1.1. System and Control Cabinet

The Maverick System Control Cabinet is composed of the Keyboard Video Monitor (KVM), Signal Processor, and Radar Control Unit, Local UPS, Power Controller, DC Power Supplies and the Communications Interface for the radar system. The components are located in a short 19-inch rack and attached box assembly and it connects to the pedestal and transceiver units via a fiber-optic communications connection and DC power cables. The Indoor Control Cabinet comes in one of two configurations and is equipped with cabinet blowers to control the environment inside the cabinet when properly installed in a climate-controlled environment.

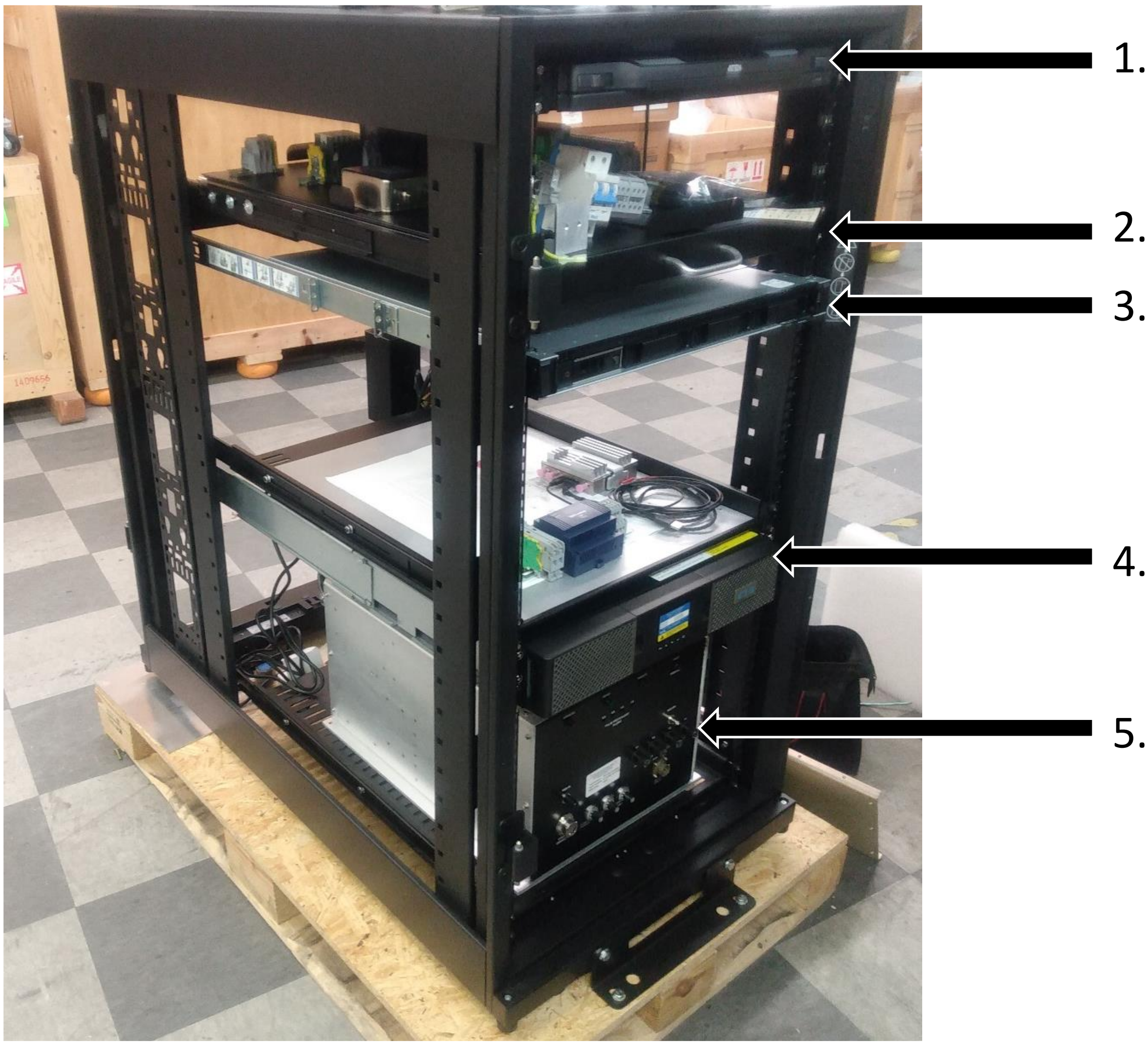

Figure 1. Control Cabinet (Front)

1. Keyboard Video Monitor (KVM)
2. IQ2 Reciever Assembly
3. Radar Control Unit (RCU)
4. Uninterruptible Power Supply (UPS)
5. Solid State Modulator Power Supply Assembly

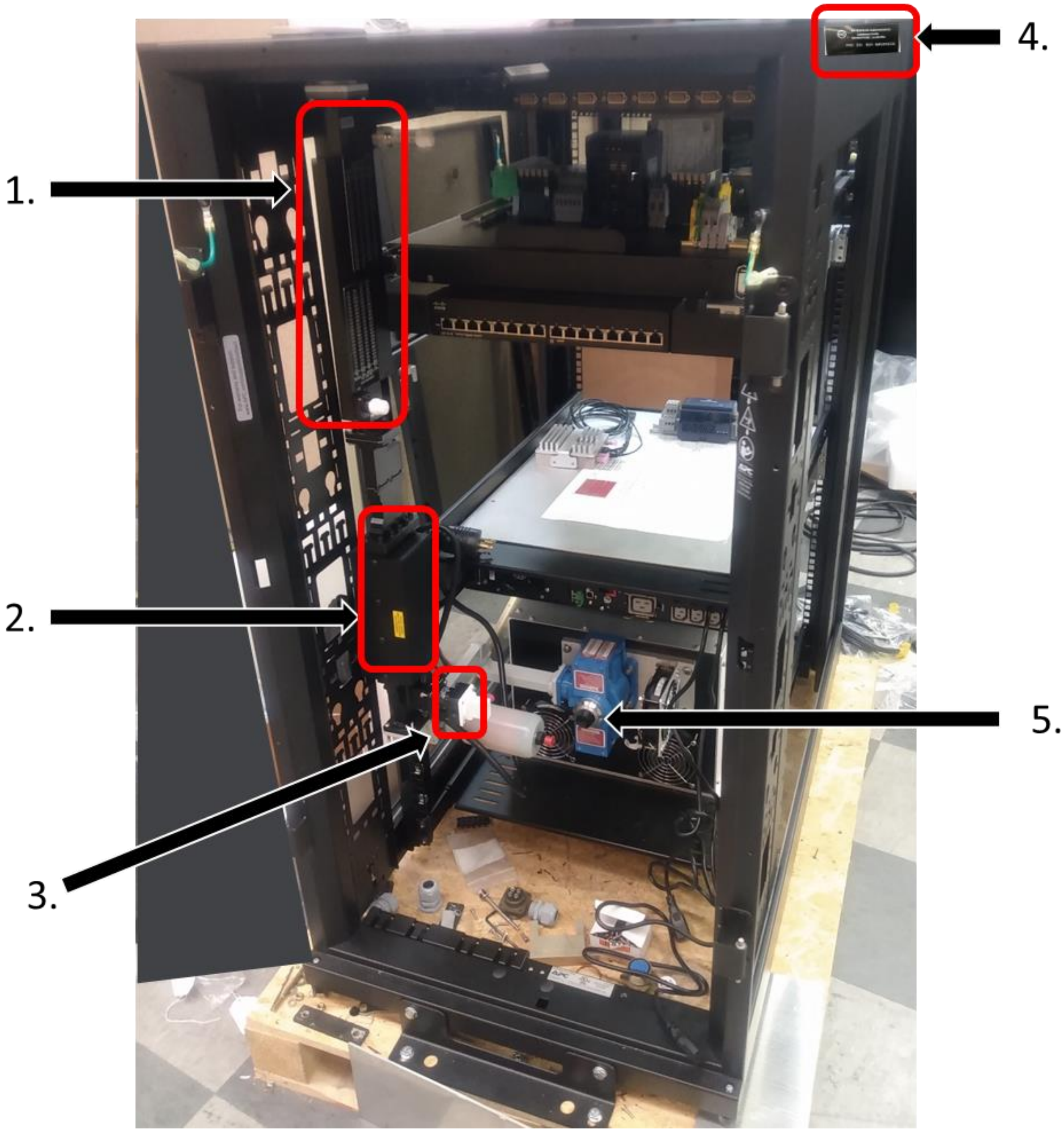

Figure 2. Control Cabinet (Rear)

1. Bi-Directional Coupler
2. X-Band Circulator

3. TR Limiter
4. FCC Certification Label
5. Magnetron

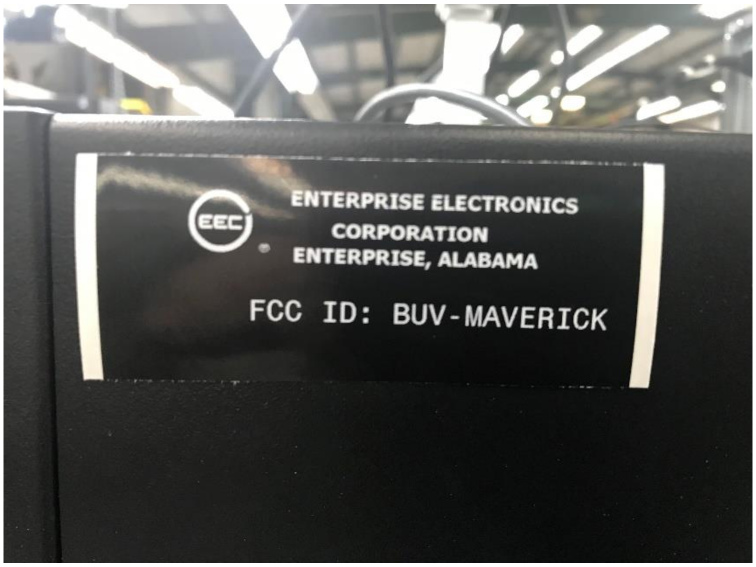

Figure 3. FCC Certification Label

1.1.1. RCU with Serial Card

The RCU host computer is a Linux based standard industrial PC that physically converts to Ethernet I/O slave modules to control and monitor radar hardware, using the open industrial standard ModbusTCP for communications. The Radar Control Unit is loaded with Cobra Software.

Implementation of command and control of the pedestal is over the Ethernet link from the Radar Control Unit PC (COBRA Application software) all of the other components in the Control Cabinet and the Pedestal Unit. The control of the azimuth and elevation servo is directly through an Ethernet connection to the Servo Controller Assembly.

Position commands route to the Servo Controller from the COBRA software system based on commands from either the Human Machine Interface (HMI) or the remote host operator. A position command invokes a command interpreter script in COBRA that sends the appropriate command to the pre-loaded servo control module. The Servo Controller has an extensive standard command and control set and an extended command set for use with radar servo systems.

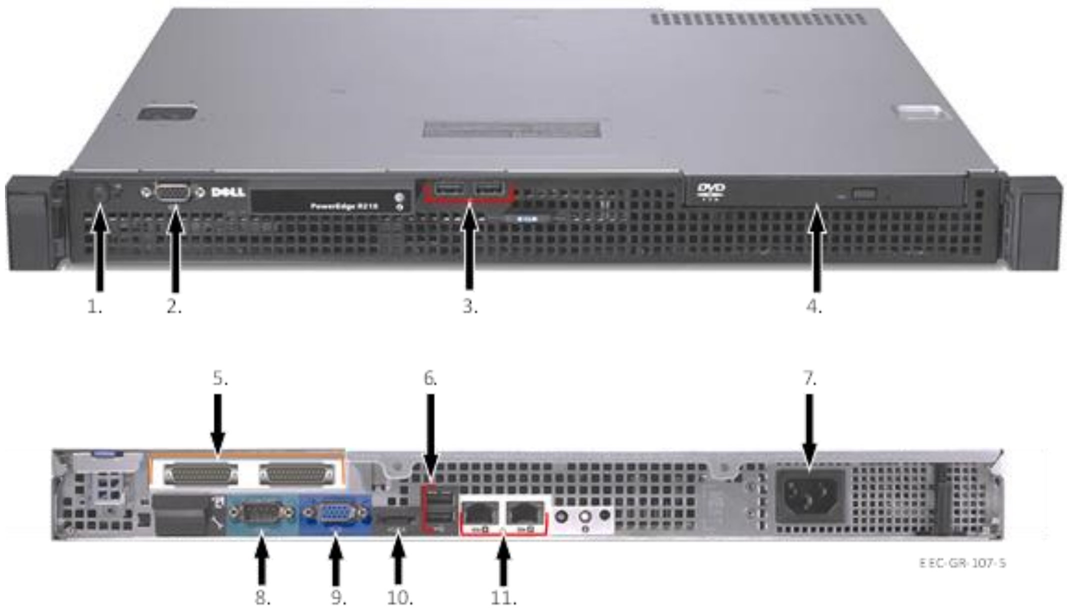

Figure. Radar Control Unit

1. Power Switch
2. Front VGA Port
3. Front USB Ports (2)
4. DVD Drive
5. Synclink Ports (2) – (IQ2-DSP Connect)
6. Rear USB Ports (2) – (KVM Connect)
7. Power Connect
8. RS232 Port (Inclinometer) – (OPTIONAL)
9. VGA Port (KVM Connect)
10. eSATA Port
11. Ethernet (2) – (Ethernet Switch)

1.1.1.1. COBRA RCP Module

The COBRA Radar Control Processor (RCP) module controls the radar hardware through a series of coordinated and supervised hardware Analog and Digital control modules. These I/O modules connect to the RCU by Ethernet. The Ethernet communication layer between the RCU and the distributed modules is functionally isolated from any point beyond the RCU so there is no danger to having a remote host attempt to communicate directly with the hardware control modules.

The COBRA RCP software is hardware independent through a software abstraction layer. This allows easy transition to other vendors and products based on availability and features

In order to assure accurate and complete time stamping of each command, response, and status, each module comprising the RCU is synchronized using the Network Time Protocol (NTP). Additionally, filters and other integrity checks within the RCU and associated software elements ensure that any command, response, error message, or status message is appropriately logged and repeated entries are avoided.

1.1.1.2. COBRA HCI Module

The COBRA HCI software module operates at the gateway between the RCP module and the EEC EDGE Radar Host computer.

1.1.1.3. COBRA HMI Module

The Human Machine Interface (HMI) module is a computer based local control and operator interface to the COBRA program functions. In this configuration, the HMI runs on the same computer as the COBRA software. The user display shares the standard commercial keyboard and video monitor unit with the IQ2-DSP and EDGE Host computer.

The software communicates with various radar components through the COBRA application software in order to provide user commands to the system and reflect control and status data to the user. Such data includes but is not limited to azimuth and elevation position, power levels, and voltage/current measurements. The ability to monitor the radar performance over Ethernet connections provides the flexibility and opportunity to monitor the radar from virtually anywhere.

HMI presents the radar control information as familiar indicators and controls on the computer screen as a virtual control panel. Common indicator styles include the LED, round gauges and seven-segment digital readouts. Some indicators switch views when clicked. Interaction is through the keyboard and touch pad.

1.1.2. IQ2 Digital Signal Processor

The IQ2 DSP consists of a PCIe card in a high-performance Host Computer used for signal processing deployed in the Control Cabinet. This design of the computer and PCIe card ensures the highest performance available, as well as for flexibility in adapting to various radar system configurations. The DSP receives digital I/Q over the high-speed optical link from the IQ2-IFD, passes this data to the high-speed server for moments processing.

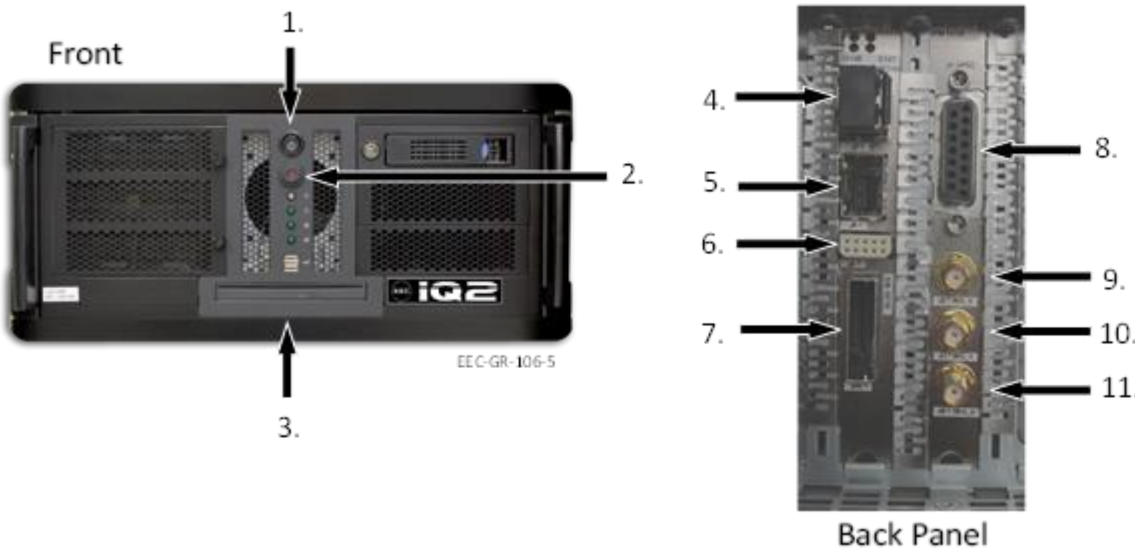

Figure 4. IQ2-DSP Computer

1. Power Switch
2. Power Indicator
3. DVD Drive
4. J7 - Fiber-Optic Connect
5. J8 – Ethernet
6. J6 – Antenna Serial Anglers
7. J10 – PCIe Connect
8. J1 – GPIO
9. J2 – Waveform Generator (Primary)
10. J3 – Waveform Generator (Secondary)
11. J4 – Trigger Output

1.1.2.1. IQ2 Host Computer

The IQ2-DSP Host Computer is equipped with a powerful, state-of-the-art, signal processor that receives In-Phase and Quadrature (I/Q) data from the IQ2-IFD coming in real time. The Signal Processor elaborates the real-time I/Q data to create the required single polarization meteorological moments.

The IQ2-DSP consists of a PCIe communications card plugged into a high-speed server. The PCIe card receives the high-speed optical link from the IQ2-IFD, passes this data to the high-speed server for the processing of meteorological moments, and provides additional interfaces that may be required to support other radar-site systems.

The IQ2-DSP Host Computer processes the I/Q data stream, already broken into range-gate intervals, with floating-point algorithms to provide all required moments. The server also provides all the configuration and control signals to all of the components in the IQ2-DSP system.

The IQ2-DSP Host Computer is a Linux based standard industrial PC. The standard mode of operation is the well-defined, proven pulse-pair method of Doppler radar data processing that produces the standard data moments of:

- Uncorrected Reflectivity (U)
- Corrected Reflectivity (ZH)
- Vertical Reflectivity (Zv)
- Velocity (V)
- Spectrum Width (W)

The standard IQ2-DSP algorithms for the horizontally and vertically polarized channels include but are not limited to the following:

- Thresholding: Noise, SQI 1& 2, SIGPOW, CCOR, & RHOHV
- Speckle Remover: Z, V, W, & DP
- Averaging: Time and Range
- Doppler Clutter Filters: Time- and Frequency- Domain
- Pulse-Pair Processing
- Discrete Fourier Transform (DFT) Processing
- Staggered PRT Processing or Dual PRT (DPRT)
- Second Trip Processing
- Range-Doppler Dilemma.

Each moment for the current mode of operations routes to the EDGE radar product generator for further processing and display.

1.1.3. IQ2 DSP PCIe Board

The EEC IQ2-DSP utilizes a PCIe used for signal processing deployed in the Control Cabinet. This IQ2-DSP Host Computer and PCIe card design allows for the highest performance available, as well as for flexibility in adapting to various radar system configurations.

1.1.4. Keyboard Video Monitor

The Keyboard/Video Monitor (KVM) is a control unit that allows access to multiple computers from a single keyboard, video monitor, and mouse console. The configuration of the KVM allows it to control the RCU and IQ2-DSP. A local host computer (EDGE) also connects to the KVM. The cover had a built-in

LCD display, and the keyboard and touchpad are built-in to the base. The KVM module fully integrates into the cabinet and can slide out and open for use.

Figure 5. Keyboard, Video Monitor

1.	17-Inch Display
2.	Source Selection
3.	Keyboard
4.	Touchpad
5.	EDGE (V1)
6.	RCU (V2)
7.	IQ2-DSP (V3)

The keyboard has a standard laptop-style touchpad with two command buttons for manipulation of the command cursor and executing operator commands. The display screen is a 17-in. liquid crystal display (LCD) color monitor.

Key features of the KVM include:

- Integrated KVM console featuring a 17-in. LCD color monitor in slide-away housing
- LCD module rotates up to 115° for a more comfortable viewing angle
- 105-key keyboard

- Compatible with all operating systems (O/S) platforms PC (Windows, Linux, Unix, Mac)
- Less than 1U high mountable rack
- Auto PS/2 and universal serial bus (USB) interface detection
- Internal built-in power
- Dedicated hotkey mode and on-screen display (OSD) invocation keys
- Computer selection via pushbutton, hotkeys and OSD
- Superior video quality - up to 1280x1024
- A-Grade thin-film-transistor (TFT) LCD panel
- RoHS compliant.

1.1.5. EDGE Workstation

The EDGE Workstation (see separate EDGE Manual) is a standard computer system nearly identical to the IQ2-DSP computer system. The EDGE software operates on the Linux platform and shares the KVM with the IQ2-DSP and RCU systems. The following images may not reflect the actual hardware delivered with the Maverick system. They represent typical hardware used in EEC radar systems worldwide. Hardware may vary by manufacturer and model.

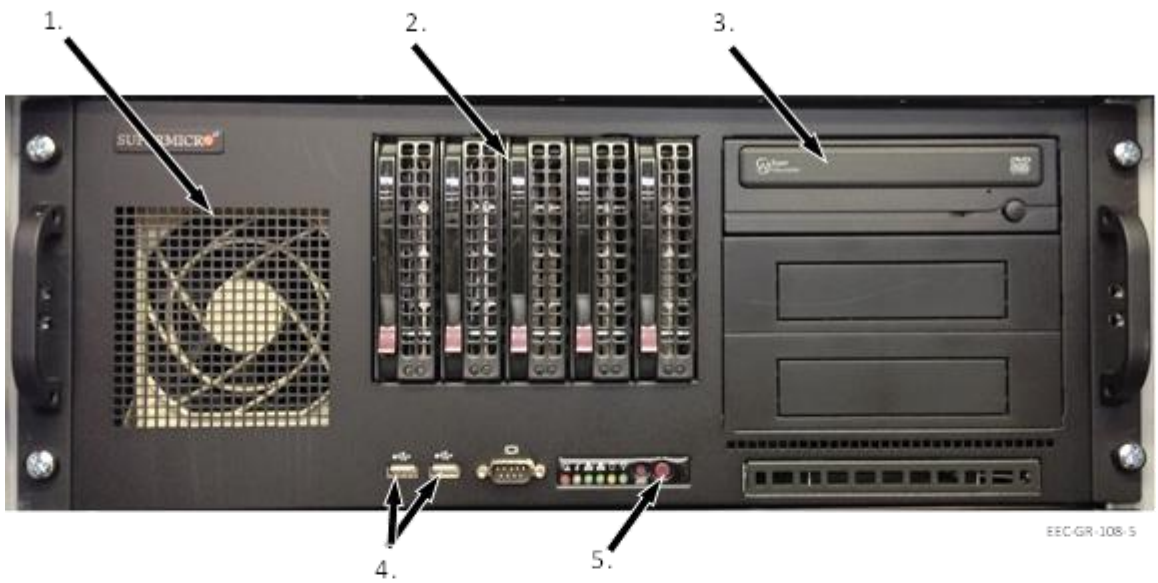

Figure 6. EDGE Workstation, Rack Mount

1. Cooling Fan 2. Raid Drives 3. DVD Drive 4. USB Ports 5. Power Button

EDGE Computer Characteristics	
Processor	Intel Xeon quad-core 5520 or superior
Memory:	16GB DD3
Disk:	1TB in RAID1, including SATA RAID Card
Ethernet:	Two Gigabit Ethernet ports
Operating System:	Linux
Extra Drive Bay	16X DVD R/W
Video Card	Nvidia GTS 450 1GB or better

Table 1. EDGE Computer Characteristics

1.1.6. UPS, 2000/1800 KVA

The 2KVA Uninterruptable Power Supply (UPS) provides adequate power for the Control Cabinet. The 2KVA UPS provides backup power and line conditioning for the all components in the Control Cabinet.

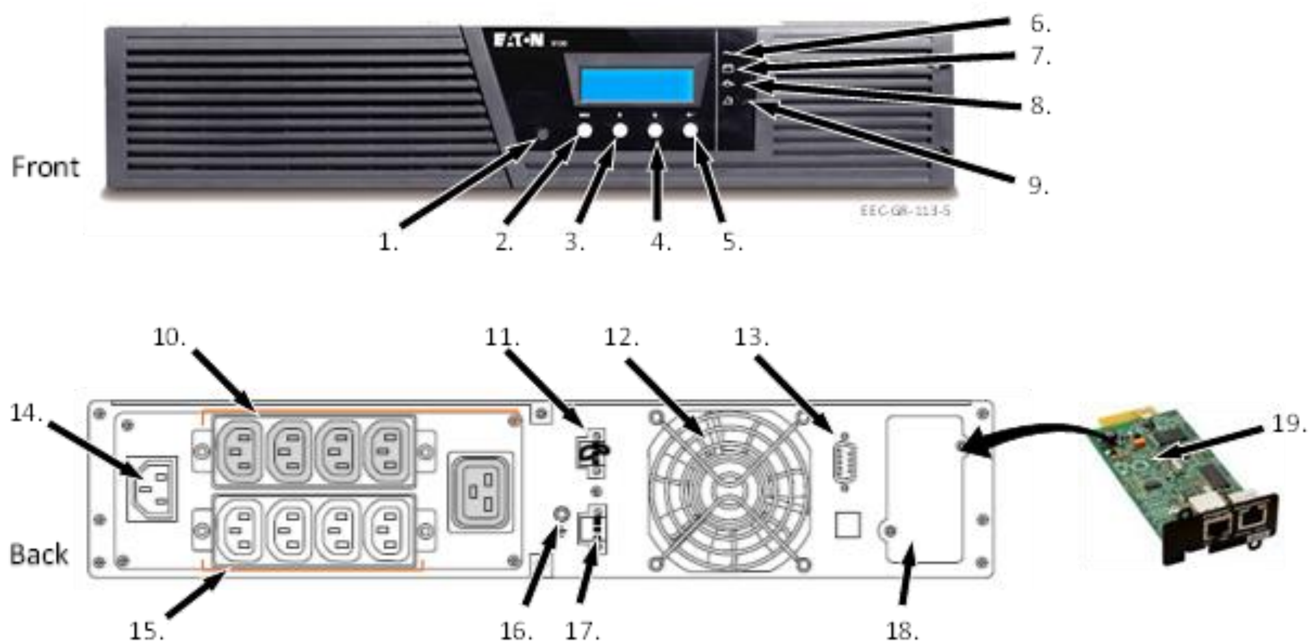

Figure 7. UPS

1. On / Off Button
2. Escape Button
3. UP Button
4. DOWN Button
5. Enter Button
6. Power Indicator (Green)
7. On Batter Indicator (Yellow)
8. Bypass Indicator (Yellow)
9. Alarm Indicator (Red)
10. Power Output Segment 1
11. Remote Power Off (REPO)
12. Cooling Fan
13. RS232 Connection
14. Power Input
15. Power Output Segment 2
16. Ground Connection
17. Standard Relay Output Contact
18. Communication Bay
19. SNMP Card (Ethernet)

The UPS will power the Maverick for up to 15 minutes. External (optional) battery packs can extend the operational time of the UPS and Maverick.

1.1.7. IQ2-IFD Receiver Assembly

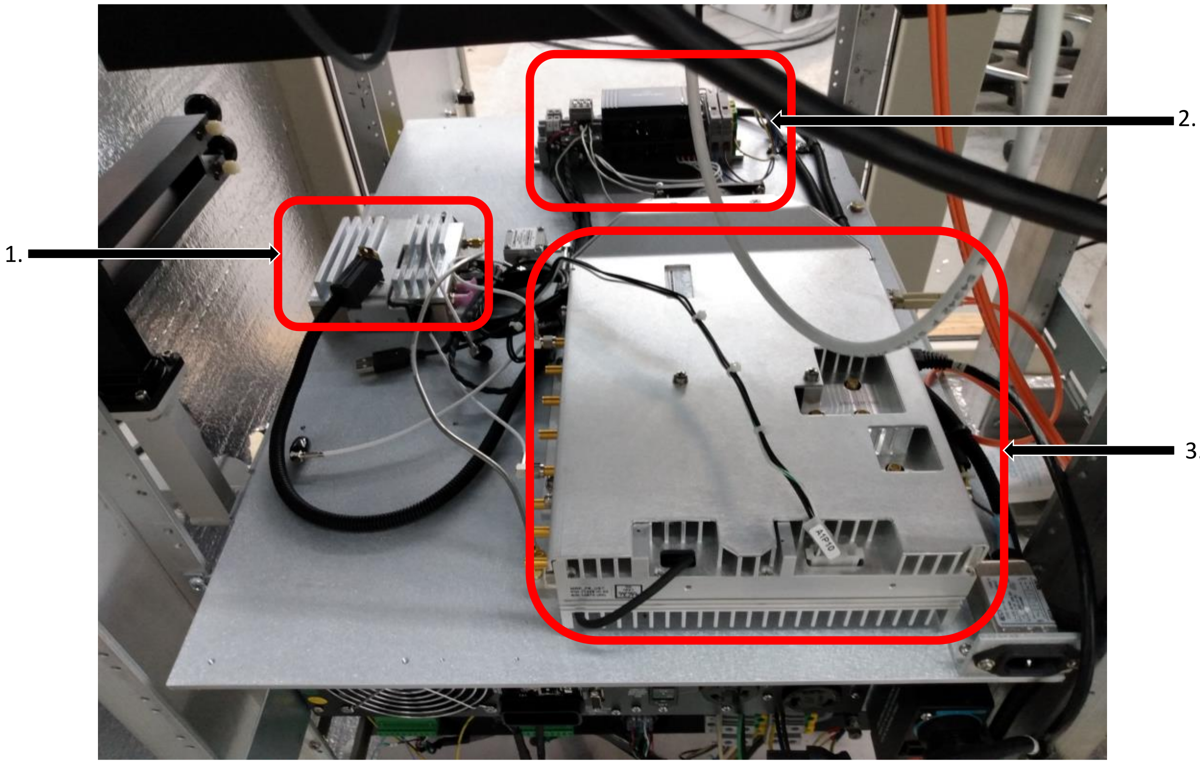

Figure 8. IQ2-IFD Receiver Assembly

1. STALO
2. Power Supply Unit
3. IQ2-IFD

1.1.7.1. IQ2-IFD

The IQ2-IFD receives the IF. The IQ2-IFD digitizes the received IF and outputs I and Q serial data from the receiver. The data is sent to the IQ2-DSP via a fiber optic cable.

1.1.7.2. STALO

The Stabilized Local Oscillator (STALO) is the primary frequency reference for the Maverick radar system and determines the overall stability of the processed signals. The IQ2-IFD automatically controls the frequency of the STALO using the AFC function within the IFD. The IQ2 system calculates the frequency offset of the transmit burst, and sends commands to the STALO using an RS-232 serial connection. The STALO applies the command and modifies the output frequency to precisely track 60 MHZ above the receive signal frequency.

Description	Specification
Frequency Range	0.65 to 10 GHz
Resolution	0.001 Hz
Switching Time	100 μs in triggered list mode 200 μs for individual commands
Power	+15dBm min.
RF Output On/Odd Ratio	60 dB min.
Output Return Loss	-10 dB nom.
Output Frequency	10 MHz nom.
Output Power	+5 ±2 dBm
Output Impedance	50 Ω nom.
Frequency Temperature Stability	±1 ppm

Description	Specification
Locking Range	±5 ppm
Input Frequency	10 MHz
Input Power	+5 dBm ±10 dBm
Absolute Maximum Input Level	+15 dBm
Input Impedance	50 Ω nom
Harmonics	-12 dBc typ
Non-harmonic Spurious	-60 dBc max
Supply Voltage	+12 VDC
Absolute Maximum Supply Voltage	+15 VDC
Operating Power Consumption	12.6 W nom.
Operating Temperature	0ºC to +55ºC

Table 2. STALO Specification Table

Phase Noise										
dBc/Hz										
	0.65 GHz (typ.)	0.65 GHz (max.)	1 GHz (typ.)	1 GHz (max.)	5 GHz (typ.)	5 GHz (max.)	10 GHz (typ.	10 GHz (max.)	20 GHz (typ.	20 GHz (max.)
100 Hz	-83	-77	-80	-74	-66	-60	-60	-54	-54	-48
1 kHz	-126	-120	-124	-118	-110	-104	-104	-98	-98	-92
10 kHz	-138	-132	-136	-130	-123	-117	-117	-111	-111	-105
100 kHz	-138	-132	-136	-130	-123	-117	-117	-111	-111	-105
1 MHz	-138	-132	-136	-130	-123	-117	-117	-111	-111	-105

Table 3. STALO Phase Noise

1.1.8. Bi-Directional Coupler

The Bi-Directional Coupler is a dual sidewall waveguide coupler permitting sensing of both the forward and reverse RF power. The output of the Bi-Directional coupler routes to the input of the Double Stub Tuner.

1.1.9. Magnetron

The Maverick X-band magnetron has an 85kW peak power output and is tunable from 8.5 to 9.6 GHz.

1.1.10. TR Limiter

The TR Limiter protects the sensitive receiver components from the high-energy burst of the transmit RF burst. The TR Limiter is a passive device.

1.1.11. Double Stub Tuner

The Double-Stub Tuner allows for power output adjustment while monitoring reverse power and is successful when the lowest reverse power reading is attained, i.e. the lowest Voltage Standing Wave Ratio (VSWR). The output of the Double Stub tuner is the input to the waveguide connecting the transmitter to the pedestal.

1.1.12. Bi-Directional Coupler

The Bi-Directional Coupler is a dual sidewall waveguide coupler permitting sensing of both the forward and reverse RF power. The output of the Bi-Directional coupler routes to the input of the Double Stub Tuner.

1.1.13. Solid State Modulator Power Supply Assembly

The Maverick Solid State Modulator and Power Supply consists of a single module that contains the circuits and functions described in the following sections.

1.1.13.1. Solid State Modulator

The Solid State Modulator functions as a voltage step up device and is the final drive element interfacing to the magnetron tube. The design limits the switching voltage level within the solid-state switch and avoids stacking switches in series configuration.

The design of the Modulator allows the cathode to pulse a coaxial Magnetron at the Pulse Repetition Frequency (PRF) selected by the operator. The Modulator delivers a high-voltage pulse, with rise and fall time regulated to prevent the system from driving past the maximum duty cycle, to the cathode of the Magnetron.

The Modulator is inside an oil-filled container for cooling and insulation.

The magnetron mounts directly to the rear of the module and no high voltage is exposed to the operator during normal maintenance and operation.

1.1.13.2. Solid State Modulator power Supply

The Solid State Modulator Power Supply is also called the High-Voltage Power Supply (HVPS). The HVPS component of the modulator system requires an AC source of 220V 50/60Hz at a maximum current of 12 Amps.

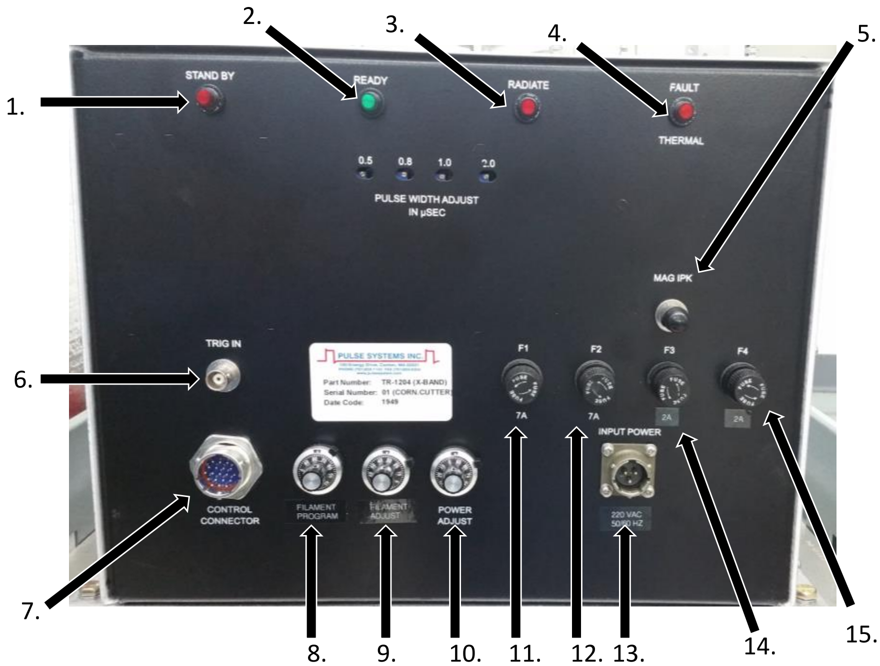

Figure 9. Solid State Modulator

1. Stand-By LED
2. Ready LED
3. Radiate LED
4. Fault alert LED
5. Magnetron Cathode Current (BNC)
6. Trigger In
7. Control Connector / MS Bayonet
8. Filament adjustment dial
9. Filament adjustment dial
10. Power adjustment dial
11. F1 7A ASB
12. F2 7A ASB
13. Input power (220 VAC; 50/60HZ)
14. F3 2A ASB
15. F4 2A ASB

The Power Supply control is through the “Power Adjust” potentiometer on the front panel. There is also a manual Reset button, which will bring the Power Supply back online following the occurrence of a fault within the Modulator Assembly. The front panel provides adjustment controls for the Pulse Widths (PW).

AC voltage enters the Power Supply where it is rectified and filtered to generate High Voltage. A transformer within the Power Supply provides the power necessary to produce the low voltages used within the Modulator Assembly. The final outputs of the Power Supply are rectified and filtered again which are essential for the quality Doppler performance of the radar system. After all conditioning is completed, the output of the Power Supply is sent to the Modulator. The output current from the Modulator to the Magnetron is monitored and if a factory set level is exceeded the Power Supply will shut the system down.

The Solid State Modulator Power Supply generates a DC voltage (approximately 800Vdc) that goes to the Solid State Modulator (SSM) storage capacitors. When the operator issues the "Radiate" command (master transmitter trigger through the BNC connector on the back of the Power Supply Unit), the one-shot oscillator produces the Insulated Gate Bipolar Transistor (IGBT) gate at the selected pulse duration and applies the gate to the IGBT switch array in the SSM. The IGBT switch gate closes the IGBT switches providing a discharge path from the SSM storage capacitors through the primary winding of the Pulse Transformer (PT). The pulse transformer steps up the discharged high voltage pulse to the level required by the magnetron cathode (approximately 21,000 volts) to drive the magnetron tube into oscillation. When the magnetron tube goes into oscillation, the result is an RF pulse of specific frequency determined by the characteristics and settings of the magnetron.

The control of the final pulse shaping and pulse width happens in the modulator discharge capacitors and the pulse transformer. Monitoring circuits within the transmitter provide status, fault isolation information, and shutdown capability for the Power Supply, SSM, and magnetron.

Additional circuits within the Power Supply provide the magnetron filament (also called heater) power. The magnetron requires a filament voltage de-rating using linear correlation proportional to the amount of current drawn by the tube.

The solid-state power supply contains the following sections:

1. Off-Line Power Factor, Filters, and Controls
2. Series Resonance Full Bridge Inverter
3. Series Resonance Frequency Modulation Controller
4. High Voltage Output Section
5. Low Voltage Power Supplies
6. Hard Tube Modulator Control
7. Filament Power Supply (control section)
8. Soft failure IGBT circuit & control

1.2. Control Box Assembly

1.2.1 Ethernet 16-Channel Discrete I/O Module

The 16-Channel Discrete (Digital) I/O (Input/Output) device has 16 bi-directional channels available supporting an input/output mix in a single unit. It has a very small footprint. All 16-channels update in 1ms.

The system utilizes loop-back monitoring on all channels where the inputs confirm output states for increased system reliability. There are watchdog timers and failsafe outputs whereby a communication fault sends output to a pre-defined state or holds the last value. Output fault detection is selectable on individual channels.

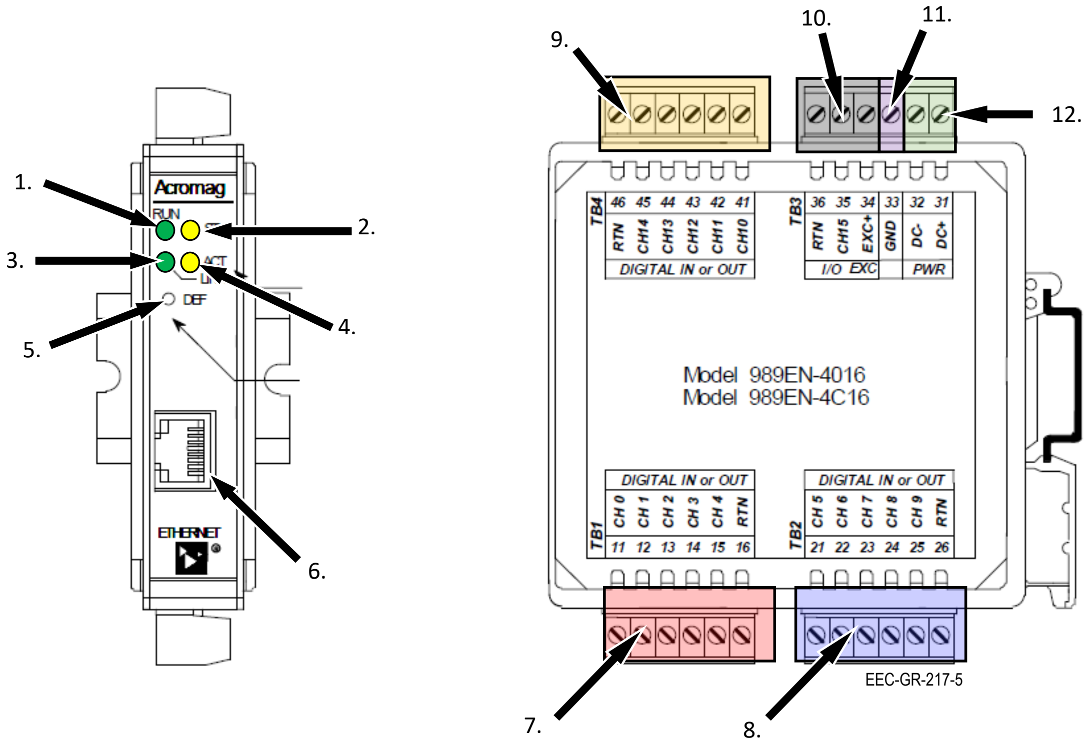

Figure 10. Ethernet 16-Channel Discrete I/O Module – Connections

1. Run / Power LED (Green)
2. Status LED (Yellow)
3. Ethernet Link (Green)
4. Activity LED (Yellow)
5. Default Address Button
6. RJ45 Ethernet Connector
7. Terminal Block 1
8. Terminal Block 2
9. Terminal Block 4
10. Terminal Block 3
11. Ground
12. DC Power

1.2.2 Ethernet 12-Channel Analog I/O Module

The 12-Channel Analog modules provide an isolated Ethernet network interface for analog input channels. They have multi-range inputs to accept signals from a variety of sensors and devices. They are high-resolution, low noise, A/D converters to deliver high accuracy and reliability.

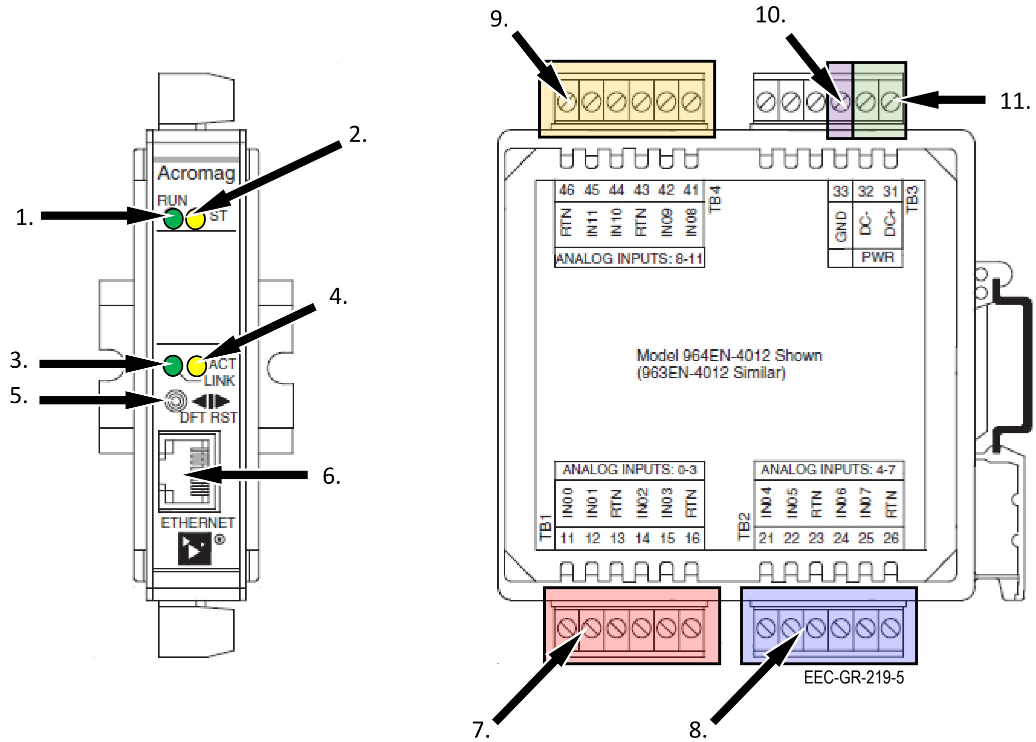

Figure 11. Ethernet 12-Channel Analog I/O Module – Position

1. Run/Power LED (GREEN)
2. Module Status LED (YELLOW)
3. Ethernet Activity LED (YELLOW)
4. Link LED (GREEN)
5. Reset / Default Address Toggle Switch
6. RJ45 Ethernet Connector
7. I/O Port (CH0-3)
8. I/O Port (CH4-7)
9. I/O Port (CH8-11)
10. Ground
11. DC Power

1.2.3 Signal Filter Assembly

The Signal Filter Assembly PCA is a line filter for the I/O Control Modules. The filter reduces entry of RF noise from the high voltage components in the Solid State Modulator Power Supply to prevent interference with other components connected to the I/O Control Module.

1.2.4 Trigger Distribution Amplifier PCA

The Gate Trigger Distribution Amplifier PCA is an amplification and distribution device for an external trigger (magnetron) input signal, and will also generate and distribute two configurable internal triggers. The PCA is capable of distributing the trigger to three separate TTL logic level outputs and one output of 15 VDC.

The PCA provides a web-based module for monitoring external triggers/gate and configuring Pulse Repetition Frequency limits for up to four individual pulse widths to prevent over duty cycle conditions.

There are 8 digital inputs and 8 digital outputs available for external control and status indications.

There are 12 LEDs (3 BLUE, 9 GREEN) on the Gate Trigger Distribution Amplifier PCA used to indicate the DC power and operating status.

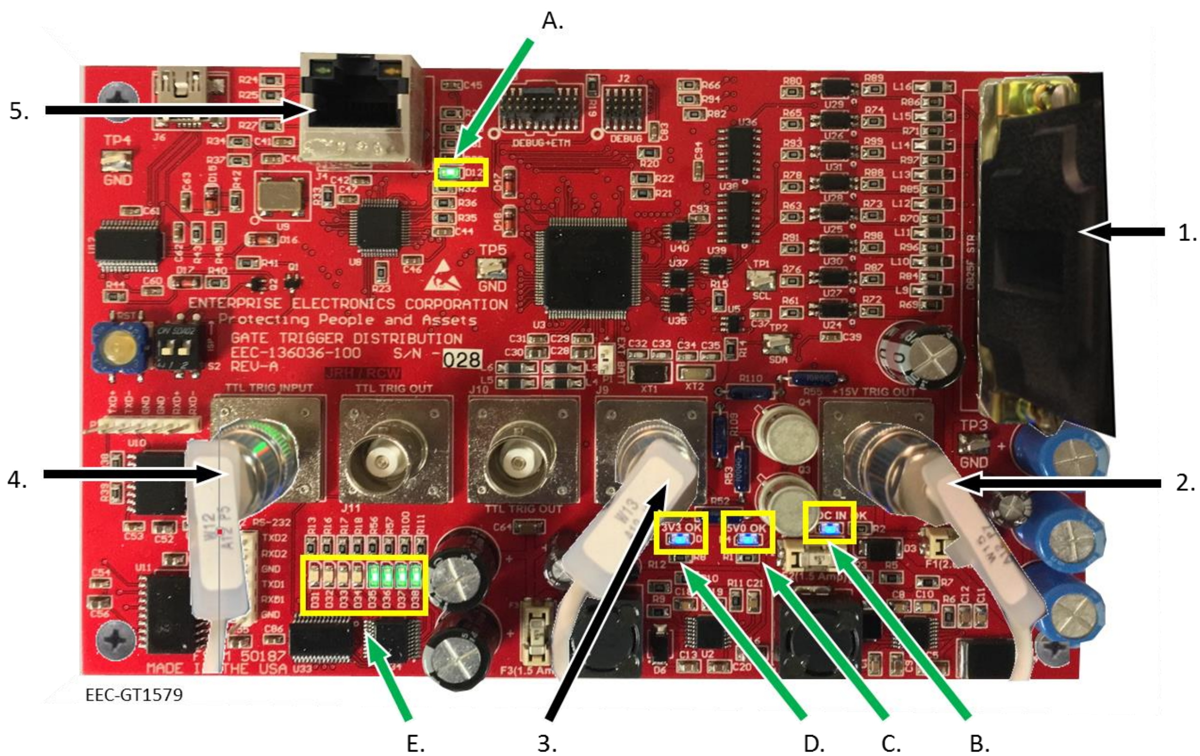

Figure 12. Trigger Distribution Amplifier (Top)

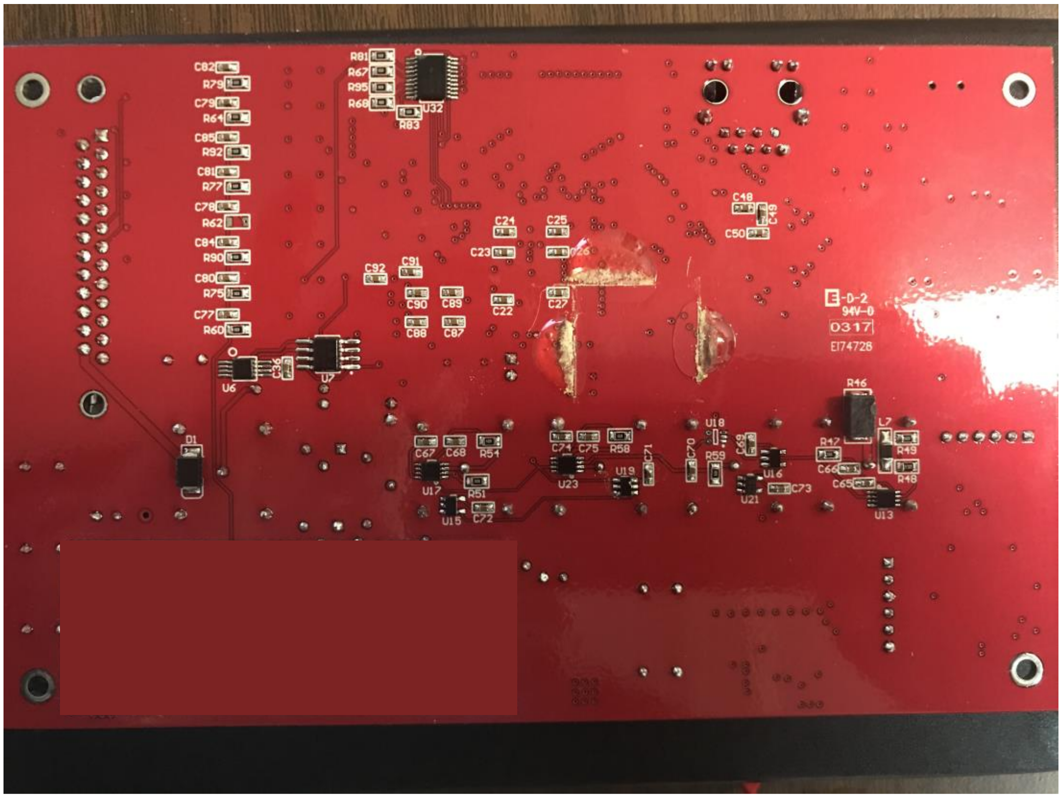

Figure 13. Trigger Distribution Amplifier (Bottom)

Connectors (Black Arrows)

1. J1. Communications and Power Connector
2. J7. Trigger Output to Sector Blanking
3. J9. Trigger Output to Front Panel
4. J5. Master Trigger In from IQ2
5. J4. Ethernet Connection
6.

LED Indicators (Green Arrows)

A. D12. Ethernet Processor Indicator (Green)
B. D5. 24VDC Power Indicator (Blue)
C. D4. 5VDC Power Indicator (Blue)
D. D7. 3.3VDC Power Indicator (Blue)
E. D31-D38 Status Indicators (Left to Right)
    - D31. N/A
    - D32. N/A
    - D33. N/A
    - D34. N/A
    - D35. Internal / External (ON=Local / OFF= Remote)
    - D36. Trigger Detect (ON=Pulse Trigger Present)
    - D37. Trigger Enable (ON=Enabled)
    - D38. Active MCU (Blinks – one second duration)