Communications & Power Industries

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Technical Description

200 Watt Ku-Band Outdoor Traveling Wave Tube Amplifier

Model T02UO

INTRODUCTION

This document provides a detailed technical description of the Communications & Power Industries (CPI) 200 watt Ku-band Outdoor Traveling Wave Tube Amplifier (TWTA), an amplifier designed specifically for uplink service in satellite terminals, 'fly-aways' and digital satellite news gathering (DSNG) vehicles. The TWTA employs a dual depressed collector, permitting continuous, efficient operation across the entire 13.75 to 14.50 or 12.75 to 14.50 GHz frequency range. This outdoor unit (ODU) also incorporates the use of a microprocessor control system, thereby simplifying interfacing with remote control and monitor facilities, and speeding the integration process. Features include power factor correction (0.95 min.) and optional PIN diode attenuation. Power factor correction allows the unit to meet the total harmonic distortion requirement of EN61000-3-2. The amplifier also meets EN60215 safety and 89/336/EEC electromagnetic compatibility requirements.

The T02UO ODU is a member of a comprehensive line of communication amplifiers comprising TWT Low Power Amplifiers (LPAs), Medium Power Amplifiers (MPAs), High Power TWT Amplifiers (HPAs), High Power Klystron Amplifiers (KPAs) and Solid State Power Amplifiers (SSPAs). All are designed specifically for service in satellite earth stations operating in standard frequency bands.

CPI (formerly Varian Electron Device Group) has been active in the design and manufacture of microwave power amplifiers and related products for more than 30 years. CPI Satcom Division (formerly Varian MEP) was organized in the mid-1970s to bring together, under a single business operation, the strengths of existing groups involved with commercial Satcom and Industrial power amplifiers.

Since then, CPI Satcom Division has provided thousands of fully integrated satellite uplink power amplifiers in the S, C, X, Ku, DBS and Ka- band frequency ranges to worldwide users and has become the leading supplier of this class of products.

EQUIPMENT DESCRIPTION

General

The T02UO Outdoor TWTA (Figure 1) is designed for antenna mounting. This enclosed assembly houses both the RF and power supply sections of the amplifier. The RF section includes the TWT, an optional solid state intermediate power amplifier (SSIPA), input/output isolation circuits, input attenuator, RF detectors and output harmonic filter. The power supply section includes the power factor correction, power processor, and high voltage regulation circuitry. It also contains all monitor, control and protection circuits necessary to permit safe, efficient and reliable operation of the Outdoor TWTA.

The T02UO Outdoor TWTA is protected from operational damage caused by insufficient cooling or abnormal AC, DC and RF faults. The amplifier will automatically recycle itself after a prime power interruption or transient fault condition.

Personnel safety is of utmost importance and is safeguarded by proper grounding and by access interlocks and shields, which prevent physical entry into the high voltage sections.

Principal functions are brought to two user interconnect connectors located on the amplifier front panel for remote monitor and control. Control, fault and monitoring functions are available via an RS-232 or RS-422/485 computer interface (CIF). The TWTA includes a separate switching port for use with switching/power combining subsystems.

Digital attenuation is available, allowing for RF drive attenuation adjustment via the serial remote interface ports and thereby enhancing remote monitor and control capabilities.

To expedite field maintenance procedures, the T02UO Outdoor TWTA utilizes a modular design approach consisting of Line Replaceable Units (LRUs), which permit service personnel to maintain the Outdoor TWTA in the field without having to return the entire unit to the depot or factory. Comprehensive built-in-test (BIT) sequences and diagnostic procedures allow field personnel to localize the fault to the individual LRU, make the necessary replacement and return the amplifier to service with a minimum of operational downtime.

The overall amplifier enclosure measures 8.6" (w) x 8.6" (h) x 15.75" (d), and weighs 35 lbs without options. The TWT Amplifier can be installed in a 1:1 auto switching, or power combined configuration as needed by end user mission.

RF Subsystem

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

A low level RF input signal is applied to the Outdoor TWTA via a type N connector (isolator) located at the rear of the enclosure. The isolator limits the input VSWR to a maximum level of 1.3:1 back to the source. The output of the isolator is then routed to the input of the TWT. The overall TWT Outdoor TWTA gain of 35 dB minimum at rated power is stable within +/-0.25 dB/24 hours with +/-10% line voltage variations. An optional SSIPA boosts subsystem gain up to 70 dB minimum at rated power. The IPA, which is designed to be transparent to the final amplifier RF parameters, is temperature compensated to minimize drift and does not affect the gain stability specifications. The SSIPA is also available with an internal variable attenuator. With this option, the SSIPA's pin diode attenuator typically provides a minimum control range of 30 dB with quick response and excellent linearity.

The primary TWT employed in this power amplifier is of modern design, featuring conduction cooling, dual depressed collectors for efficient operation and a Periodic Permanent Magnet (PPM) focused helix design. It is 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 a harmonic filter, a receive-band reject filter and a two-port directional coupler.

The harmonic filter contained in the output waveguide assembly provides a minimum of 60 dB attenuation to all harmonic products other than the fundamental signal. The receive reject filter serves as a high pass filter cutting off below band signals. The filters used in the T02UO series are designed to minimize noise power density in their respective receive bands. Finally, the two port directional coupler provides a reflected power port coupled via a detector to the RF power monitor assembly for reverse power protection, and a forward power port for the user to monitor forward RF power via a type N connector on the front panel. Forward Detected RF Output Power via the CIF can be derived using an optional, separate coupler. The RF sample port, calibrated in coupling ratio versus frequency, permits independent monitoring of Outdoor TWTA 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 forward power metering comes user settable low and high RF power alarms settable via the front panel access door.

The output and reflected power level readouts are available for remote monitoring via the optional CPI remote panel or the computer interface (CIF) port. RF drive is adjustable via these ports as well. The standard RF output interface to connect the Outdoor TWTA to the external waveguide run is a WR-75F (flange) termination. The Outdoor TWTA comes with a WR-75G (grooved, threaded) rear connector and a waveguide gasket.

Power Supply Subsystem

Overview

The power supply portion of the Outdoor TWTA provides all of the internal voltages necessary to operate the TWT, RF driver (IPA), forced air cooling system and auxiliary circuits for control, monitoring and protection of the Outdoor TWTA. Only the AC input power is required for operation. The travelling wave tube derives its operation from four DC power supplies: a filament heater low voltage supply, a helix high voltage supply, and two collector high voltage supplies. The high-density power supply design utilized in the T02UO is of the high frequency, switch mode power conditioner (SMPC) 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 Outdoor TWTA 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. A simplified block diagram of the power supply is shown in Figure 3. The principal circuit modules are discussed in the following paragraphs.

Power Factor Correction Module

Input primary power (single phase, 99 to 264 VAC nominal) 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 Outdoor TWTA to meet the requirements of EN61000-3-2 regarding total harmonic distortion.

Power Processor Module

The power processor circuits provide the necessary line and load regulation of the input 375 volt DC bus, which is converted via a switch regulator and bridge circuit to a nominal 200 volt, 150 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 over voltage/under voltage or short circuit conditions. Low voltage outputs are also produced by this assembly (+/-15 VDC and 16 VAC) which are used to operate various internal circuit functions as well as provide power for the RF monitor circuit, micro-controller assembly, front panel display, and IPA. Internal sensors provide the necessary over-current protection functions for these supplies.

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 resistors for critical TWT voltages. The incoming 200 volt, 150 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% (collector #1) and 25% (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 heater voltage.

Control and Display Modules

The Control and Display Modules are designed to assure correct operation of the power amplifier and easy maintainability with minimal operator training and activity. Microprocessor circuits along with status and fault LEDs provide automatic sequencing of Outdoor TWTA operation and continuous monitoring of critical parameters. If a fault should occur, the Outdoor TWTA either recycles back to its state prior to the fault or latches into the FAULT state. In either case, the front panel lamp will illuminate. Also, a detail fault summary is available via the CIF interface.

The Product Specifications present a complete list of controls, displays, and LED indicators on the front panel. All panel indicators are reliable, bright LEDs.

When control power is turned on, the microprocessor self-tests all internal functions and starts HTD (Heater Time Delay). Once the HTD is completed, the STANDBY indicator illuminates to tell the operator that the high voltage may be applied. Depressing the TRANSMIT/STANDBY key initiates the BOS (Beam On Sequence). At the successful conclusion of BOS, the unit is in the TRANSMIT state (high voltage is on). Alternatively, the operator may depress the TRANSMIT/STANDBY key during HTD causing the STANDBY LED to flash. In this case, the BOS is initiated automatically at the completion of HTD. In the interest of promoting long life of the TWT, the heater voltage is reduced by 10 percent whenever the Outdoor TWTA is in any beam off state (either STANDBY or FAULT states) for more than one minute.

In the event of AC prime power interruptions, the power supply will automatically recycle when the AC power is reapplied. If the loss of power is less than a few seconds, the amplifier will return immediately to its previous state. If the outage is of longer duration, a proportional HTD is performed before returning to the previous state. The longest HTD is three minutes.

If a fault occurs during TRANSMIT, the FAULT LED will light and the unit will switch from TRANSMIT to FAULT. Two scenarios are possible. The first scenario occurs when a fault lasts less than four seconds (a transient fault) or when fewer than three transient faults occur within twenty seconds. In this case, the unit will recycle back to TRANSMIT. Each transient fault will generate a recycle. Each recycle from FAULT to TRANSMIT will be delayed by one second. If the unit does not successfully recycle to TRANSMIT, the FAULT LED will light until the user presses RESET.

The second scenario occurs when a fault lasts longer than four seconds or when at least three faults occur within twenty seconds. In this case the unit will be latched into FAULT and the FAULT LED will light.

This LED will remain lit until the RESET button is depressed or power is cycled. If the fault was successfully cleared, the FAULT LED will extinguish and the unit will be in STANDBY. Press FAULT RESET to resume transmitting.

Power Monitor Module

The RF power monitor assembly receives signals from the forward and reflected power RF detectors for use in fault/alarm sensing and forward power metering. The reflected RF fault sensor/recycle circuit protects the TWT against excessive reflected power due to abnormal waveguide or antenna conditions. Also included is a forward power, low RF alarm circuit, which compares the output power with a user-settable low RF set point and triggers an alarm, should output power fall below this level.

Mechanical Design

General

The T02UO is packaged in an outdoor configuration measuring 8.6" wide by 8.6" high and 15.75" deep. The unit is cooled via a forced air cooling system using a centrifugal blower.

LRU Philosophy

The Outdoor TWTA utilizes a modular design approach incorporating LRUs for ease of maintainability in the field. The maintenance concept employed in the T02UO is to localize a malfunction or circuit failure down to the level of an LRU, extract the LRU and replace 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 Outdoor TWTA to the depot for servicing. The philosophy is to configure the Outdoor TWTA LRUs as building blocks with a specific function that can be monitored by sensors and fault indicators on a real-time basis.

PRODUCT SPECIFICATIONS

The following specification limits and characteristics apply to the 200 W T02UO Series standard version (13.75 – 14.50 GHz) and wideband version (12.75 – 14.50 GHz) unless otherwise specified.

Electrical

Frequency	Standard	13.75 to 14.50 GHz
	Wideband	12.75 to 14.50 GHz
Output Power		
•TWT		200 W min. (53.01 dBm)
•flange		175 W min. (52.43 dBm)
Bandwidth	Standard	750 MHz
	Wideband	1750 MHz
Gain		
•at rated power		35 dB min., 55 dB max.
	with SSIPA option	70 dB min., 85 dB max.
•small signal		41 dB min., 58 dB max.
	with SSIPA option	75 dB min., 87 dB max.
RF Level Adjust Range (requires SSIPA and attenuator options)		0 to 30 dB typ.
Attenuator Step Size (requires SSIPA and attenuator options)		±0.1 dB
Gain Stability		
•at constant drive & temperature		±0.25 dB/24 hrs. max.(after 30 min. warm-up)
•over temperature, constant drive (any frequency)		±1.0 dB over oper. temp. range
Small Signal Gain Slope		±0.04 dB/MHz max.
Small Signal Gain Variation		
•across any 80 MHz band		1.0 dB pk-pk max.
•across the 750 MHz band		2.5 dB pk-pk max.
•across the 1750 MHz band (Wideband)		4.0 dB pk-pk max.

Electrical, continued

Input VSWR		1.3:1 max.
Output VSWR		2.2:1 max. (1.3:1 max with optional external circulator)
Load VSWR		
•full spec compliance		1.5 max.
•operation without damage		any value
•continuous operation		2.0:1 max.
Residual AM		
•below 10 kHz		-50 dBc
•10 to 500 kHz		-20 [1.5 + log F (kHz)] dBc
•above 500 kHz		-85 dBc
Phase Noise		
•Phase Noise		12 dB below IESS 308 continuous mask
•AC fundamental		-50 dBc
•Sum of all spurs		-47 dBc
AM/PM Conversion		2.0°/dB max. for a single carrier up to 7 dB OBO (2.0°/dB up to 4 dB OBO with optional linearizer)
Harmonic Output		-60 dBc
Noise Power Density (at maximum gain)	Standard	<-150 dBW/4 kHz, below 12.75 GHz
	Wideband	<-150 dBW/4 kHz, below 11.7 GHz
	Both	<-70 dBw/4 kHz, passband to 18.0 GHz
Noise Figure		35 dB max. (10 dB max. with SSIPA option)
Intermodulation		-24 dBc or better with two equal carriers at total power level 7 dB OBO (4 dB OBO with linearizer)
Noise Power Ratio	Standard	18 dB or better at 7 dB OBO (at 4 dB OBO with linearizer option)
	Wideband	16 dB or better at 7 dB OBO (at 4 dB OBO with linearizer option)

Electrical, continued

Spectral Regrowth	Standard	21 dB or better at 0 dB OBO (27 dB with linearizer option)
	Wideband	20 dB or better at 0 dB OBO (26 dB with linearizer option)
Group Delay (in any 80 MHz band)		0.01 ns/MHz linear 0.005 ns/MHz^2 parabolic max. 0.5 ns pk-pk ripple max.
Primary Power		99-264 VAC, single phase 47-63 Hz
Power Factor		0.95 min. (meets requirements of Harmonics EMC Directive EN61000-3-2
Power Consumption		800 VA typ. 850 VA max.
Inrush Current		200% max.

Environmental

Ambient Temperature	
•operating	-40° to +55°C including solar loading
•non-operating	-40° to +70°C
Relative Humidity	100% condensing
Altitude	
•operating	10,000 ft., w/ standard adiabatic derating of 2°C/1,000 ft.
•non-operating	50,000 ft.
Shock and Vibration	20 g pk, 11 msec, ½ sine 2.1 g_{rms}, 5 to 500 Hz

Mechanical

Cooling	Forced air w/integral blower
RF Input Connection	Type N Female

Mechanical, continued

RF Output Connection	WR-75 grooved waveguide flange, threaded 6-32 UNC 2B
RF Output Monitor	Type N Female
Dimensions, (W x H x D)	8.6 x 8.6 x 15.75 in. (219 x 219 x 400 mm)
Weight	35 lbs (16 kg) max. with no options

Heat and Acoustic

Heat Dissipation	650 Watts max.
Acoustic Noise	65 dBA (as measured at 3 ft.)

Local Monitors and Controls

Control Functions	Transmit/Standby (Beam on/off) (Transmit Select in HTD) Local/Remote/Computer (CIF) Select Fault Reset
Monitoring	RF Output Sample Port (-40 dB nominal, Type N)
Control/ Status Display (LEDs)	Power On (Red) Transmit Select (Flashing Amber) Standby (Amber) Transmit (Beam on) (Green) Local/Remote (Amber)
Fault/Alarm Display (LEDs)	Fault (Red)

Computer Interface (CIF)

Control Functions	TX (Transmit) Select Transmit/Standby (Beam On/Off) RF Power Setting* Attenuator Setting* RF Inhibit Fault Reset RF Alarm/Fault Settings

Computer Interface (CIF), continued

Monitoring	RF Output Power (watts and dBm) Attenuator Setting* RF Reflected Power (watts) Helix Current (mA) Helix Voltage (kV) Heater Elapsed Time Meter Heater Time Delay Countdown Beam-On Elapsed Time Meter TWT Temperature History Log
Status Displays	Heater Time Delay (HTD) TX (Transmit) Select Standby Transmit (Beam On) Local/Remote
Fault/Alarm Displays	Fault Low RF Fault and Alarm High RF Fault and Alarm High Reflected Power Power Supply/Interlocks open (cover open) Helix Over Current Helix Over Voltage Power Supply Arc TWT Over-Temperature Fault Internal Air Over-Temperature Fault External Interlocks Fault Helix Voltage in Standby SSIPA Overcurrent*

**requires attenuator and/or SSIPA options*

RF Switch Port Interface

Features	RF Inhibit Command Low RF Relay Fault Relay (can be reassigned)

Options and Features

Options & Compatibility	Solid State IPA Forward detected RF output power over CIF Attenuator (requires SSIPA option) Integral linearizer External receive band reject filter (increases loss by at least 60 dB up to 12.7 GHz) Remote Control Panel (1 RU with Multidrop up to 1:4) Redundant and Power Combined Subsystems Internal 1:1 Switch Control and Drive External output circulator Integral L-Band Block Up Converter (BUC --- (requires SSIPA)
Features	Designed to meet EN60215/EN61000-3-2 Safety/ Harmonic standards as well as 89/336 EEC/ EMC Standards Filament voltage reduction of 10% in standy Auto Fault Recycle Internal test points for ease of maintenance MTBF of 40,000 hours with TWT MTTR<1 hour RS-232 or RS422/485 (4 wire) interface standard RF detection meter standard PC based remote software included

Characteristics and performance limits are based on current data and are subject to change without notice. Please contact CPI Satcom Division before using this information for system design.

Options and Accessories Descriptions

Following are brief descriptions of the options that are designed for use with the CPI Outdoor TWTA.

Remote Control Panel

The Remote Control Panel is a 19 inch, rack-mountable unit, 1.75 inches high, that duplicates all of the controls and indicators of the main (local) control panel. The Remote Control Panel communicates with the amplifier via serial interface. The panel requires a source of AC power, and includes the connectors for the interconnect cable from the amplifier, but not normally the cable. This panel is addressable through RS-432, RS-422, RS-485 and Ethernet.

Protection Switching

The 1:1 Switching Subsystem consists of an output waveguide switch and dummy load. The control is housed inside the amplifier. The circuit provides 1:1 redundant protection with automatic transfer or manual operation, local or remote, as selected by the operator. An optional remote panel is available. Options are also available for the addition of an input power divider or a ganged input transfer switch. More complex 1:2 switching systems can also be provided.

Power/Phase Combining

The Power/Phase Combiner consists of a coaxial input divider network, phase shifter and an output waveguide combining system. The combiner is an electrically operated variable ratio hybrid device, which provides the following operating modes:

1. PA1 and PA2 combined on line (antenna)
2. PA1 on line, PA2 to dummy load
3. PA2 on line, PA1 to dummy load
4. PA1 and PA2 combined to dummy load

In the normal combining mode, a fault in one PA will automatically switch the combiner to mode (2) or (3), resulting in “soft fail protection,” by providing full output from the surviving PA. In the manual mode the operator may select by pushbutton any on eof the four operating modes.

Solid State Intermediate Power Amplifier (SSIPA) and PIN Diode Attenuator

The SSIPA and PIN Diode Attenuator can be added to provide the user with an additional 30 dB of gain, as well as 30 dB of gain control.

Options and Accessories Descriptions, continued

Linearizer

The optional linearizer provides an improvement in AM/PM, third order intermodulation products spectral regrowth and NPR performance. A linearized unit operating at 4 dB total output backoff and a non-linearized unit operating at 7 dB total output backoff would have similar performance for these four parameters. The linearizer can be tuned through the optional CPI remote panel or through the supplied “Setup and Remote Control” software.

L-Band Block Up Converter (BUC --- requires SSIPA)

An optional, internal, L-band upconverter can be provided. A block up converter (BUC) is a frequency converter that translates the industry-standard L-band frequency range up to the RF frequency of the host amplifier. The BUC is integrated into the amplifier's enclosure so that the customer does not need to worry about it. This lowers the frequency of the amplifier's input so that the cabling to the amplifier can be much less expensive. The BUC translates the entire frequency range of the amplifier, not just one transponder like narrow-band single-transponder up converters.

Incorporating a BUC in CPI amplifiers allows the customer to eliminate the single transponder up converters used previously. This saves the customer the cost of multiple up converters, one for each transponder.

CPI's BUCs use DRO (Dielectric Resonant Oscillators) which can operate independently, or be phase locked to a high-stability reference. The reference signal is brought into the amplifier by multiplexing the reference onto the cable carrying the input signals, so that no extra cables are required. Refer to CPI document MKT-74 for a complete technical description.

External Output Circulator

Attached at the RF Output (WR-75 Grooved), the External Output Circulator lowers maximum Output VSWR from 2.2:1 to 1.3:1 back to the source

Forward Detected RF Output Power via the CIF

An external coupler provides an extra port for use by the front panel forward power metering circuit, which uses a detector to process to the RF signal.

Options and Accessories Descriptions, continued

PC Based Remote Software

PC Remote Software enables a single PC to remotely monitor and control up to ten outdoor HPAs. The software communicates using the PC's serial communication port or an Ethernet LAN interface. Windows displaying meter readings and status information for each HPA may be displayed simultaneously.

SUPPORT SERVICES

Documentation

CPI Satcom Division provides a standard commercial documentation package for all products. The standard package for satellite communications power amplifiers includes a comprehensive operation and maintenance manual, outline and interface drawings and acceptance test procedure/report (ATP).

The technical manual provides instruction for unpacking and installation, initial set-up, calibration, normal operation, maintenance and repair of the equipment. The manual includes schematic diagrams, block diagrams, and wiring information sufficient for use by maintenance personnel. Outline and interface drawings provide dimensions and the location and size of mounting holes, duct work, and waveguide, so that site preparation can be accomplished prior to receipt of the equipment.

The ATP outlines the tests performed, circuit and test equipment used, and limits established. Space is provided for recording and certifying the test results, consolidating all related information in one document. The spare parts documentation package consists of a commercial recommended spare parts list to support the equipment for a one-to-two year period of operation.

Training

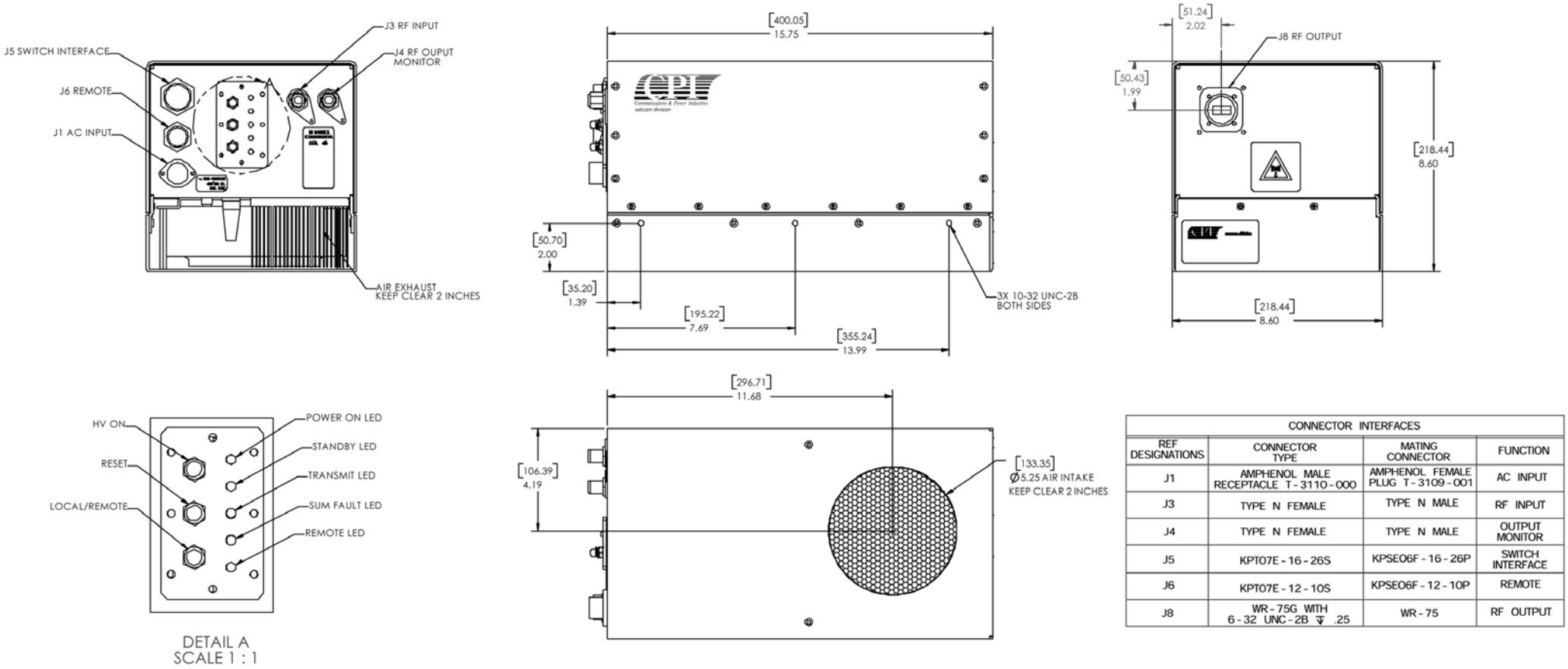
CPI Satcom Division is prepared to conduct training courses covering the installation, operation and maintenance of its equipment. The training course on high power amplifiers consists of lectures using training material, such as technical manuals and drawings, plus actual operation and adjustments demonstrated on the equipment. Small training groups (up to five students) assure the customer that each student has an opportunity to participate fully in demonstration activities. Courses may be conducted at the CPI factory or on-site. Course duration varies from two days to one or two weeks, depending on the scope of work agreed upon and the skill level of the students.

SUPPORT SERVICES, continued

Field Service

The product support activity of CPI includes a staff of experienced, professional service technicians to assist users in maintaining full performance from their CPI power amplifiers. A telephone “hot line” permits access to one of these technicians on a 24-hour per day basis. Operational problems often can be diagnosed, corrective action prescribed, and normal operation restored through telephone consultation. Service technicians are prepared to give on-site assistance when desired.

Product Support carries an inventory of spare parts that can be made ready for shipment within 24 hours. Coupled with a dedicated dial-in telephone line, this service is effective in aiding users to restore equipment to operational status with minimum downtime. Technical assistance and factory approved replacement parts are also available at strategically located Regional Service Centers in the U.S.A., Europe, Africa, South America and the Pacific Rim.



CONNECTOR INTERFACES			
REF DESIGNATIONS	CONNECTOR TYPE	MATING CONNECTOR	FUNCTION
J1	AMPHENOL MALE RECEPTACLE T-3110-000	AMPHENOL FEMALE PLUG T-3109-001	AC INPUT
J3	TYPE N FEMALE	TYPE N MALE	RF INPUT
J4	TYPE N FEMALE	TYPE N MALE	OUTPUT MONITOR
J5	KPT07E-16-26S	KPSE06F-16-26P	SWITCH INTERFACE
J6	KPT07E-12-10S	KPSE06F-12-10P	REMOTE
J8	WR-75G WITH 6-32 UNC-2B ↧ .25	WR-75	RF OUTPUT

Figure 1. Outdoor TWTA Outline Drawing (ref. 01031702)

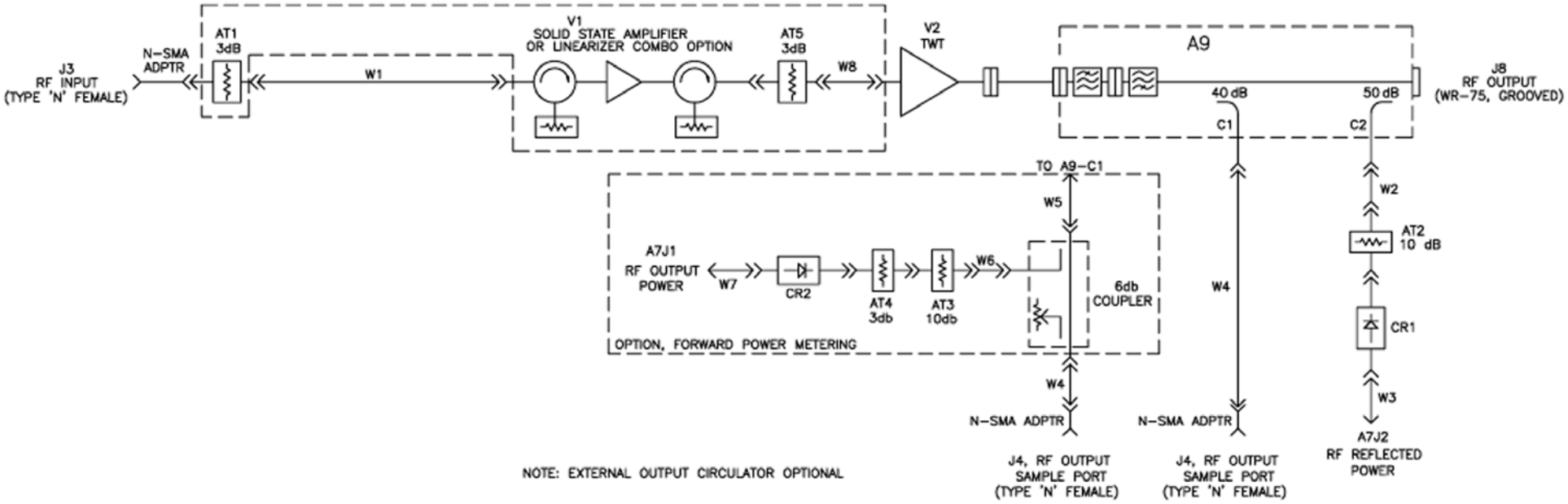


Figure 2. Outdoor TWTA RF Block Diagram (ref. 01031701)

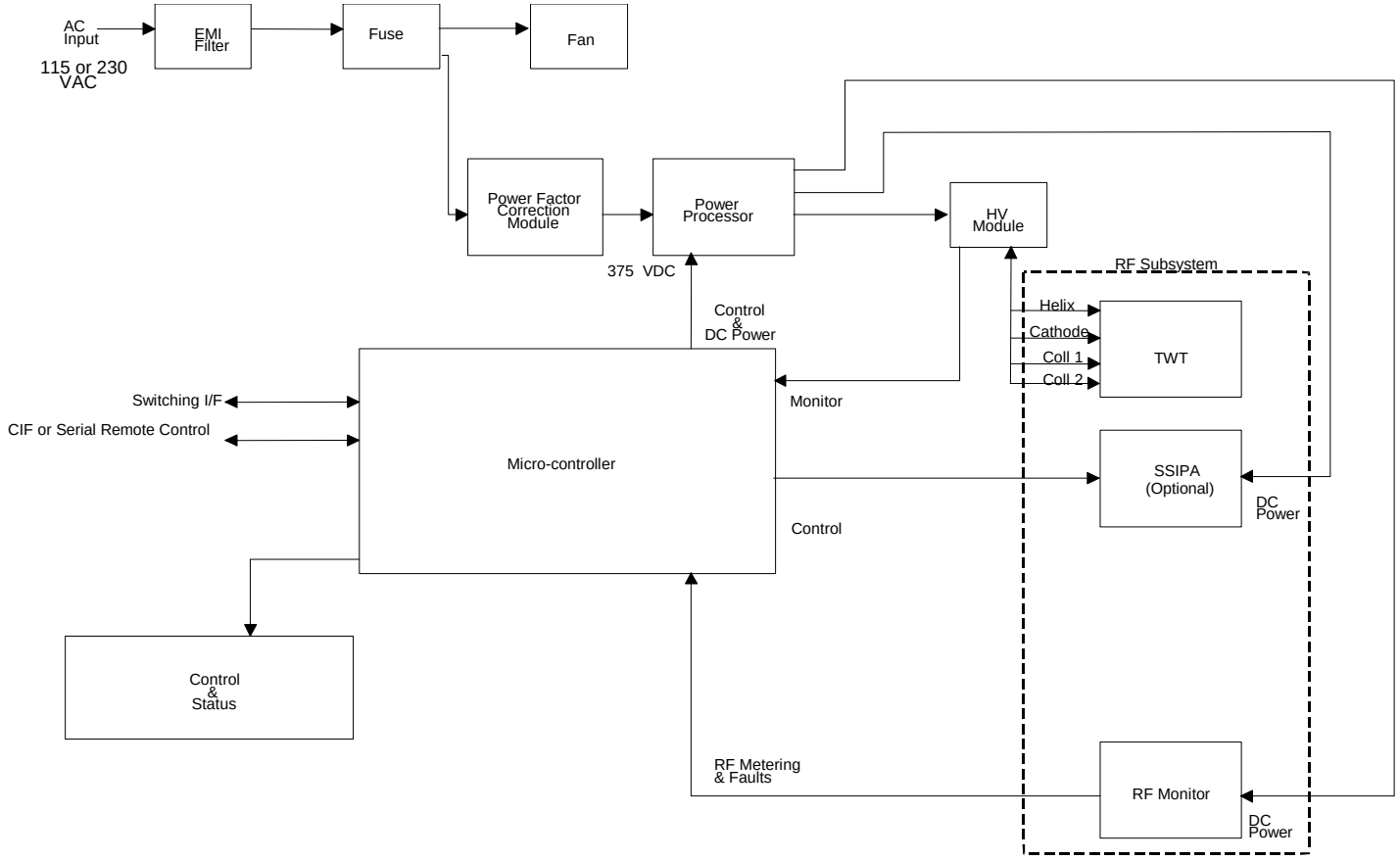


Figure 3. Power Supply Block Diagram