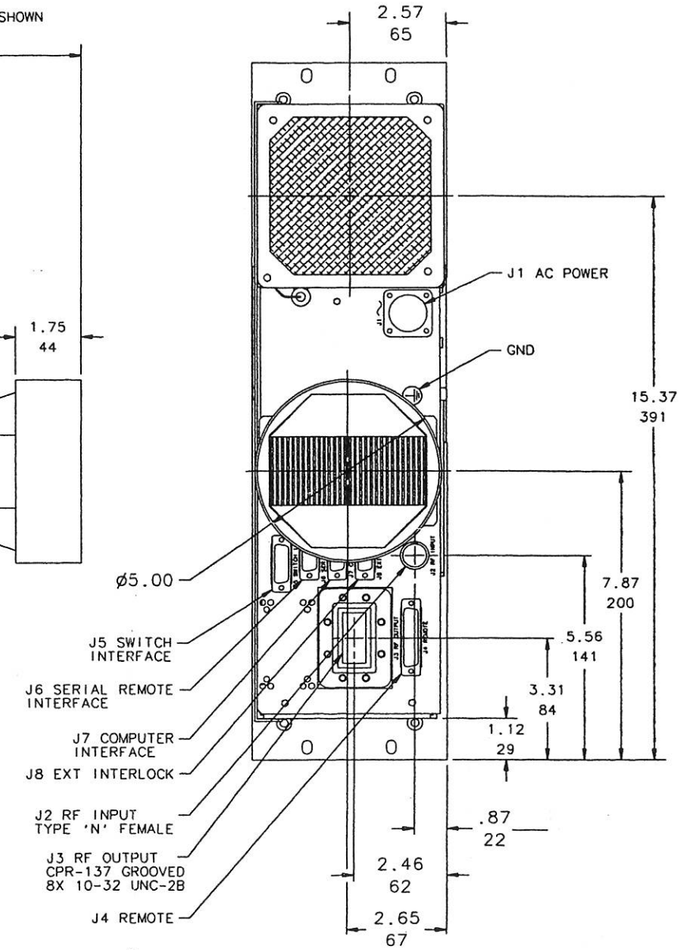
D 01018591

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	1	PRE-RELEASE		08/17/94	
	2	ADDED FAN FILTER		08/30/94	
	-	ENG RELEASE		08/31/94	BP
	3	INC ECO	D2173	11/17/96	JD/









D 01018593

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PROJECTION
INCH
MM

01022098	VZC-6962E2	
01018638	VZC-6964A4	
NEXT ASSEMBLY	USED ON	
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC: 1PL ± .1 2PL ± .02
3PL± .005 FRAC 1/64
ANG± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

DR	D. COTE	08/17/94
CHK		
APPD		
APPD		
DESIGN ACTIVITY APPROVAL		
CUSTOMER APPROVAL		

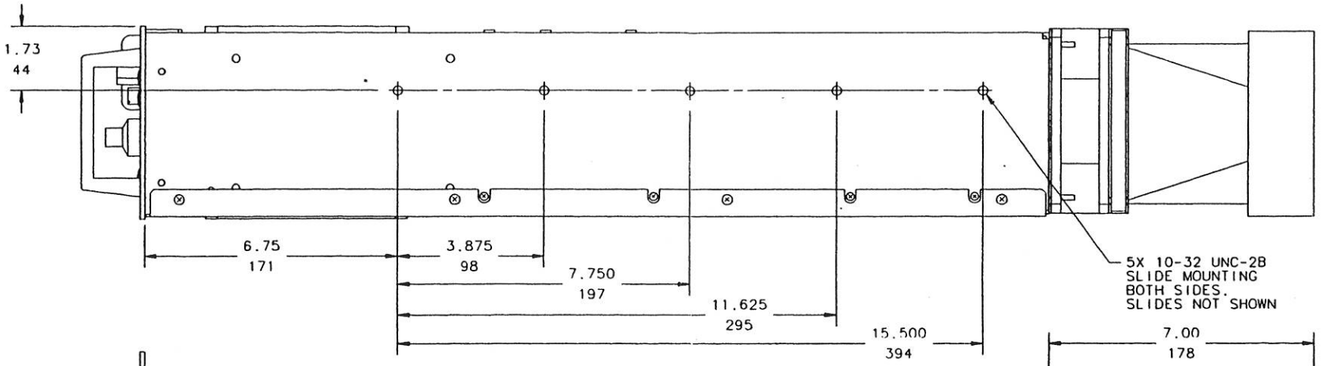
Communications & Power Industries
SATCOM DIVISION

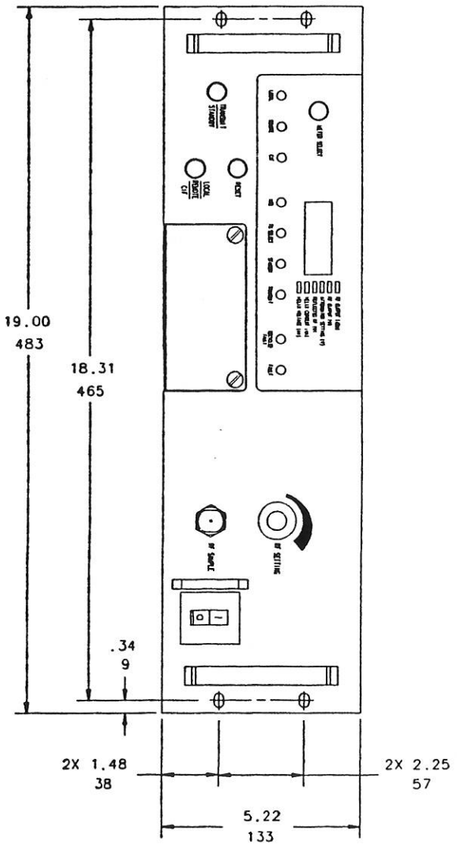
OUTLINE, C BAND COMPACT MPA/LPA

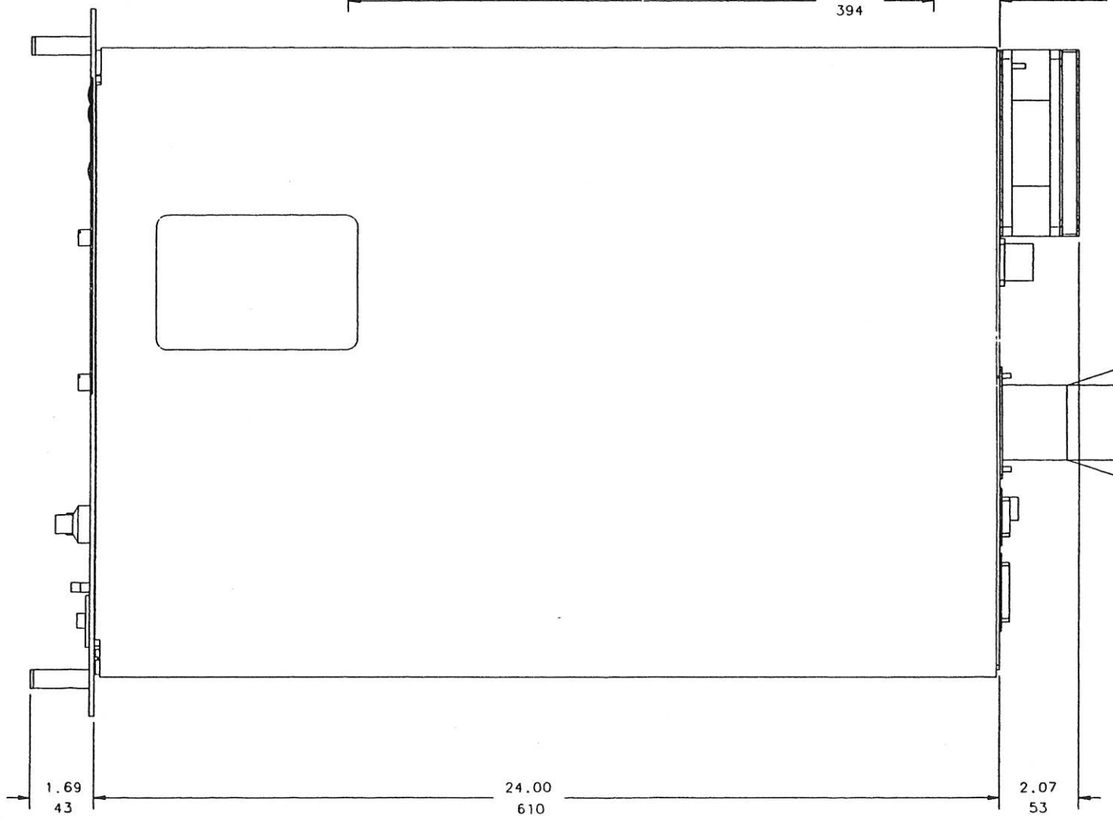
SIZE	FSCM NO.		
D	59782	01018593	3
SCALE: 1/2	CLASS B	SHEET 1 OF 1	

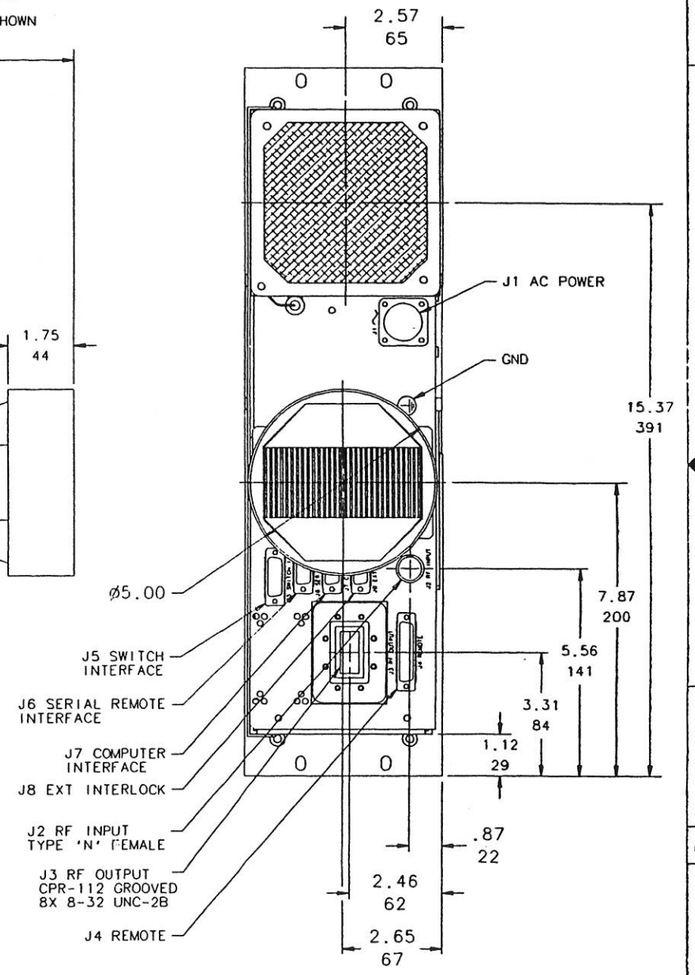
CAD= cmpa->01018982.asc

REVISIONS				
ZONE	REV	DESCRIPTION		APPROVED
	1	PRE-RELEASE	10/6/94	
	-	ENG RELEASE	4/6/94	









COPY

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

PROJECTION

INCH
MM

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.

NEXT ASSEMBLY	USED ON
01018595	VZX-6984A3
APPLICATION	

DR	D. COTE	09/01/94
CHK		
APPD		
APPD		
DESIGN ACTIVITY APPROVAL		
CUSTOMER APPROVAL		

varian — microwave equipment products
SANTA CLARA, CALIFORNIA

OUTLINE, X BAND COMPACT MPA

SIZE	FSCM NO.		
D	59782	01018596	1

SCALE. 1/2 CLASS B SHEET 1 OF 1

D 01018596

CAD= cmpa->d_01018986.asc

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	7	ENG. RELEASE		9/5/94	
	8	INC ECO	37435	9/16/94	
	9	INC ECO	37605	11/11/94	BJ
	10	INC ECO	37747	12-20-94	BJ/BJ
	11	INC ECO	D1206	4-30-96	VC/

AC PWR INLET J1 — LINE, NEUT, GND — EMI FILTER — CB1 — PWR FACTOR MODULE (A1) — +375V, 375 RTN — +28VDC PS (A3) — +28V, 28V RTN, +28V, 28V RTN — B1, B2

PWR ON INDICATOR, INDICATOR RTN

POWER PROCESSOR CCA (A2)

HIGH VOLTAGE MODULE ASSY (A4) — 20KHZ — TB1 — J1: HELIX F.B., HELIX F.B. RTN, 16VAC .A, 16VAC .B, HTR C.T., INTERLOCK, HELIX V MONITOR, ARC TRIP, HELIX I AVG, HELIX RTN

A4J2 TWT P2: CATHODE, HEATER, COLLECTOR 1, COLLECTOR 2, HELIX, INTERLOCK, THERMAL RTN, THERMAL

TWT J1

COVER INTERLOCK S1

DC-DC ASSY (A8): +16V, GND, +5V, GND, +5V, GND, +5V ISO, +5 ISO RTN

RF MONITOR PCB (A7): +15V, -15V, GND, RF OUTPUT, RF OUT RTN, REFL RF, REFL RF RTN, TWT B.P. TEMP, TWT B.P. RTN, PEAK IND., THERM ALARM, PEAK/THERM RTN, GND

J1: STATUS RTN, DC BIAS STATUS, +5 ISO RTN, +5 ISO, GND, +5V, GND, +5V, +16V, +15V, GND, -15V, PS THERM/INTRLK, HBO CMMD, HV ON CMMD, GND, HELIX V MON., ARC TRIP, HELIX I AVG, HELIX RTN, THERM/INTRLK RTN, TWT THERM

uP/LOGIC CONTROLLER (A5)

J2: PWR STATUS, PWR STATUS RTN, RF OUTPUT, RF OUTPUT RTN, REFL RF PWR, REFL RF RTN, TWT B.P. TEMP, TWT B.P. RTN, PEAK IND., THERMAL ALARM, PEAK/THERM RTN, GND, +16V IPA, GND, +15V, GND, -15V, GAIN CNTRL, RF UP CNTRL, RF DOWN CNTRL, RF UP/DN RTN

J8, J7, J6, J5 — 40 CONDUCTOR RIBBON CABLE — J4

J3 — A6J1 — 01018685 40 WIRE RIBBON CABLE

J4 — 26 CONDUCTOR RIBBON CABLE — J2 — FRONT PANEL/DISPLAY (A6)

IPA ASSY

A11J1, A11P1 — PIN DIODE RF UP/DOWN SWITCH (A11) — COMMON PIN 10 — 1 - RED, 10 - GRN, 3 - BLK

A10P1, A10J1 — +15, GND, -15, CV — PIN DIODE ATTEN. (OPTIONAL) (A10)

FILE COPY
MAKE YOUR OWN COPY
REPLACE IN THE FILE

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.

DASH NO.	NEXT ASSEMBLY	USED ON
	01018600	VZU-6994A3
		VZC-6964A4
		VZX-6984A3
	APPLICATION	

DR	T. HOLTHOUSE	5/13/94
CHK		
APPD		
APPD		
DESIGN ACTIVITY APPROVAL		
CUSTOMER APPROVAL		

varian VA — microwave equipment products — SANTA CLARA, CALIFORNIA

INTERCONNECT DIAGRAM, POWER SUPPLY ASSEMBLY, COMPACT MPA

SIZE	FSCM NO.		
D	59782	01018601	11
SCALE: NONE	CLASS B	SHEET 1 OF 2	

D 01018601

REVISIONS
SEE SHT 1

AC PWR INLET J1 — LINE, NEUT, GND — EMI FILTER — LINE, NEUT — CB1 (LINE, LOAD)

PWR FACTOR MODULE (A1) — E1, E2 — 5 6 2 1 — +375V J2, J3 — 375 RTN J4, J5 — CB1J

J1 — 1 GND, 3 N, 5 L — +28VDC PS (A3)

J2 — 10 8 9 7 2 1 / 1 3 2 4 9 10 — +28V, 28V RTN, +28V, 28V RTN — B1, B2

PWR ON INDICATOR
INDICATOR RTN

LINEARIZER OPTION (A12) — J1 — GND, -15V, +16V — A12P2 — TO J4 W/THIS OPTION

POWER PROCESSOR CCA (A2) — E6 E5 E2 E1 — E3 E4

HELIX F.B	25	4	HELIX F.B.
HELIX F.B. RTN	13	2	HELIX F.B. RTN
16VAC .A	6	10	16VAC .A
16VAC .B	7	9	16VAC .B
HTR C.T.	21	8	HTR C.T.
THERMAL/INTLK	9	7	INTERLOCK
+15V	2	6	HELIX V MONITOR
-15V	1	3	ARC TRIP
GND	4	5	HELIX I AVG
		1	HELIX RTN

J1 — GND, +16V, -15V, +16V, GND, -15V, GND, THERM/INTLK, HBD CMND, HV ON CMND, GND

20KHZ — TB1 — J1 — HIGH VOLTAGE MODULE ASSY (A4)

A4J2 TWT P2

6	CATHODE
5	HEATER
3	COLLECTOR 1
4	COLLECTOR 2
1	HELIX
2	INTERLOCK

THERMAL RTN
THERMAL

TWT J1 — A B C

COVER INTERLOCK S1 — 1 2

DC-DC ASSY
DC-DC ASSY (A8)

+16V	1
GND	2
+5V	3
GND	4
+5V	5
GND	6
+5V ISO	7
+5 ISO RTN	8

J1 — STATUS RTN, DC BUSS STATUS, +5 ISO RTN, +5 ISO, GND, +5V, GND, +5V, +16V, +15V, GND, -15V, PS THERM/INTRLK, HBD CMND, HV ON CMND, GND, HELIX V MON., ARC TRIP, HELIX I AVG, HELIX RTN, THERM/INTRLK RTN, TWT THERM

uP/LOGIC CONTROLLER (A5)

PWR STATUS	20
PWR STATUS RTN	21
RF OUTPUT	1
RF OUTPUT RTN	2
REFL RF PWR	5
REFL RF RTN	6
TWT B.P. TEMP	3
TWT B.P. RTN	4
PEAK IND.	14
THERMAL ALARM	15
PEAK/THERM RTN	16
GND	12
+16V IPA	7
GND	8
+15V	9
GND	10
-15V	11
GAIN CNTRL	13
RF UP CNTRL	17
RF DOWN CNTRL	19
RF UP/DN RTN	18

J2 — J3 — A6J1 — 01018685 40 WIRE RIBBON CABLE

J8, J7, J6, J5 — 40 CONDUCTOR RIBBON CABLE — J4

J4 — 26 CONDUCTOR RIBBON CABLE (NOT USED W/LINEARIZER OPTION) — J2

FRONT PANEL/DISPLAY (A6)

A11J1 — A, B, C — A11P1

COMMON PIN 10 — 10 1 3 — PIN DIODE RF UP/DOWN SWITCH (A11)

1 - RED
10 - GRN
3 - BLK

A10P1 — J1

23	+16 RF CIRCUIT
10	GND RF CIRCUIT
11	+ 15V
12	GND
9	-15V
25	RF CONT.

IPA W/PIN DIODE (A10)

J3 — 1 +15V, 3 -15V, 2 GND, 7 RF OUTPUT, 8 RF OUT RTN, 9 REFL RF, 10 REFL RF RTN, 13 TWT B.P. TEMP, 14 TWT B.P. RTN, 15 PEAK IND., 11 THERM ALARM, 12 PEAK/THERM RTN, 4 GND

RF MONITOR PCB (A7)

FOR -03
POWER SUPPLY ONLY

D 01018601

FILE COPY
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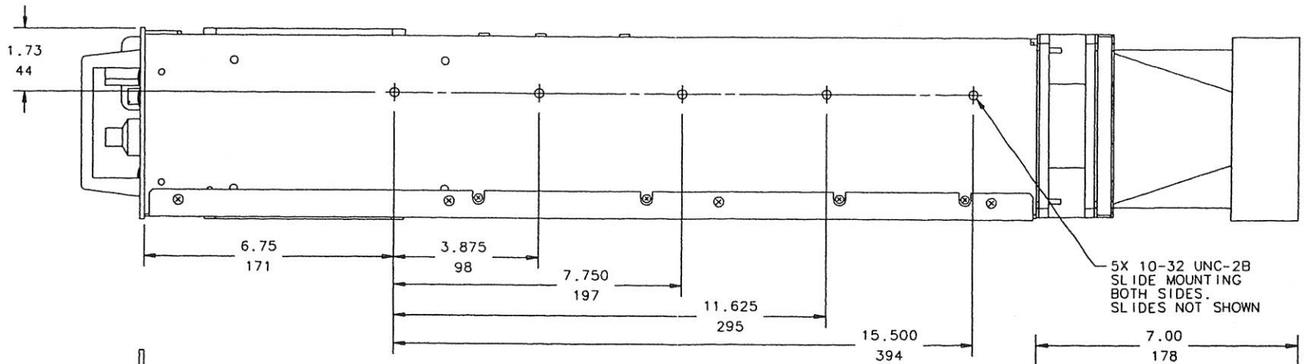
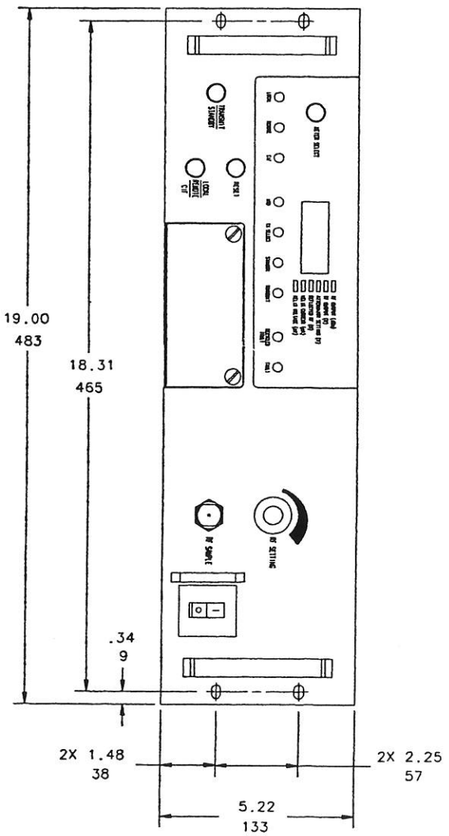
REPLACE IN THE FILE

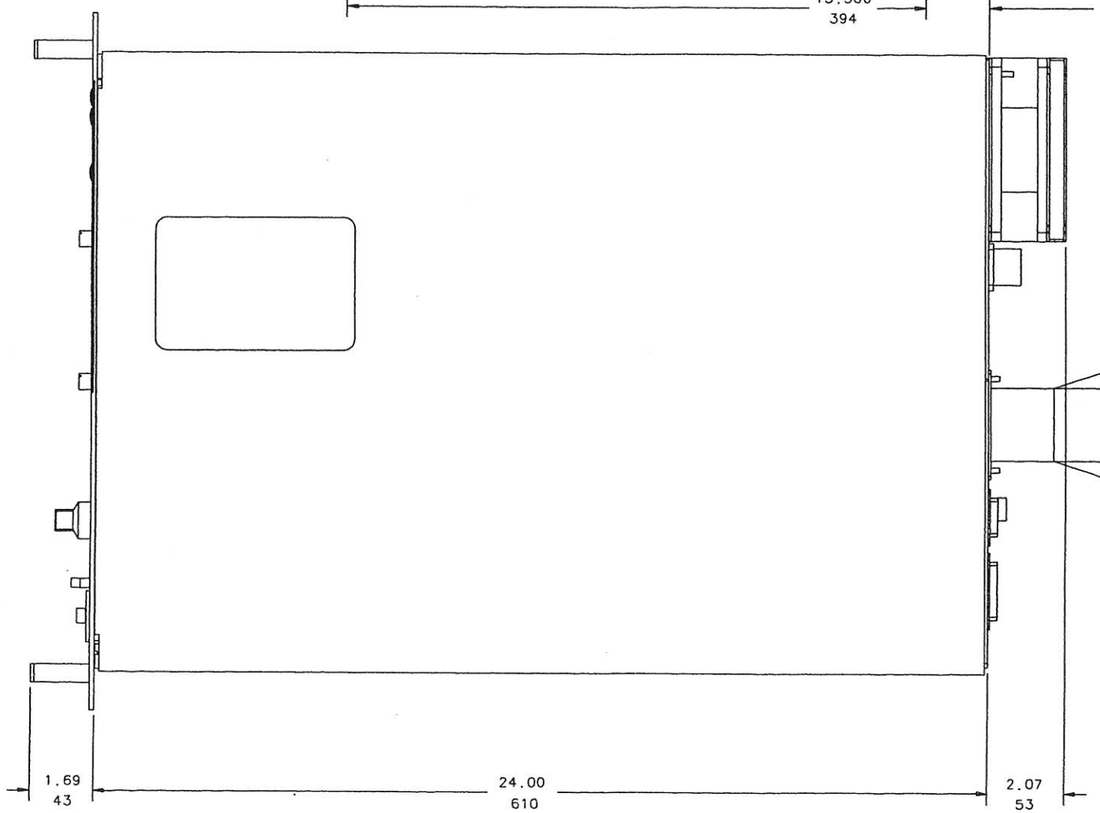
INTERCONNECT DIAGRAM,
POWER SUPPLY ASSEMBLY,
COMPACT MPA

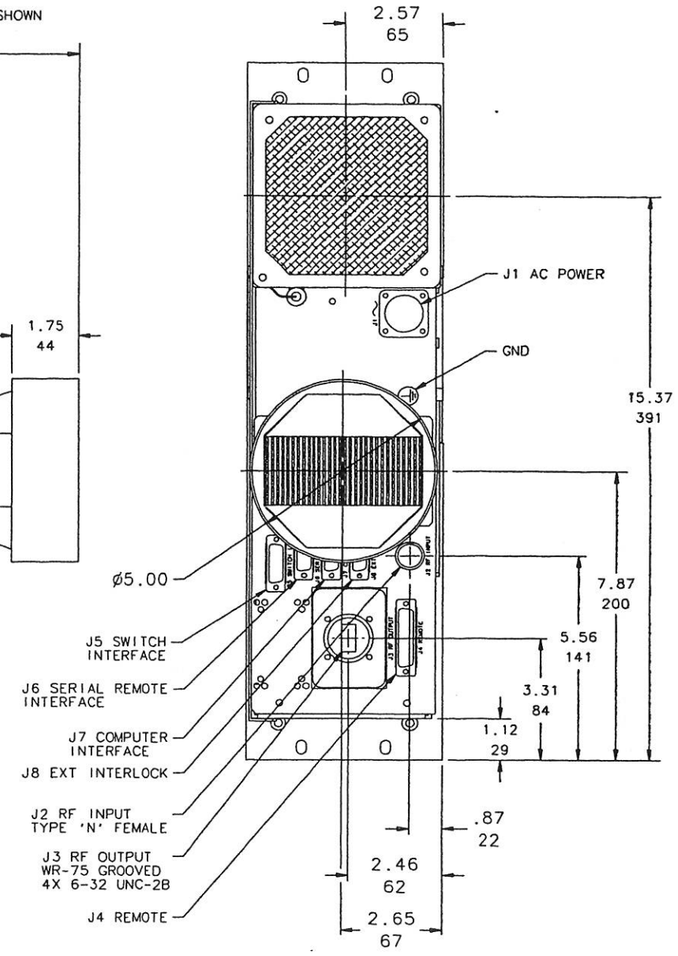
SIZE	FSCM NO.		
D	59782	01018601	11
SCALE: NONE	CLASS B	SHEET 2 OF 2	

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	1	PRE-RELEASE		10/26/93	
	2	REVISED AND REDRAWN		01/12/94	
	3	MOVED AC PWR & INPUT ISOLATOR		01/18/94	
	4	ADDED AIR DUCTS		02/18/94	
	5	ADDED SIDE VIEW		03/26/94	
	6	REDESIGNED		07/18/94	
	7	ADDED FAN FILTER		08/29/94	
	-	ENG RELEASE		08/29/94	BP
	8	INC ECO	D2173	11/17/96	JD/









D 01018602

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PROJECTION
INCH
MM

01022097	VZU-6992E2	
01018599	VZU-6994A3	
NEXT ASSEMBLY	USED ON	
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC: 1PL ± .1 2PL ± .02
3PL± .005 FRAC 1/64
ANG: 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
LIST OF MATERIALS				

DR	D. COTE	10/26/93	Communications & Power Industries SATCOM DIVISION
CHK			
APPD			
APPD			
DESIGN ACTIVITY APPROVAL			
CUSTOMER APPROVAL			

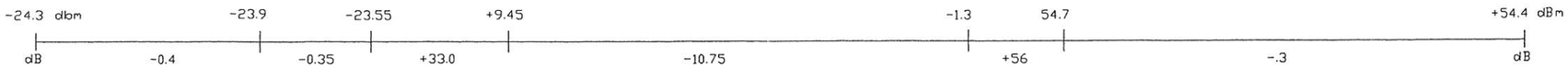
OUTLINE, Ku BAND COMPACT MPA/LPA

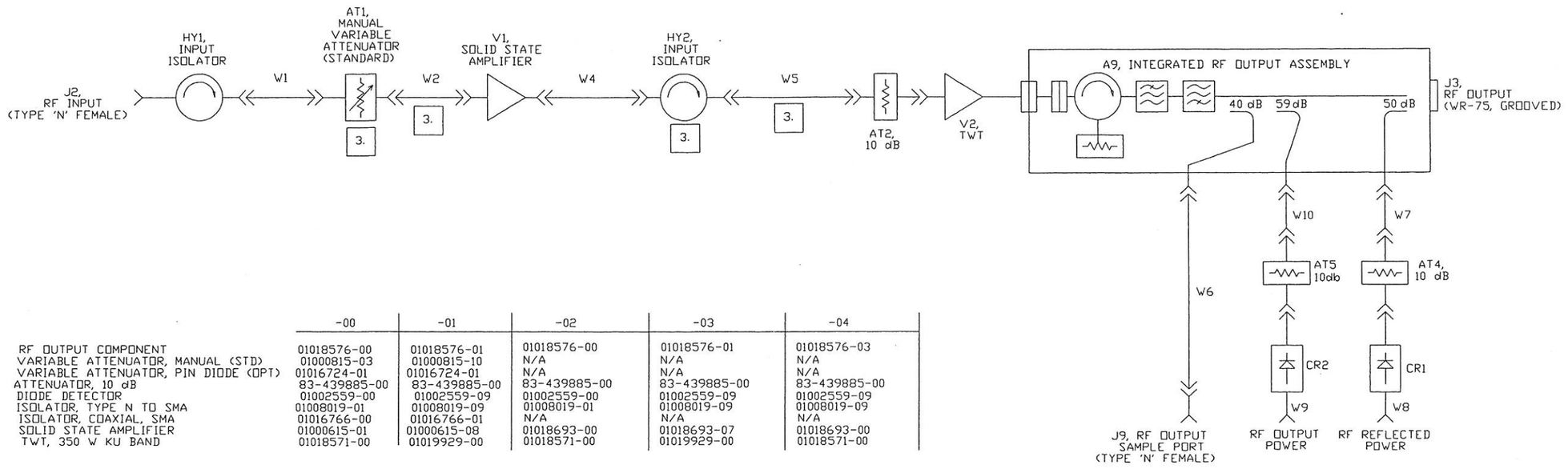
SIZE	FSCM NO.		
D	59782	01018602	8
SCALE: 1/2	CLASS B	SHEET 1 OF 1	

CAD= cmpa->01018602.asc

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	1	PRE-RELEASE		12/17/93	
	2	CLEANED UP		1/11/94	
	3	CHANGED FORWARD COUPLING		01/13/94	
	4	ADDED LOW PASS FILER P/N		01/27/94	
	5	REMOVED LOW PASS FILTER,		05/23/94	
		FIXED ERRORS			
	-	ENG. RELEASE		6/10/94	
	6	ECO INC	37452	9-14-94	AT/MJC
	7	ECO INC	D0191	5-09-95	DC/
	8	ECO INC	D1359	4-19-96	VC/
	9	ECO INC	D2607	4/19/97	JD/
	10	ECO INC	D3245	11/11/97	ON/

TYPICAL LEVEL DIAGRAM





		-00	-01	-02	-03	-04
A9	RF OUTPUT COMPONENT	01018576-00	01018576-01	01018576-00	01018576-01	01018576-03
AT1	VARIABLE ATTENUATOR, MANUAL (STD)	01000815-03	01000815-10	N/A	N/A	N/A
AT1	VARIABLE ATTENUATOR, PIN DIODE (OPT)	01016724-01	01016724-01	N/A	N/A	N/A
AT5, AT2, AT4	ATTENUATOR, 10 dB	83-439885-00	83-439885-00	83-439885-00	83-439885-00	83-439885-00
CR1	DIODE DETECTOR	01002559-00	01002559-09	01002559-00	01002559-09	01002559-09
HY1	ISOLATOR, TYPE N TO SMA	01008019-01	01008019-09	01008019-01	01008019-09	01008019-09
HY2	ISOLATOR, COAXIAL, SMA	01016766-00	01016766-01	N/A	N/A	N/A
V1	SOLID STATE AMPLIFIER	01000615-01	01000615-08	01018693-00	01018693-07	01018693-00
V2	TWT, 350 W KU BAND	01018571-00	01019929-00	01018571-00	01019929-00	01018571-00

3. COMPONENTS USED IN -00 + -01 VERSIONS ONLY.

2. ALL REFERENCE DESIGNATORS REFER TO BASIC KU BAND AMPLIFIER LM # 01018700.

1. ACTUAL COMPONENT VALUES DETERMINED IN TEST. COMPONENTS SHOW TYPICAL VALUES.

NOTES: UNLESS OTHERWISE SPECIFIED.

DASH NO.	NEXT ASSEMBLY	USED ON
-02	01018700-04	VZU-6994AC
-03	01018700-03	VZU-6994AB
-02	01018700	VZU-6994A3
-01	01018700	VZU-6994AB
-00	01018700	VZU-6994A3
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC.1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

DR	D. COTE	12/17/93	
CHK			
APPD			
APPD			
DESIGN ACTIVITY APPROVAL			
CUSTOMER APPROVAL			

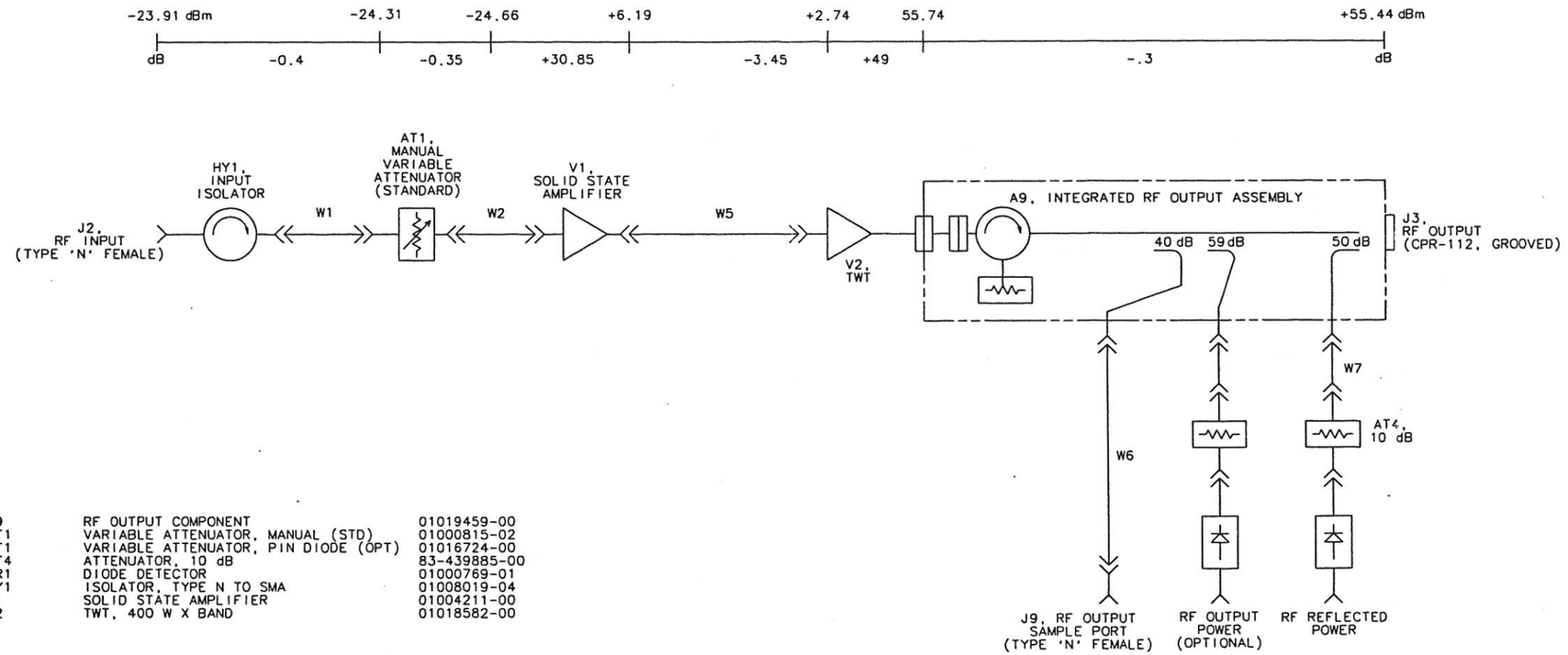
Communications & Power Industries
SATCOM DIVISION

RF DIAGRAM, COMPACT MPA, Ku BAND

SIZE	FSCM NO.		
D	59782	01018614	10
SCALE: NONE	CLASS B	SHEET 1 OF 1	

REVISIONS					
ZONE	REV	DESCRIPTION	ECO	DATE	APPROVED
	1	PRE-RELEASE		09/01/94	
	-	ENG. RELEASE		09/09/94	WCJ
	2	INC ECO	D0522	08/22/95	MGA

TYPICAL LEVEL DIAGRAM



A9	RF OUTPUT COMPONENT	01019459-00
AT1	VARIABLE ATTENUATOR, MANUAL (STD)	01000815-02
AT1	VARIABLE ATTENUATOR, PIN DIODE (OPT)	01016724-00
AT4	ATTENUATOR, 10 dB	83-439885-00
CR1	DIODE DETECTOR	01000769-01
HY1	ISOLATOR, TYPE N TO SMA	01008019-04
V1	SOLID STATE AMPLIFIER	01004211-00
V2	TWT, 400 W X BAND	01018582-00

2. ALL REFERENCE DESIGNATORS REFER TO BASIC X BAND AMPLIFIER LM # 01018595.

1. ACTUAL COMPONENT VALUES DETERMINED IN TEST. COMPONENTS SHOW TYPICAL VALUES.

NOTES: UNLESS OTHERWISE SPECIFIED.

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D 01019458

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DEC: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH √
MATERIAL

DASH NO.	NEXT ASSEMBLY	USED ON
-00	01018595	VZX-6984A4

APPLICATION SPEC NO.

DR	D. COTE	09/01/94
CHK		
APPD		
APPD		
DESIGN ACTIVITY APPROVAL		
CUSTOMER APPROVAL		

varian VA — microwave equipment products — SANTA CLARA, CALIFORNIA

RF DIAGRAM, COMPACT MPA, X BAND

SIZE	FSCM NO.		
D	59782	01019458	2

SCALE: NONE CLASS B SHEET 1 OF 1

SECTION 8

SUPPLEMENTARY DATA

This section includes the following appendixes:

- **Appendix A: Specifications**
- **Appendix B: Front Panel Controls**
- **Appendix C: Replaceable Parts**
- **Appendix D: Warranty/Support Information**
- **Appendix E: Options and Features**

APPENDIX A

SPECIFICATIONS

This appendix lists the technical specifications and requirements of the Compact Medium Power Amplifier (CMPA), which has three versions:

- **Model VZC-6964A4 C-Band 5.85–6.65 GHz**
- **Model VZC-6964AA Extended C-Band 5.85–7.075 GHz**
- **Model VZC-6964AD Special C-Band 5.715-5.765 GHz**
- **Model VZX-6984A4 X-Band 7.90–8.40 GHz**
- **Model VZU-6994A3 Ku-Band 14.0–14.50 GHz**
- **Model VZU-6994AB Extended Ku-Band 12.75–14.50 GHz**
- **Model VZU-6994AP Special Ku-Band 14.7–15.2 GHz**
- **Model VZU-6994AC Ku-Band 13.75–14.5 GHz**

Included are the application notes, electrical requirements, output specifications, environmental specifications, mechanical specifications, locations of customer interfaces, and worst-case accuracies for the meters and other instruments.

APPLICATION

The Compact Medium Power Amplifier (CMPA) is a microwave amplifier that is used for satellite uplink transmissions. It can operate in one of three bands: C-, X-, or Ku-band. In an electrical block diagram sense, the amplifier may be split into three sections: RF, high-voltage power supply, and controls.

- The RF section consists of a Solid-State Intermediate Power Amplifier (SSIPA) that feeds a Traveling Wave Tube (TWT). The output of the tube is filtered, then fed to the output flange for the user to plumb to the antenna.
- The high-voltage power supply section provides the power for the TWT.
- The control section is multifaceted. It supports a front panel and two remote serial interfaces, monitors the CMPA for fault conditions, and sequences the high voltage and RF sections based on these inputs.

NOTE:

The following pages contain separate electrical specifications for the C-band, X-band, and Ku-band.

TABLE A-1
Electrical Specifications—C-Band

Frequency	5.850-6.650 GHz (Optional 5.85-7.075 GHz 5.715-5.765 GHz)
Output Power	
• TWT	400 W
• Flange	350 W
Bandwidth	800 MHz
Gain	
• At rated power	75 dB minimum
• Small signal	78 dB minimum
RF Level Adjust Range	0 to 20 dB
Output Power Setability	± 0.2 dB
Gain Stability	
At constant drive and temperature	± 0.25 dB/24-hr maximum (30-min warm-up) ± 1.0 dB over oper. temp range (typical) ± 0.75 dB over ± 10°C (typical)
Gain Slope	± 0.02 dB/MHz maximum
Gain Variation	
• Across any 80 MHz band	1.0 dB peak-to-peak
• Across the 800 MHz band	2.5 dB peak-to-peak
Input VSWR	1.3:1 maximum
Output VSWR	1.3:1 maximum
Load VSWR	
• Full spec compliance	1.5:1
• Operation without damage	Any value
• Continuous operation	2.0:1 maximum
Residual AM	
• Below 10 kHz	-50 dBc
• 10 to 500 kHz	-20 (1.3 + logF kHz) dBc
• Above 500 kHz	-85 dBc

TABLE A-1
Electrical Specifications—C-Band (Continued)

Phase Noise	
• IESS phase noise profile	-6 dBc
• AC fundamental	-36 dBc
• Sum of all spurs	-47 dBc
AM/PM Conversion	2.5°/dB maximum for a single carrier at 6 dB below rated power
Harmonic Output	-60 dBc at rated power, second and third harmonics
Noise and Spurious (at rated gain)	<-130 dBw/4 kHz, 3.4 to 4.2 GHz <-65 dBw/4 kHz, 4.2 to 12.0 GHz <-110 dBw/4 kHz, 12.0 to 40.0 GHz
Noise Figure	10 dB maximum (including SSIPA)
Intermodulation	-24 dBc or better with two equal carriers at total power level 7 dB below rated single carrier output
Group Delay	0.02 ns/MHz linear maximum
	0.001 ns/MHz sq. parabolic maximum
	0.5 ns p-p ripple max. (in any 40 MHz band)
Primary Power Voltage Frequency	 Single phase, 110 - 240 VAC ± 10% 47-63 Hz
Power Factor	0.95 min. (meets requirements of IEC-555- total harmonic distortion)
Power Consumption	1.3 kVA (typical) 1.5 kVA (maximum)
Inrush Current	200% maximum

TABLE A-2
Electrical Specifications—X-Band

Frequency	7.900-8.400 GHz
Output Power	
• TWT	400 W
• Flange	350 W
Bandwidth	500 MHz
Gain	
• At rated power	75 dB minimum
• Small signal	78 dB minimum
RF Level Adjust Range	0 to 20 dB
Output Power Setability	± 0.2 dB
Gain Stability	
At constant drive and temperature	± 0.25 dB/24-hr maximum (30-min warm-up)
Gain Slope	± 0.02 dB/MHz maximum
Gain Variation	
• Across any 80 MHz band	1.0 dB peak-to-peak
• Across the 500 MHz band	2.5 dB peak-to-peak
Input VSWR	1.3:1 maximum
Output VSWR	1.3:1 maximum
Load VSWR	
• Full spec compliance	1.5:1
• Operation without damage	Any value
• Continuous operation	2.0:1 maximum
Residual AM	
• Below 10 kHz	-50 dBc
• 10 to 500 kHz	-20(1.3 + logF kHz) dBc
• Above 500 kHz	-85 dBc
Phase Noise	
• IESS phase noise profile	-6 dBc
• AC fundamental	-36 dBc
• Sum of all spurs	-47 dBc

TABLE A-2
Electrical Specifications—X-Band (Continued)

AM/PM Conversion	2.5°/dB maximum for a single carrier at 6 dB below rated power
Harmonic Output	-60 dBc at rated power, second and third harmonics
Noise and Spurious (at rated gain)	<-70 dBw/4 kHz, 7.9 to 8.4 GHz
Noise Figure	10 dB maximum (including SSIPA)
Intermodulation	-24 dBc or better with two equal carriers at total power level 7 dB below rated single carrier output
Group Delay	0.02 ns/MHz linear maximum
	0.001 ns/MHz sq. parabolic maximum
	0.5 ns peak-to-peak ripple maximum (in any 40 MHz band)
Primary Power Voltage Frequency	 Single phase, 110 - 240 VAC ± 10% 47-63 Hz
Power Factor distortion)	0.95 min. (meets requirements of IEC-555-total harmonic
Power Consumption	1.4 kVA (typical)
	1.5 kVA (maximum)
Inrush Current	200% maximum

TABLE A-3
Electrical Specifications—Ku-Band

Frequency	13.75 - 14.5 GHz (Optional 12.75 - 14.50 GHz, 14.7 - 15.2 GHz)
Output Power	
• TWT	350 W
• Flange	275 W
Bandwidth	500 MHz
Gain	
• At rated power	73 dB minimum
• Small signal	78 dB minimum
RF Level Adjust Range	0 to 20 dB
Output Power Setability	± 0.2 dB
Gain Stability	
• At constant drive and temperature	± 0.25 dB/24-hr maximum (30-min warm-up)
• Over temperature, const. dr.	± 1.0 dB over oper. temp range (typical)
• Any frequency	± 0.75 dB over ± 10°C (typical)
Gain Slope	0.02 dB/MHz maximum
Gain Variation	
• Across any 80 MHz band	1.0 dB peak-to-peak
• Across any 500 MHz band	2.5 dB peak-to-peak
Input VSWR	1.3:1 maximum
Output VSWR	1.3:1 maximum
Load VSWR	
• Full spec compliance	1.5:1
• Operation without damage	Any value
• Continuous operation	2.0:1 maximum
Residual AM	
• Below 10 kHz	-50 dBc
• 10 to 500 kHz	-20 (1.3 + logF kHz) dBc
• Above 500 kHz	-85 dBc

TABLE A-3

Electrical Specifications—Ku-Band (Continued)

Phase Noise	
• IESS phase noise profile	-6 dBc
• AC fundamental	-36 dBc
• Sum of all spurs	-47 dBc
AM/PM Conversion	3^{o}/dB maximum for a single carrier at 8 dB below rated power
Harmonic Output	-60 dBc at rated power, second and third harmonics
Noise and Spurious (at rated gain)	<-150 dBw/4 kHz, 10.9 to 12.75 GHz <-70 dBw/4 kHz, 14.0 to 18.0 GHz <-105 dBw/4 kHz, 18.0 to 26.0 GHz <-125 dBw/4 kHz, 26.0 to 40.0 GHz
Noise Figure	10 dB max. (including SSIPA)
Intermodulation	-24 dBc or better with two equal carriers at total power level 7dB below rated single carrier output (-22 dBc for special band)
Group Delay	0.01 ns/MHz linear maximum 0.001 ns/MHz sq. parabolic maximum 0.5 ns peak-to-peak ripple max. (in any 80 MHz band)
Primary Power Voltage Frequency	 Single phase, 110 - 240 VAC ± 10% 47-63 Hz (100 VAC optional)
Power Factor	0.95 min. (meets requirements of IEC-555-total harmonic distortion)
Power Consumption	1.3 kVA (typical) 1.4 kVA (maximum)
Inrush Current	200% maximum

ENVIRONMENTAL

Ambient Temperature	
• operating	-10 to +50_C
• non-operating	-40 to +70_C
Relative Humidity	95% non-condensing
Altitude	
• operating	10,000 ft., w/standard adiabatic derating of 2°C/1,000 ft.
• non-operating	40,000 ft.
Shock and Vibration	Meets normal transportation environment per Section 514.4 MIL-STD-810E. Withstands 20G at 11 ms (1/2 sine pulse) in non-operating condition.

MECHANICAL

Cooling	Forced air w/integral blowers. Rear intake and exhaust. Maximum external pressure loss allowable: 0.10 inch water column.
RF Input Connection	Type "N" Female
RF Output Connection	
C-band	CPR-137G waveguide flange, grooved, threaded UNF 2B 10-32
X-band	CPR-112G waveguide flange, grooved, threaded UNC 2B 8-32
Ku-band	WR-75G waveguide flange, grooved, threaded UNC 2B 6-32
RF Output Monitor	Type "N" Female
Dimensions (w x h x d)	19 x 5.25 x 24 in. (483 x 133 x 610 mm)
Weight	65 lbs. maximum

HEAT AND ACOUSTIC

Heat Dissipation	
C/X-band	1,200 W maximum
Ku-band	1,100 W maximum
Acoustic Noise	65 dBA (as measured at 3 ft.)

APPENDIX B

FRONT PANEL/SERIAL REMOTE CONTROLS

Control Functions	• Main Power On/Off (Front Panel only) • TX (Transmit) Select • Transmit/Standby (Beam On/Off) • RF Drive Adjust (manual standard Pin Diode needed for Remote Attenuation) • Local/Remote/Computer (CIF) Select • Indicator Test • Fault Reset
Monitoring	• RF Output Sample Port (-40 dBm nominal, Type "N", Front Panel only) • RF Reflected Power (W) • Helix Current (mA) • Helix Voltage (kV)
Control/Status Display	• Power On • Heater Time Delay (HTD) • TX (Transmit) Select • Standby • Transmit (Beam On) • Local/Remote/CIF • Meter Select Switch
Fault/Alarm Display	• Recycled Fault • Fault • Low RF (with Forward Power Metering) • High Reflected RF • Interlocks Open (power supply temperature or amplifier cover) • Helix Overcurrent • Helix Voltage • Power Supply Arc • DC Bus Fault • TWT Overtemperature • Fault Log
Metering Option	• RF Output Power (dBm and Watts)

	• Attenuator Setting (applicable with PIN Diode Attenuation option)

FRONT PANEL/serial remote CONTROLS (Continued)

Miscellaneous	• Beam Elapsed Hour meter
	• Heater Elasped Hour Meter
	• Fault Beeper
	• Beam On Meter
	• Beam Elapsed Hour meter

DISCRETE REMOTE CONTROL INTERFACE

Control Functions	• Transmit/Standby (Beam On/Off)
	• Fault Reset
	• RF Drive Adjust (with optional PIN Diode Attenuator)
Control/Status	• Power On/Off
	• TX Select (Transmit Select)
	• Heater Time Delay (HTD)
	• Standby
	• Transmit (Beam On)
	• Local/Remote/Computer IF
Fault/Alarm Displays	• Recycled Fault
	• Fault

APPENDIX C

REPLACEABLE PARTS

Description	CPI Part Number
CCA, Power Factor Correction	01018660-00 Obsolete (100-120 VAC) 01019960-00 Current
CCA, Power Factor Correction	01018660-01 Obsolete (200-240 VAC) 01019960-00 Current
CCA, Power Processor	01018650-00
28 VDC Power Supply	01019623-00
HV Module	01018680-00
CCA, Controller	01018695-00
CCA, Display	01018705-00
CCA, RF Monitor	01018670-01
CCA, DC/DC	01018709-00
Tunnel Diode (C-Band)	01000769-00
Tunnel Diode (X-Band)	01005965-00
Tunnel Diode (Ku-Band)	01002559-00
Solid-State IPA (C-Band)	00135675-00
Solid-State IPA (X-Band)	01019461-00
Solid-State IPA (Ku-Band)	01000615-01
TWT, 400 W C-Band	01018581-00
TWT, 400 W X-Band	01018582-00
TWT, 350 W Ku-Band	01018571-00

APPENDIX D

WARRANTY AND SUPPORT INFORMATION

RETURN PROCEDURE

Authorization

Before the return of any equipment to CPI Microwave Equipment Products, please obtain a Returned Authorization Number (RMA#) by contacting the applicable number.

CPI, SATCOM SERVICE

As a CPI customer you have access to HPA support services no other company can match:

- Local, factory-trained service technicians
- 24-hour technical assistance hotline
- Immediate troubleshooting assistance
- Worldwide parts availability
- On-site and factory training
- Preventive maintenance and repair programs
- Installation assistance

TELEPHONE DIRECTORY

Customer Location	*CPI Office*	*Telephone*
N. America-West Latin America	Palo Alto, CA USA	1-800-231-4818* 1-415-846-3600*
N. America-East Caribbean	South Amboy, NJ USA	1-908-727-6300
Western Europe, Middle East & Africa	Utrecht, Netherlands	31-30-262-38-58
Eastern Europe	Moscow, Russia	7-096-214-5762
Far East	Singapore	65-225-0011
Japan	Tokyo	81-3-3648-8112
China	Nanjing, PRC	86-25-342-2679
Indonesia	Jakarta	62-21-566-3730
India	Calcutta	91-33-242-2570

*24-hour

e-mail: marketing@satcom.cpii.com www.cpii.com/satcom/

Protection and Marking

NOTE:

If the equipment is to be shipped to CPI for service or repair, please attach tag TO THE EQUIPMENT, as well as the shipping container, identifying the owner. Also indicate the service or repair required, the problems encountered, and other information considered valuable to the service facility (refer to the WARRANTY CLAIM FORM in the back of the manual).

Remove klystron and Beam P/S Cart from Cabinet. Place the equipment in the original shipping containers making sure that there is adequate packing around all sides of the equipment and that all front panels are protected. If original shipping containers were discarded, use heavy wooden boxes with adequate padding and protection for the paint. Pack klystron and P/S Cart separately form the cabinet. Pack all removed other parts separately, such as the air plenum, hoses, motor drive, etc.

All interconnecting waveguides must be supported at both ends or removed and shipped separately to avoid damage in shipment. All waveguide openings must be covered.

Sealing the Container

Seal the shipping container with heavy tape or metal bands strong enough to handle the weight of the equipment and the container.

Marking

Please write the words "FRAGILE", "DELICATE INSTRUMENT", ETC., in several places on the outside of the shipping container. In all applicable correspondence, please refer to the unit by both the model number and the serial number.

Please use the following address for all returned products.

CPI , Satcom Division
P.O. Box. 51625
Palo Alto, CA 94303
Attention: Customer Support
RMA NUMBER:

APPENDIX E:

OPTIONS AND FEATURES

Options	• Forward Power Metering (CW or Peak; required for remote forward power monitoring, for use of High/Low RF Alarm feature and/or when configured in a redundant operation) • PIN Diode Attenuation (required for remote attenuation) • Remote Control Panel • Redundant and Power Combined Subsystems
Features	• Designed to meet IEC-215/555 Safety/Harmonic Standards as well as 89/336 EEC/EMC Standards • MTBF of 20,000 hours less TWT • MTTR <1 hour • Available in 350 W Ku-band and 400 W C/X- bands • Filament voltage reduction of 10% in standby • Auto Fault Recycle • Internal test points for ease of maintenance • RS-232, RS-422/485 (4-wire) computer interface standard

ISO 9000 CERTIFICATE OF COMPLIANCE

This is to certify that the Quality Management System of:

COMMUNICATIONS & POWER INDUSTRIES, INC.

SATCOM DIVISION
811 HANSEN WAY
PALO ALTO, CA 94303

has been assessed by ABS Quality Evaluations, Inc. and found to be in compliance with the following quality standards:

ISO 9001

The Quality Management System is applicable to:

DESIGN AND MANUFACTURE OF SATELLITE COMMUNICATION EQUIPMENT, AND RF/MICROWAVE AND ELECTRO-MAGNETIC COMPATIBILITY TESTING EQUIPMENT

Certificate No.:	30515
Effective Date:	20 April 1994
Expiration Date:	19 April 2000
Rev. No./Date:	02/9 April 1997

on behalf of ABS Quality Evaluations, Inc.

Accredited by
the Dutch Council
for Certification

ABS Quality Evaluations, Inc. ★ Quality Assurance Certification ★

Validity of this certificate is subject to the organization and procedures being audited twice annually and the audited company submitting to ABS Quality Evaluations, Inc. interim written reports of any major changes in the elements of its Quality Management System.

varian

WARRANTY

LIMITED WARRANTY FOR PRODUCTS OF MICROWAVE EQUIPMENT DIVISION VARIAN ASSOCIATES, INC.

1. WARRANTY

a. Equipment, components, and subsystems (i.e. "Products"), exclusive of microwave tubes, manufactured and sold by Varian Microwave Equipment Division (MED) are warranted to be free of defects in material and workmanship for a period of one (1) year except as otherwise specified on Varian's quotation or agreed to in writing by Varian. Varian's obligation under all MED warranties is limited in accordance with the periods of time and all other conditions stated in all provisions of this warranty.

b. This warranty applies only to defects in material and workmanship in Products manufactured by Varian, including non-Varian parts, except microwave tubes. Varian makes no warranty whatsoever concerning Products or Accessories not of its manufacture.

c. Microwave tubes, which are supplied as an integral part of MED Products, are warranted only in accordance with the Tube Manufacturer's applicable warranty.

d. Power Supplies and passive components which include electromagnets, solenoids, filters, waterloads, circulators, couplers, waveguide windows, diplexers, and other passive devices are warranted for one (1) year of unlimited hours of operation following the date of shipment thereof, unless otherwise specified.

e. Repair, or at Varian's option, replacement of the Varian Products or defective parts therein shall be the sole and exclusive remedy for all valid warranty claims; provided that under certain circumstances Varian may, as an alternative, elect to refund an equitable portion of the purchase price of the Product.

2. WARRANTY PERIOD

The applicable warranty period shall commence on the date of shipment from Varian's Microwave Equipment Division (MED) to the original purchaser and extend for the stated period following the date of shipment. The warranty period for microwave tubes shall commence on the date of shipment from MED and extend for the specified number of hours of operation in accordance with the terms of the applicable express written warranty of the Tube Manufacturer. Upon beginning of the applicable Varian warranty period, all customer's remedies shall be governed by the terms stated or referenced in this warranty. In-warranty repaired or replacement Products or parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the repaired or replaced Products or parts. Repair or replacement of Products or parts under warranty does not extend the original warranty period.

3. WARRANTY COVERAGE LIMITATIONS

a. The following are expressly not covered under warranty:

1) Any loss, damage, and/or malfunction relating in any way to shipping, storage, accident, abuse, alteration, misuse, neglect, failure to use Products under normal operating conditions or within respective Varian specified ratings, failure to use Products according to any operating instructions provided by Varian, lack of routine care and maintenance as indicated in any operating or maintenance instructions, or failure to use or take any proper precautions under the circumstances.

2) Products, items, parts, accessories, subassemblies, or components which are expendable in normal use or are of limited life, such as but not limited to bulbs, fuses, lamps, glassware, etc.

3) Microwave tubes, except as provided in the Tube Manufacturer's applicable express written warranty.

b. Varian reserves the right to revise the foregoing list of what is not covered under this warranty.

4. WARRANTY REPLACEMENT AND ADJUSTMENT

The Warranty Replacement and Adjustment provisions stated in the standard Terms and Conditions of Sale, Electron Device Group, Varian Associates, Inc., are incorporated herein by reference. In addition thereto, the following provisions shall apply to replacement of parts under warranty in MED Products.

a. At Varian's sole option, it may furnish warranty replacement parts to the Customer before the defective part is returned to and received by Varian. If Varian furnishes such parts in advance, the Customer understands and agrees that it will return the replaced defective parts to Varian within sixty (60) days after Varian's advance shipment. In the event defective parts are not returned and received by Varian within this sixty (60) day period, the advance replacement parts shall be deemed not furnished under warranty and Customer agrees to pay Varian's invoices for all such advance shipment replacement parts at their then current selling prices.

b. Varian will not make warranty adjustments for failures of Products or parts which occur after the specified warranted hours of operation or after the specified maximum adjustment period. Unless otherwise agreed, failure shall be deemed to have occurred no more than seven (7) working days before the first date on which a notice of failure is received by Varian. Under no circumstances shall any warranty exceed the period stated above unless expressly agreed to in writing by Varian. In the event Customers and/or users of any Varian MED Products subject to this warranty fail to keep accurate records of the number of hours of operation or time period of use, Varian, at its sole discretion, may reject any such claims or determine probable usage for the equipment, component, or subsystem involved.

5. LIABILITY LIMITATIONS

a. THIS WARRANTY IS EXPRESSLY IN LIEU OF AND EXCLUDES ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGA-

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