

TRICOM
RESEARCH, INC.

OPERATOR'S MANUAL
TCR-U/L-50
UHF/L-BAND RF AMPLIFIER



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TCR-U/L-50 OPERATOR'S MANUAL

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1.0 INTRODUCTION

1.1 GENERAL INFORMATION

The TCR-U/L-50 Power Amplifier (PA) evolved from the widely fielded TCR-MBA-50v2 to meet the demands for increased communication range of existing and emerging handheld and manpack radios utilizing UHF and L-Band waveforms. It shares the same footprint as the TCR-MBA-50v2 to support vehicular, airborne, maritime, man-portable, or fixed-station applications with user-configurable antenna ports.

- Transmit amplification for the 225-450 MHz, 1.25-1.45 GHz (L1), and 1.75-1.85 GHz (L2) frequency ranges
- Three co-site filtered receive bands: 225-450 MHz, 1.25-1.45 GHz, and 1.75-1.85 GHz
- Low Noise High Dynamic Range Receive Pre-Amplifier (LNA) for all bands
- Two automatic switching antenna ports: UHF and L-Band
- Active and DC Off/Failsafe L-Band Bypass
- Carrier Detect Keying and Automatic Frequency Detection
- ANW2C and SRW Wideband Networking
- Tactical Waveforms mode for advanced waveforms
- RS-485 and USB connectivity for end-user devices and optional Remote Face Plate and Bias-Tee
- Simple, three button menu-based user interface with Night Vision Goggle (NVG) compatible display
- MIL-STD-810G, MIL-STD-461, MIL-STD-464 (Near Strike Lightning)
- Excessive temperature, voltage, and current protection



Figure 1-1. TCR-U/L-50 Amplifier

1.2 ABBREVIATIONS AND GLOSSARY

AM	Amplitude Modulation
ANT	Antenna
ANW2C	Adaptive Networking Wideband Waveform Revision C
ATAK	Android Tactical Assault Kit
dB	Decibel
dBm	Decibel referenced to 1 milliwatt (0 dBm = 1 mW)
FM	Frequency Modulation
Hz	Hertz
IW	Integrated Waveform
JITC	Joint Interoperability Test Center (DISA)
kHz	Kilohertz
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LOS	Line of Sight
MHz	Megahertz
mW	Milliwatt
OLED	Organice Light Emitting Diode
RCV	Receive
SRW	Soldier Radio Waveform
TW	Tactical Waveforms
UHF	Ultra-High Frequency
VDC	Volts, Direct Current
VSWR	Voltage Standing Wave Ratio
W	Watt
WB	Wideband
XMT	Transmit

1.3 EQUIPMENT DESCRIPTION

The TCR-U/L-50 (Tricom PN: 11000-00927) is a bi-directional half duplex RF Power Amplifier (PA) designed to enhance communications in vehicular, airborne, maritime, man-portable, or fixed-station applications. Current wideband military waveforms are supported including ANW2C and SRW as well as advanced waveforms in the Tactical Waveforms (TW) Mode. Three individual receive band co-site filters with high dynamic range low noise amplifiers (LNAs) are used to cover the UHF, L1, and L2 ranges to greatly improve reliable communications in high co-site installations. Harmonic filters are used to control harmonic and spurious emissions. The L-Band Bypass mode suppresses frequencies below 30 MHz. An intuitive menu driven user interface simplifies operation of the PA and provides status to the operator.

1.3.1 MODES AND RECEIVE FILTER SELECTION

Listed below are the receive band filter ranges with the associated PA modes. The PA modes are listed in the format that they are displayed. Mode selection is accomplished using the TCR-U/L-50 front panel push buttons, further described in Section 2.3:

<u>RCV FILTER</u>	<u>MODES</u>
UHF	WB (WIDEBAND) and TW (TACTICAL WAVEFORMS)
L1	WB and TW
L2	WB and TW
BYPASS	BYP L-BAND

1.3.2 TRANSMIT POWER LEVELS

The PA has LOW, MED, and HI output power levels in all modes which correlate to 25, 35, and 50 Watts in UHF and 10, 15, and 25 Watts in L-Band (default settings).

Note: In the system configuration menu, the end user may define the transmit output level for each output power level (LOW/MED/HI). For example, in UHF, the user can set the "LOW" setting for any available power level (25/35/50). Refer to the flow chart for additional detail.

1.3.3 OLED DISPLAY

The TCR-U/L-50 NVG compatible OLED Home Display is used to indicate the mode of operation, power level, antenna selection, DC input power, internal temperature, RCV/TX, and in use antenna when in AUTO. During use of the Menu function, the display provides clear user instructions. Examples of the Home Display and Menu functions are shown in Figures 1-2 and 1-3.

Note: In the system configuration menu, the end user may flip the OLED 180 degrees for alternate mounting configurations. Refer to the flow chart for additional detail.

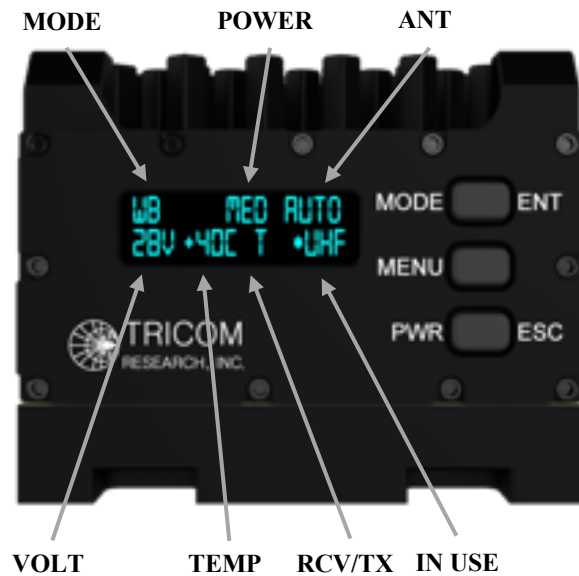


Figure 1-2. Home Display

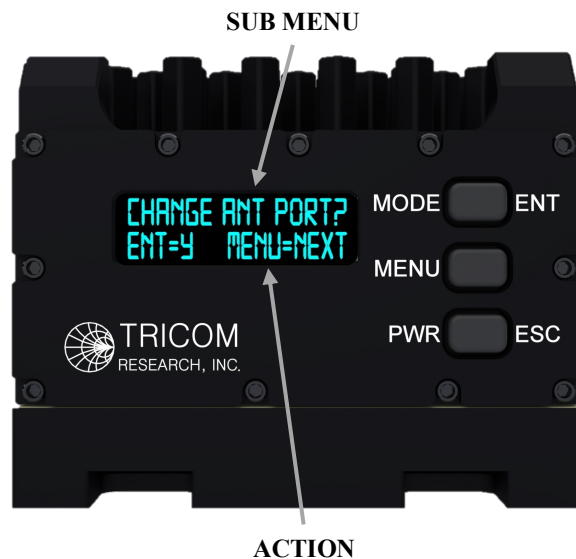


Figure 1-3. Menu Function Display

1.4 AMPLIFIER COMPONENTS

The TCR-U/L-50 Power Amplifier has a sealed, rugged enclosure finished in black anodize and designed to withstand the elements and resist corrosion. The enclosure houses all electronic subassemblies including printed circuit board assemblies, filter and switching networks, and interconnects.

1.5 POWER CABLE

A multi-conductor cable connects the amplifier with an external DC power source. A cable wiring diagram cable is shown in Section 3.3 of this manual. The DC power cable used with the widely fielded TCR-MBA-50 family of PAs may be used to power the TCR-U/L-50.

1.6 SPECIFICATIONS

Note: Information in Section 1.6 is included for reference only and does not constitute a warranty of performance.

Table 1-1. Nominal Performance Specifications

TRANSMIT:

UHF

Frequency Range 225-450 MHz

L1

Frequency Range 1.25-1.45 GHz

L2

Frequency Range 1.75-1.85 GHz

ALL TRANSMIT MODES

RF Power Input 1-5W (10W without damage)

RF Power Output 25, 35, 50W UHF
10, 15, 25W L-Band

RECEIVE:

UHF

Frequency Range 225-450 MHz with co-site filtering

Receive Gain 6 dB, 3.5 dB NF

L1

Frequency Range	1.25-1.45 GHz with co-site filtering
Receive Gain	6 dB, 4.5 dB NF

L2

Frequency Range	1.75-1.85 GHz with co-site filtering
Receive Gain	6 dB, 5.5 dB NF

BYPASS TO L-BAND ANTENNA:

Frequency Range	UHF
Typical Insertion Loss	1.75 dB

Frequency Range	1-2 GHz
Typical Insertion Loss	2.5 dB

Frequency Range	2-2.6 GHz
Typical Insertion Loss	3.0 dB

Table 1-2. Additional Specifications

ADDITIONAL SPECIFICATIONS:

Immersion	1 meter
RADIO/UHF/L-BAND Connectors	TNC female (immersion rated without cap)
DC Connector	MS3112E10-6P
AUX Connector	9 pin Fischer, DBPU 102 A059-239G
Operating Voltage	28-32 VDC nominal (22-34 VDC without shutdown)
Protection	High temperature fold back, High VSWR High voltage, DC input Reverse polarity, DC input Near Strike Lightning
DC Off	Bypasses RADIO to L-BAND antenna port
Operating Temperature	-20°C to +60°C
Cooling	Natural convection
External Finish	Black anodize
Dimensions	2.85" H x 3.5" W x 8.15" D (including connectors)
Weight	3.7 lb (est.)

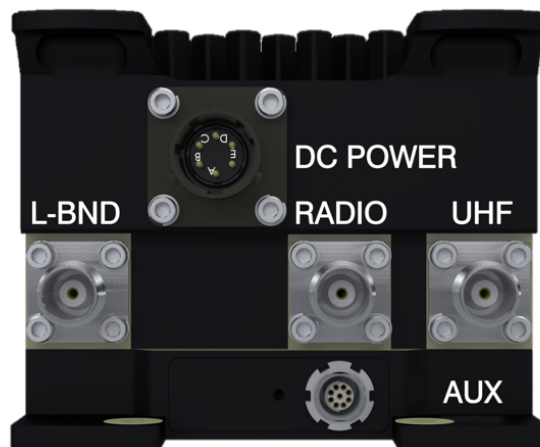


Figure 1-4. Rear Panel

Table 1-3. Interconnect Characteristics

CONN	SIGNAL/PIN	DETAIL
DC IN	DC Power Input	MS3112E10-6P (Mating connector MS3116F10-6S)
	Pin A	28-32 VDC
	Pin B	Electrical Ground (GND)
	Pin C	Reserved
	Pin D	Reserved
	Pin E	Reserved
	Pin F	Reserved
RADIO	TNC Female	RF from Radio
UHF	TNC Female	RF to UHF Antenna
L-BAND	TNC Female	RF to L-BAND Antenna
AUX	Auxiliary	Fischer DBPU 102 A059-239G (Mating Connector Fischer S 102 A059 232+)
	Pin 1	Electrical Ground (GND)
	Pin 2	+5V (output to External Device)
	Pin 3	USB +5V (input to PA from external host)
	Pin 4	USB +
	Pin 5	USB -
	Pin 6	Reserved (RS-485 A (+) future use)
	Pin 7	Reserved (RS-485 B (-) future use)
	Pin 8	Reserved (SPARE)
	Pin 9	Reserved (SPARE)

2.0 OPERATION

WARNING

ELECTROMAGNETIC RADIATION FROM THE ANTENNA CAN DAMAGE EYES AND OTHER BODY TISSUE WHEN THE SYSTEM IS TRANSMITTING. DO NOT STAND DIRECTLY IN FRONT OF THE ANTENNA OR IN CLOSE PROXIMITY TO THE SIDES OR BACK OF THE ANTENNA WHEN TRANSMITTING.

2.1 GENERAL INFORMATION

The TCR-U/L-50 can be used for operation once it has been installed as described in Section 3.

2.2 CONTROLS

The TCR-U/L-50 has a menu driven display controlled with three buttons as shown in Table 2-1:

Table 2-1. Front Panel Controls

CONTROLS	TYPE	FUNCTION
MODE/ENT	Pushbutton Switch	Select MODE "Affirmative" in Menu Function
MENU	Pushbutton Switch	Enter Menu Function Advance in Menu Function
PWR/ESC	Pushbutton Switch	Power On, Power Off Select Power Level "Negative" in Menu Function

2.3 POWER ON, INITIALIZATION, AND SET UP

Pressing the front panel PWR pushbutton initiates a Power On Self Test (POST) process after which the amplifier enters the Home Display. The PA powers on in the previous operating state.

Note: When set, the user-defined start up configuration, available on firmware 78888-01927 Revision 2.4 or later, will override the PA starting in the last operating state and instead start up in the user-defined configuration. To clear the user-defined start up configuration, perform a factory reset. Refer to the flow chart for additional detail.

The TCR-U/L-50 has an auto-start configuration which is enabled as a factory default.

Note: The auto-start configuration may be disabled/enabled within the configuration menu. When enabled, the PA will automatically turn on with application of DC power. This feature is particularly useful in installations where the front panel is not easily accessible and DC power is controlled remotely. When disabled, the PA will return to its previous state (Power On/ Off) when DC power is cycled. Refer to the flow chart for additional detail.

From the Home Display, the user can cycle through modes with momentary presses of the front panel MODE pushbutton. Modes cycle in the order depicted in Section 1.3.1.

Note: There is a three second delay in setting mode during which time the OLED will display “SETTING MODE” followed by “MODE SET”.

Power levels are set using the front panel PWR pushbutton. A single press of the PWR pushbutton from the Home Display will cycle through the available power levels: LOW, MED, and HI. The default selection is HI for all modes.

The default antenna selection is AUTO. During AUTO operation, all UHF is automatically routed to the UHF antenna port and all L-Band is routed to the L-BAND antenna port. Alternatively, the user can force RF to the UHF or L-BAND antenna ports via the Menu function. The display will show “SELECT ANTENNA” with clear instruction on menu navigation.

At all times within the Menu function: the ESC key functions as a “Negative” and returns to the Home Display or previous menu level; the ENT key functions as an “Affirmative” and results in a select action; the MENU key advances to the next Menu function.

Set Up is complete once the unit is powered on, mode selected, power level set, and antenna selected (if applicable).

Power down (off/bypass) is accomplished by pressing and holding the PWR pushbutton for greater than three seconds.

2.3.1 PUSHBUTTON FUNCTIONS

PWR Pushbutton – Power On/Off - To turn the amplifier on, press the PWR button. The PA will turn on, complete a post process, and enter the Home Display in the same state as it was last powered off. Press and hold the PWR pushbutton for more than three seconds to power down the amplifier. While off, RF is routed to the L-BAND antenna port from the RADIO port.

PWR Pushbutton – Setting Power Level - To change transmit power level, press the PWR button momentarily from the Home Display. A single press of the PWR pushbutton will cycle through the available power levels: LOW, MED, and HI. The default selection is HI for all modes.

ESC Pushbutton – Escape - A single press of the ESC Pushbutton acts as a “Negative” while in the Menu function and will return to the Home Display or previous menu while in the sub menus.

MENU Pushbutton – Menu - To enter the Menu function from the Home Display, press the MENU pushbutton momentarily. Subsequent presses will cycle through the MENU.

MODE Pushbutton – Mode - Momentary presses of the MODE pushbutton from the Home Display will cycle through available modes.

ENT Pushbutton – Enter - A single press of the ENT button acts as an “Affirmative” while in the Menu function and will result in selection of the action displayed.

The Menu function reverts back to the Home Display if no button is pressed for 10 seconds.

2.4 MODES OF OPERATION

2.4.1 WB

From the Home Display, press the MODE button repeatedly until the display shows WB. Default settings for WB are the L-BAND antenna selection and Hi output power. The WB filter bands are 225-450 MHz, 1.25-1.45 GHz, and 1.75-1.85 GHz. Receive signals outside of the selected band will be attenuated. The user may select another antenna selection or power level as described in Section 2.3.

2.4.2 TW

From the Home Display, press the MODE button repeatedly until the display shows TW. Default settings for TW are the L-BAND antenna selection and Hi output power. The WB filter bands are 225-450 MHz, 1.25-1.45 GHz, and 1.75-1.85 GHz. Receive signals outside of the selected band will be attenuated. The user may select another antenna selection or power level as described in Section 2.3.

Note: The receive filter is selected by the last transmission with the default upon mode change being 1.25-1.45 GHz. Momentary transmit is required in order to select a different receive filter. Cycling DC power does not change the receive filter.

Note: TACTICAL WAVEFORMS is designed to be compatible with emerging wideband constant envelope MANET waveforms with very fast switching speed requirements. Full operational testing is advised prior to use.

2.4.3 BYP L-BAND

From the Home Display, press the MODE button repeatedly until the display shows BYP L-BAND. When the BYP L-BAND mode is selected, RF is routed to the L-BAND antenna port with no amplification. The bypass band is 30 MHz to 2.6 GHz. Signals outside of this band will be attenuated.

2.4.4 MODE SELECTION NOTE

When a new mode is selected the PA automatically reverts back to the default power setting (HI, except in bypass) and default antenna setting (AUTO).

2.5 FREQUENCY FAULT AND RECOVERY

The TCR-U/L-50 has built-in frequency fault protection.

2.5.1 FREQUENCY FAULT, WB AND TW MODES

If the RF input frequency is outside of the actively amplified frequency range of the TCR-U/L-50 (225-450 MHz, 1.25-1.45 GHz, and 1.75-1.85 GHz) while in WB and TW modes, the amplifier automatically switches to the BYP L-BAND mode. The display will show “FREQUENCY FAULT, PA IN BYPASS” until the end of transmit or two seconds, whichever is less. The message will reappear every six seconds until a recovery occurs.

2.5.2 RECOVERY

The TCR-U/L-50 will revert to the previous mode and antenna with a subsequent in band transmission. Frequency fault settings are not saved as the last mode; therefore, a power cycle returns the amplifier to its operating state prior to the frequency fault.

2.6 BYPASS OPERATION (POWER OFF)

In an off state or with DC power removed, the amplifier defaults to BYP L-BAND mode and RF is routed to the L-BAND antenna port. The bypass band is 30 MHz to 2.6 GHz. Signals outside of this band will be attenuated.

2.7 LNA OPERATION PRECAUTIONS

There may be an interoperability issue when operating certain radios that have a receive Low Noise Amplifier (LNA). It is recommended to turn off the radio LNA for best receive sensitivity when using the PA and its internal LNA.

2.8 SYSTEM WARNINGS

The TCR-U/L-50 has built-in monitoring for voltage, current, and temperature. This section identifies warnings which are indications of improper operating conditions and may cause the amplifier to limit output power or shut down, as described.

2.8.1 HIGH TEMP ALERT

If the amplifier internal temperature sensor detects excessive heat, the warning message “HIGH TEMP ALERT, TX PWR REDUCED” will be displayed for two seconds and repeated every six seconds until the condition is cleared. Upon clearing, “HIGH TEMP CLEAR, TX PWR NORMAL” will be displayed for two seconds and the amplifier will return to normal operations.

2.8.2 HIGH TEMP FAULT

If the amplifier is in a high temp alert and continues to increase internal temperature beyond safe operating conditions, the warning message “HIGH TEMP FAULT, PA IN BYPASS UNTIL TEMP IS REDUCED <70 C” will be displayed for two seconds and repeated every six seconds until the condition is cleared. Upon clearing, “HIGH TEMP CLEAR, TX PWR NORMAL” will be displayed for two seconds and the amplifier will return to the previous operating mode.

2.8.3 HIGH CURRENT ALERT

If the amplifier high current protection circuit detects high current, the warning message “HIGH CURRENT, CHECK SYSTEM” will be displayed until the end of transmit or two seconds, whichever is less. Transmit power may be automatically reduced when high current is detected but the PA will otherwise continue to operate normally.

2.8.4 HIGH CURRENT FAULT

If the amplifier high current protection circuit detects high current and cannot reduce the current sufficiently by reducing TX power, the PA will switch to Bypass Mode and the warning message “HIGH CURRENT, PA IN BYPASS” will be displayed for two seconds and repeated every six seconds until the condition is cleared by changing modes or with a DC power cycle. If in bypass or receive modes and excessive current draw is detected, the PA will automatically power itself off and set the auto-start configuration to off. Auto-start will not be enabled until selected again in the user accessible menu.

2.9 TROUBLESHOOTING

In the event of an amplifier malfunction, check to make sure that the equipment is configured in accordance with Section 3. If the problem persists, refer to the troubleshooting guide in Table 2- 2.

Table 2-2. Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
“HIGH TEMP ALERT”	The amplifier has exceeded its normal operating temperature.	Provide additional airflow or reduce transmission time.
"HIGH TEMP FAULT"	The amplifier has exceeded its normal operating temperature limit.	Provide additional airflow or reduce transmission time.
“HIGH CURRENT, CHECK SYSTEM”	The amplifier high current protection circuit has detected high current.	Reduce input power, check antenna connections, reduce output power setting.
“HIGH CURRENT, PA IN BYPASS”	The amplifier high current protection circuit has detected high current beyond the factory determined threshold.	Reduce input power, check antenna connections, reduce output power setting.

3.0 INSTALLATION

3.1 PREPARATION FOR USE

After unpacking the system and inspecting for physical damage, select an appropriate location for the amplifier. Although the TCR-U/L-50 is weather-resistant, placing it in a location where it is protected from rain, sunlight, and salt spray will increase its service life. Make sure that adequate air flow is available to allow proper natural convection cooling.

3.2 MOUNTING PROVISIONS

The TCR-U/L-50 can be mounted using existing mounting holes for the TCR-MBA-50 family of power amplifiers (refer to Figure 3-1). These holes accommodate #10-32 screws, which screw into tapped 10-32 X 0.220 deep holes on the amplifier. Ensure the proper length screw is used to prevent damage to the threaded holes on the amplifier.

The power amplifier can also be mounted by using two (optional) mounting tabs in the front and two mounting holes on flanges in the rear. The tabs must be mounted first using 100° #8 flat head screws. To mount the power amplifier, simply slide the two slots on the front of the power amplifier onto the two tabs and secure the rear flanges with two #8 pan head screws. Other mounting points are included on the sides of the amplifier to accommodate a variety of mounting options.

See Figure 3-1 for details.

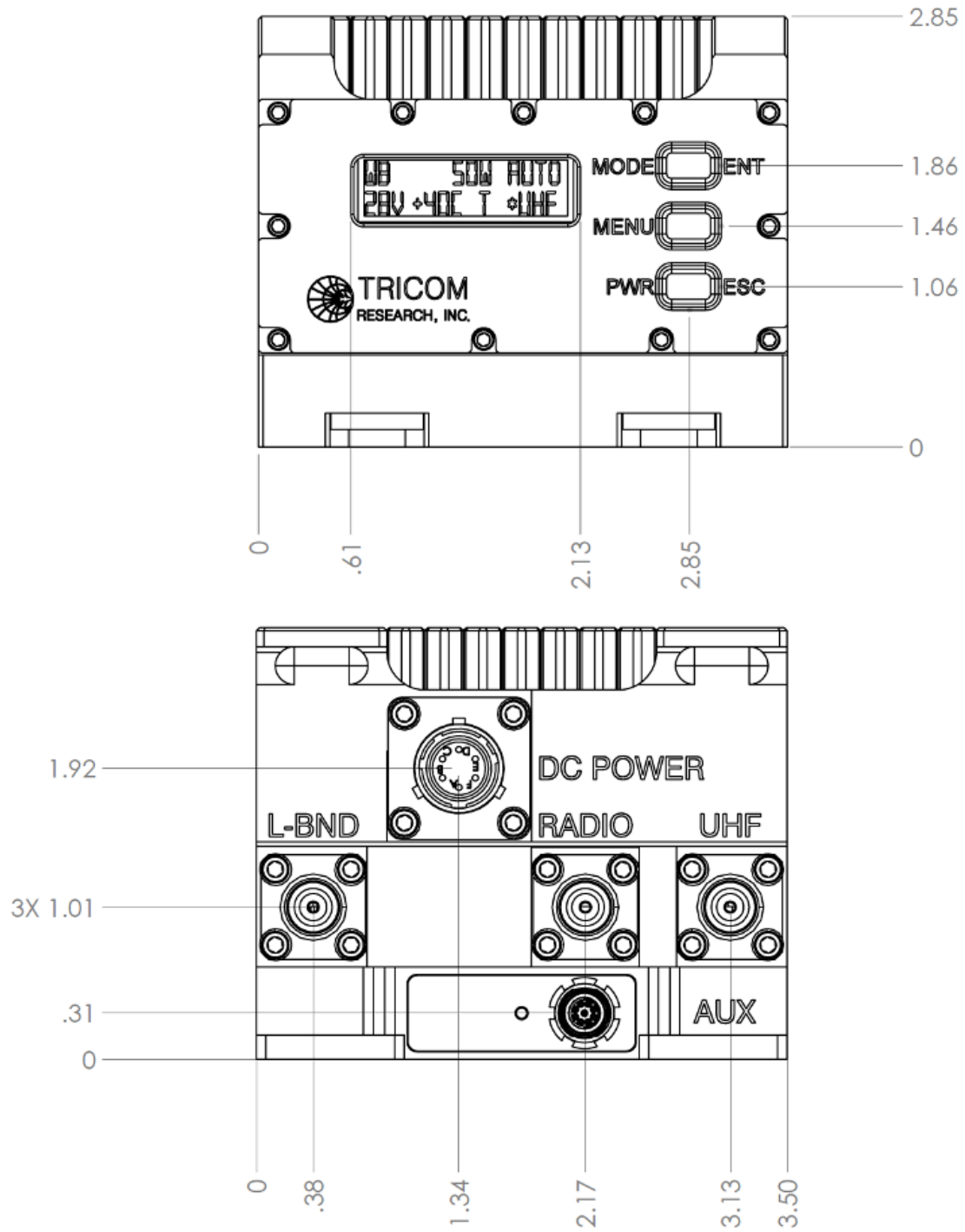


Figure 3-1. TCR-U/L-50 Outline Drawing

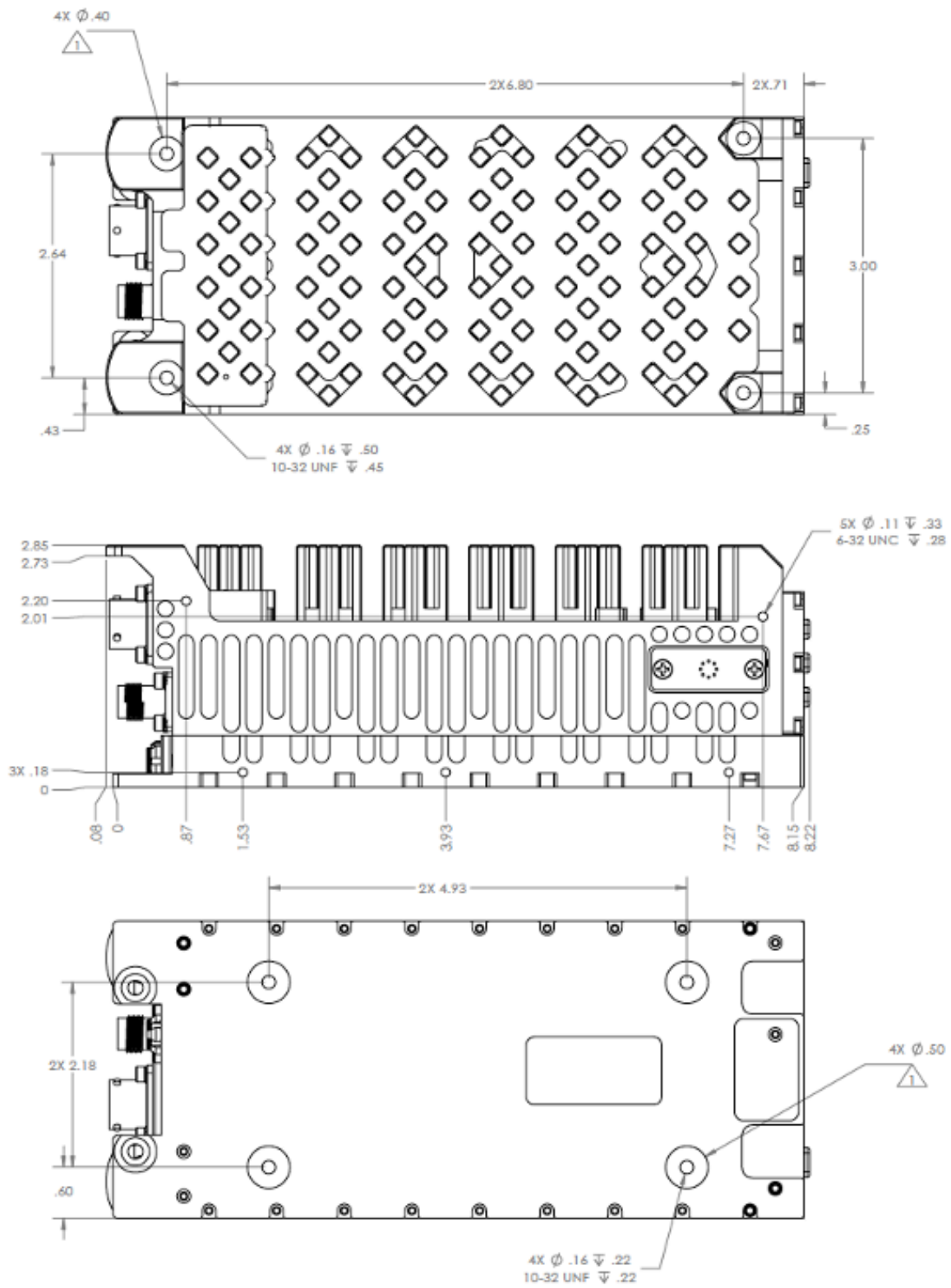


Figure 3-1. TCR-U/L-50 Outline Drawing (cont.)

3.3 DC INPUT POWER

The DC input power connector, shown in Figure 3-2, is compatible with a variety of power cables (custom made or available for purchase from Tricom Research Inc.). A typical power cable is shown in Figure 3-3. Note that the PA has true reverse polarity protection, including protection from connecting the positive voltage input to Pin B (GND) with a grounded chassis. Note that the keyway for PIN A is oriented towards the bottom of the PA.

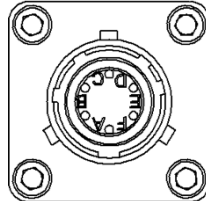


Figure 3-2. DC Input Power Connector (MS3112E10-6P)

Table 3-1. DC Input Power Connector Pinout

Pin	I/O	Description
A	I	10-32 VDC
B	I	Electrical Ground (GND)
C	I/O	Reserved
D	I/O	Reserved
E	I/O	Reserved
F	I/O	Reserved

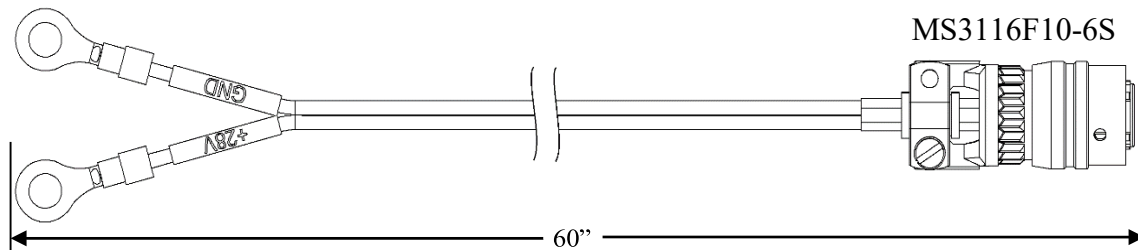


Figure 3-3. DC Power Cable (Part Number 77500-00412)

3.4 RF CONNECTIONS

Attach an RF cable from the transceiver to the RADIO input connector. Attach RF cables/antennas to the applicable antenna connections located on the rear of the amplifier.

3.5 AUXILIARY INTERFACE

The auxiliary interface AUX (shown in Figure 1-4) provides access to enhanced capabilities and firmware updates. The connector is waterproof and has a silicone dust cap. The connector should be inspected to verify there is no dirt or contaminants present before mating a cable.

AUX provides a +5VDC regulated output and a USB interface for remote control and an RS-485 interface for future use. The USB interface is automatically selected when the USB external host sources +5VDC to the PA.

Table 3-2. AUX Interface Pinout

Pin	I/O	Description
1	I	Electrical Ground (GND)
2	O	+5V (output to External Device)
3	I	USB +5V (input to PA from external host)
4	I/O	USB +
5	I/O	USB -
6	I/O	(RS-485 A (+) future use)
7	I/O	(RS-485 B (-) future use)
8	I/O	Reserved (SPARE)
9	I/O	Reserved (SPARE)

3.6 FIRMWARE UPDATES

The Power Amplifier firmware can be updated via the rear panel AUX interface.

3.7 OPTIONAL FUNCTIONALITY AND ACCESSORIES

The TCR-U/L-50 supports optional accessories and functionality through the AUX interface. Contact Tricom Research at support@tricomresearch.com for additional information.

3.7.1 REMOTE FACE PLATE

An optional Remote Face Plate is available for the TCR-U/L-50. The Remote Face Plate connects to the AUX interface and offers full functionality from a remote location. The Remote Face Plate is particularly useful when operator controls are not easily accessible due to mounting location.

3.7.2 BIAS-TEE

Optional Bias-Tee units are available for the TCR-U/L-50 with a basic and enhanced version available. The Bias-Tee places the amplifier near the antenna while maintaining control of the PA near the operator. The basic version allows the user to turn the PA on or off remotely while the enhanced version offers full remote control.

3.7.3 ATAK PLUG-IN

An ATAK Plug-In for remote control of the TCR-U/L-50 is in development. The end-user device connects to the amplifier via the AUX interface.

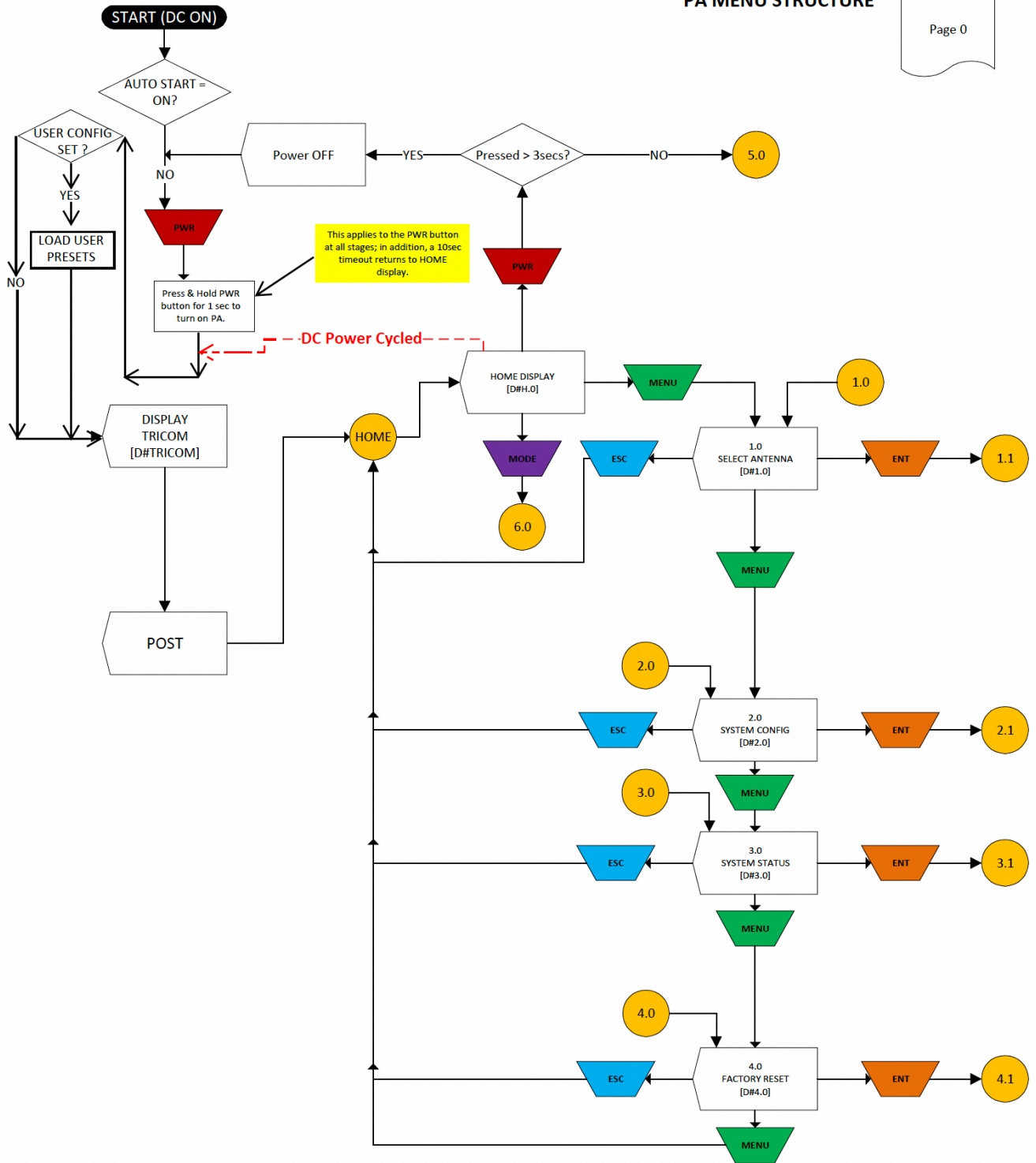
4.0 PREVENTIVE MAINTENANCE

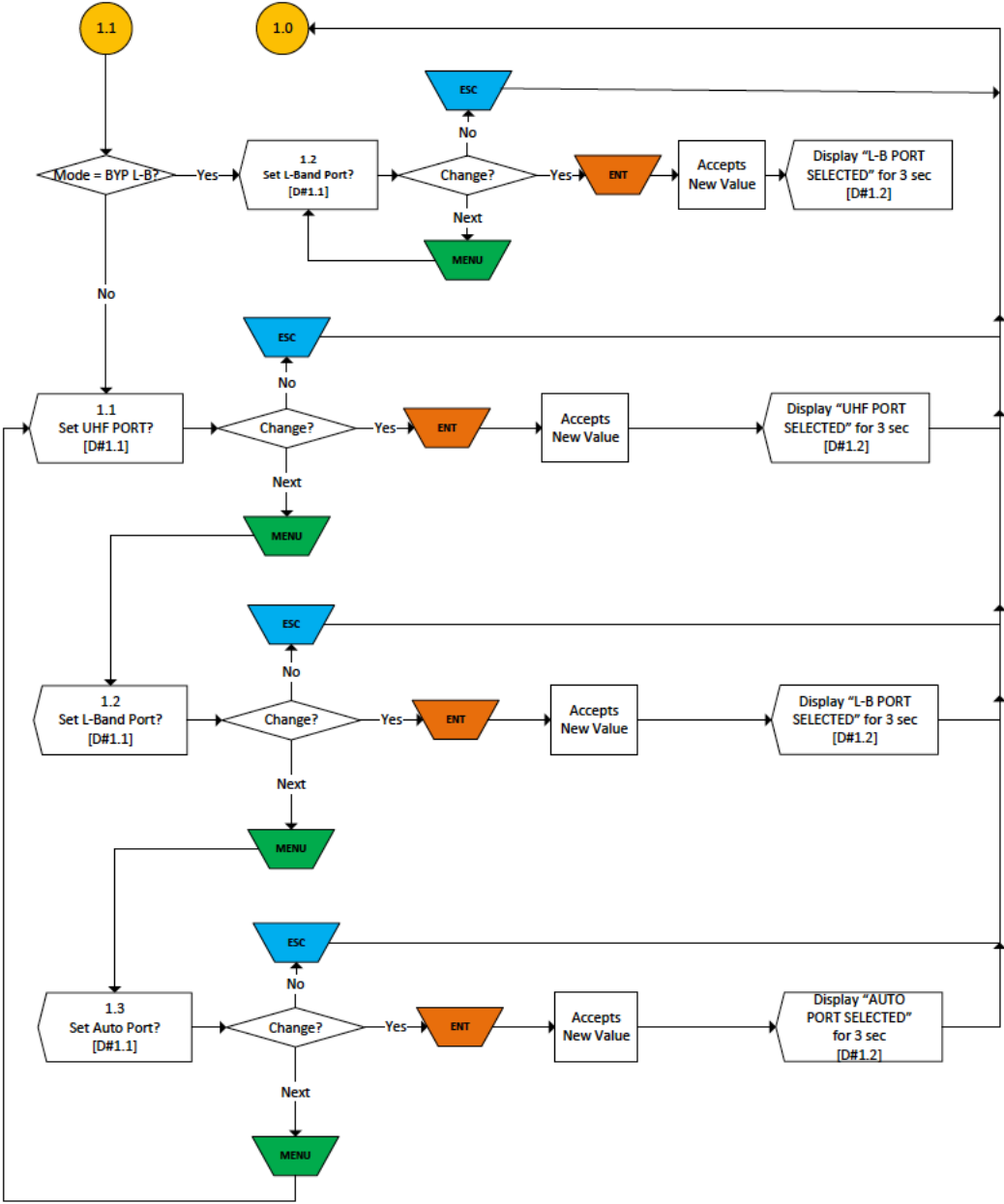
4.1 ANTI-FUNGAL

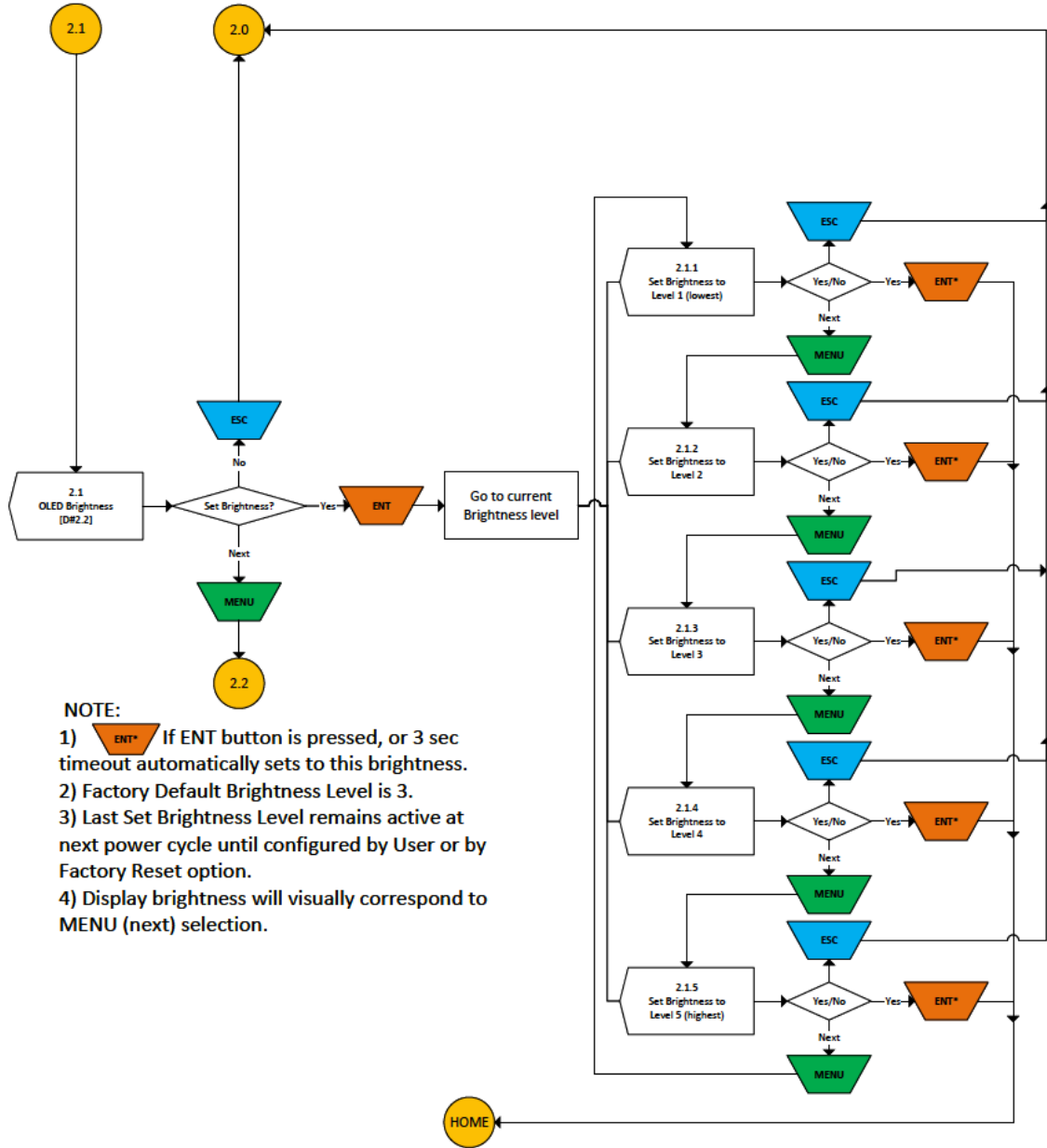
When operating in high humidity environments for extended periods of time, the front panel pushbuttons have a potential for non-deteriorating fungal growth. Thorough cleaning with isopropyl alcohol is recommended to prevent contamination and/or discoloration. Cleaning is recommended quarterly or as required.

APPENDIX A

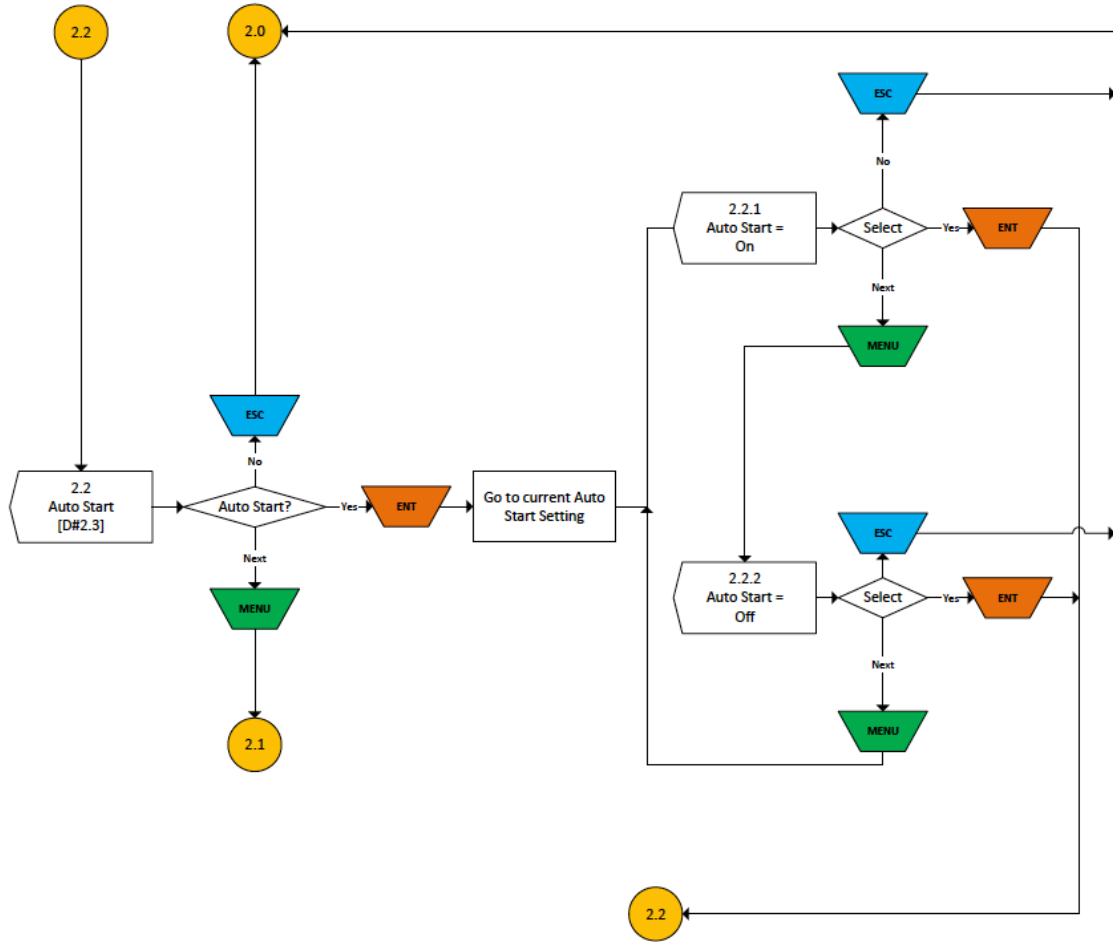
PA MENU STRUCTURE

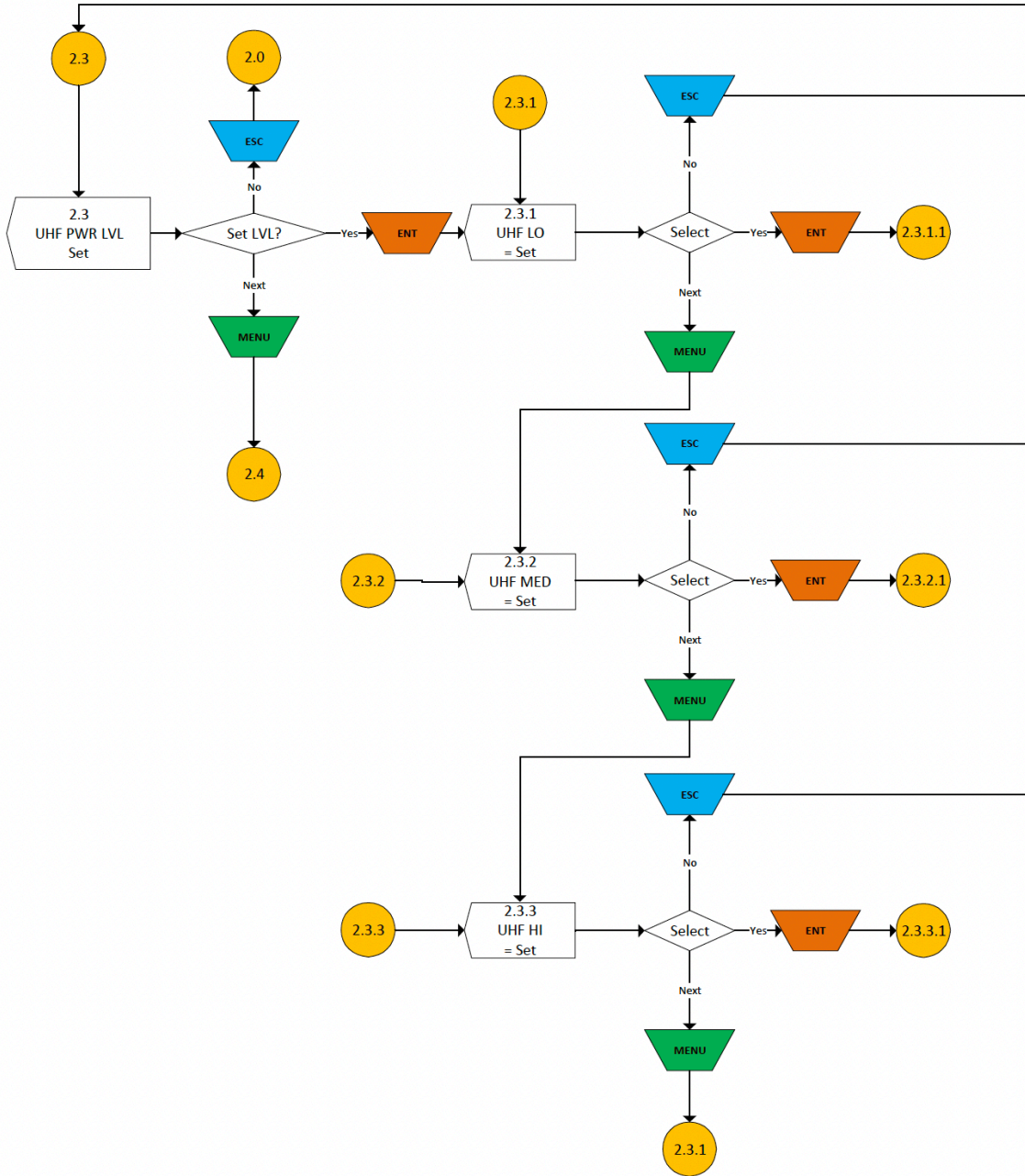


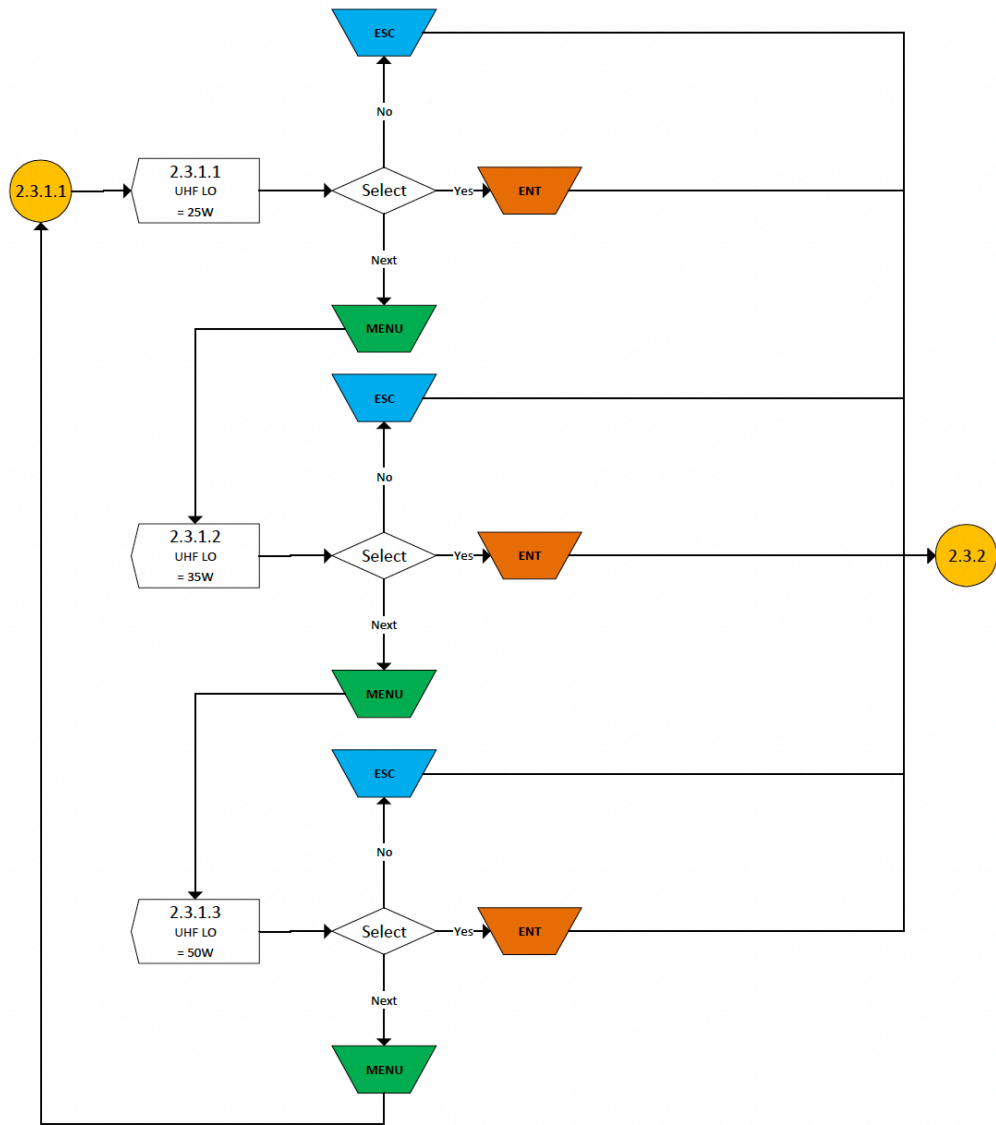


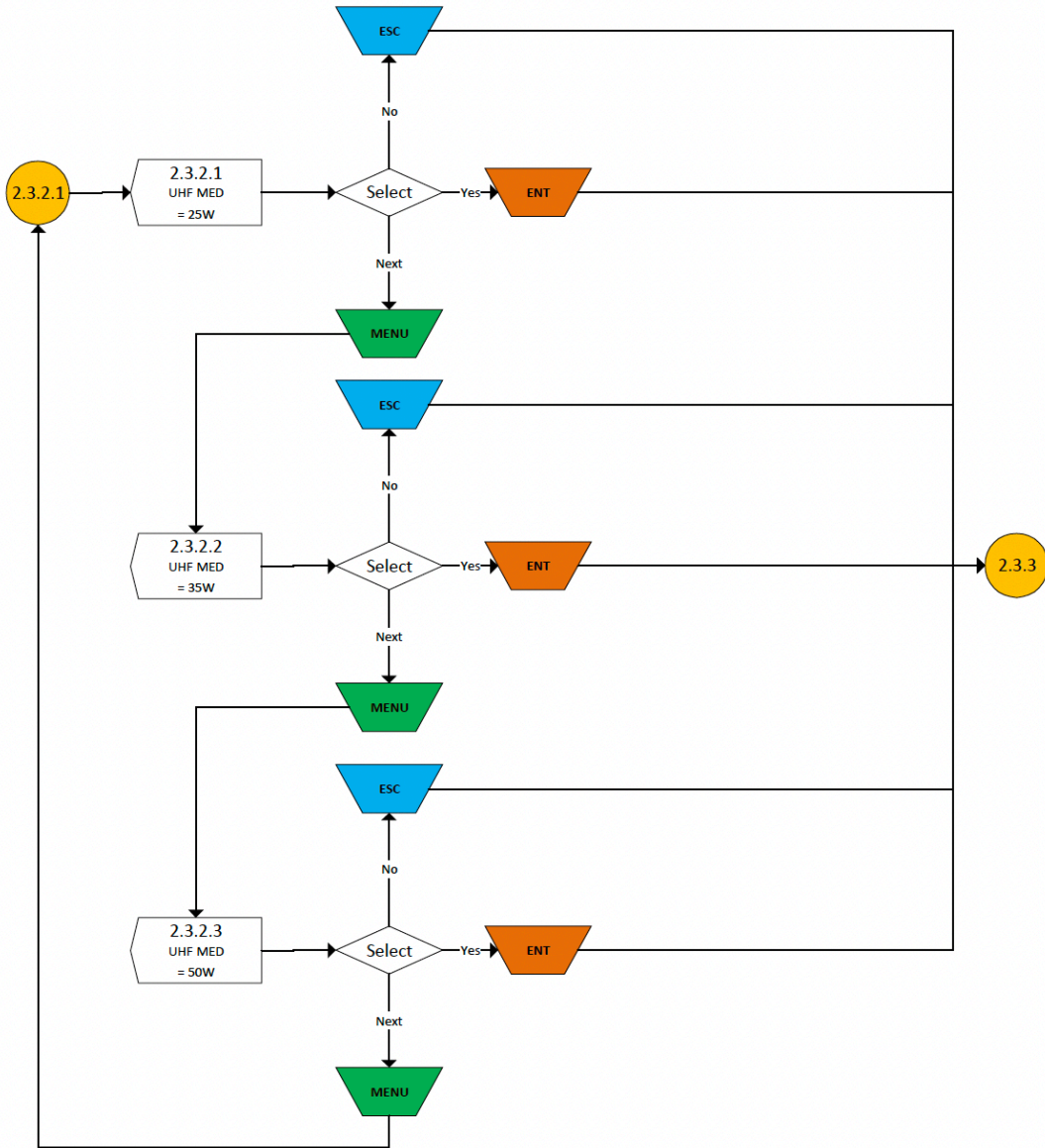


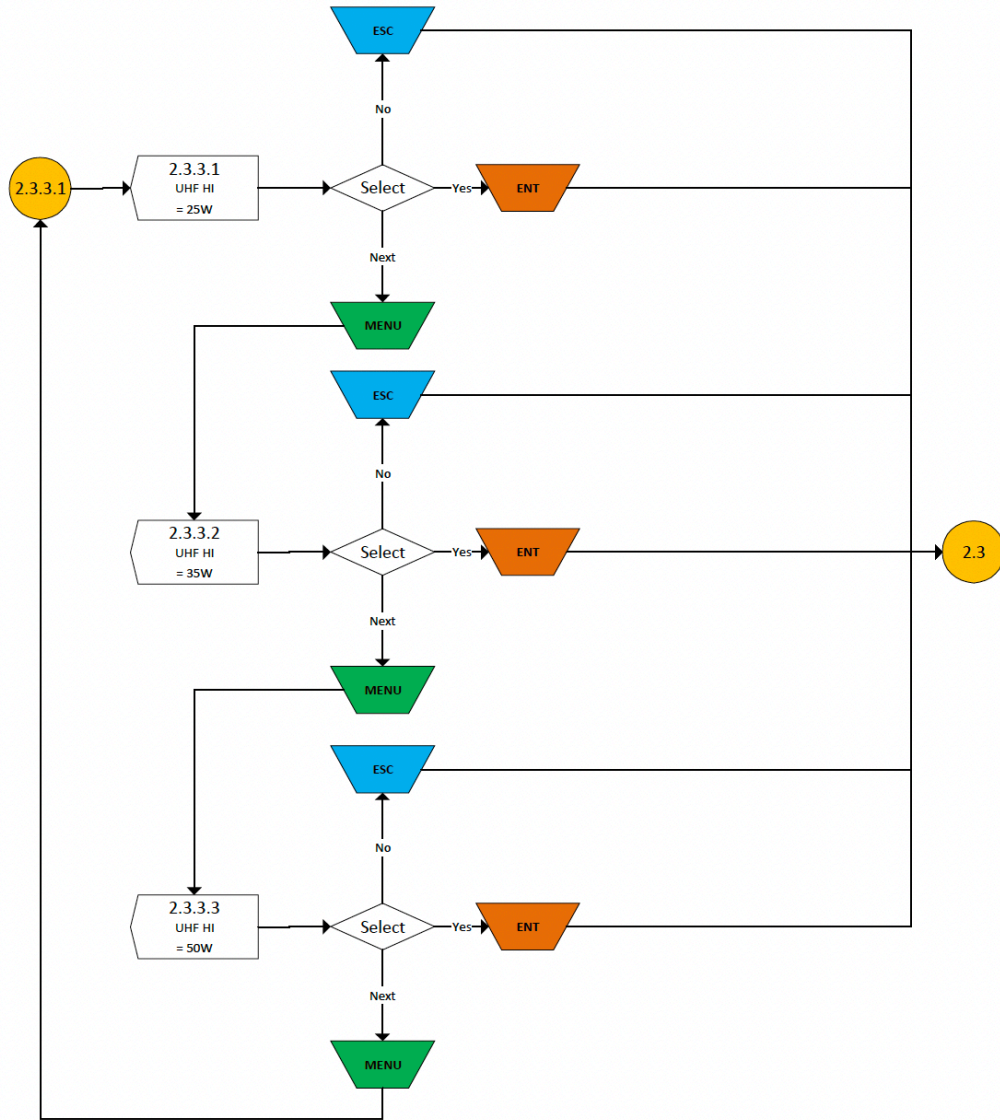
NOTE:
 1) **ENT*** If ENT button is pressed, or 3 sec timeout automatically sets to this brightness.
 2) Factory Default Brightness Level is 3.
 3) Last Set Brightness Level remains active at next power cycle until configured by User or by Factory Reset option.
 4) Display brightness will visually correspond to MENU (next) selection.

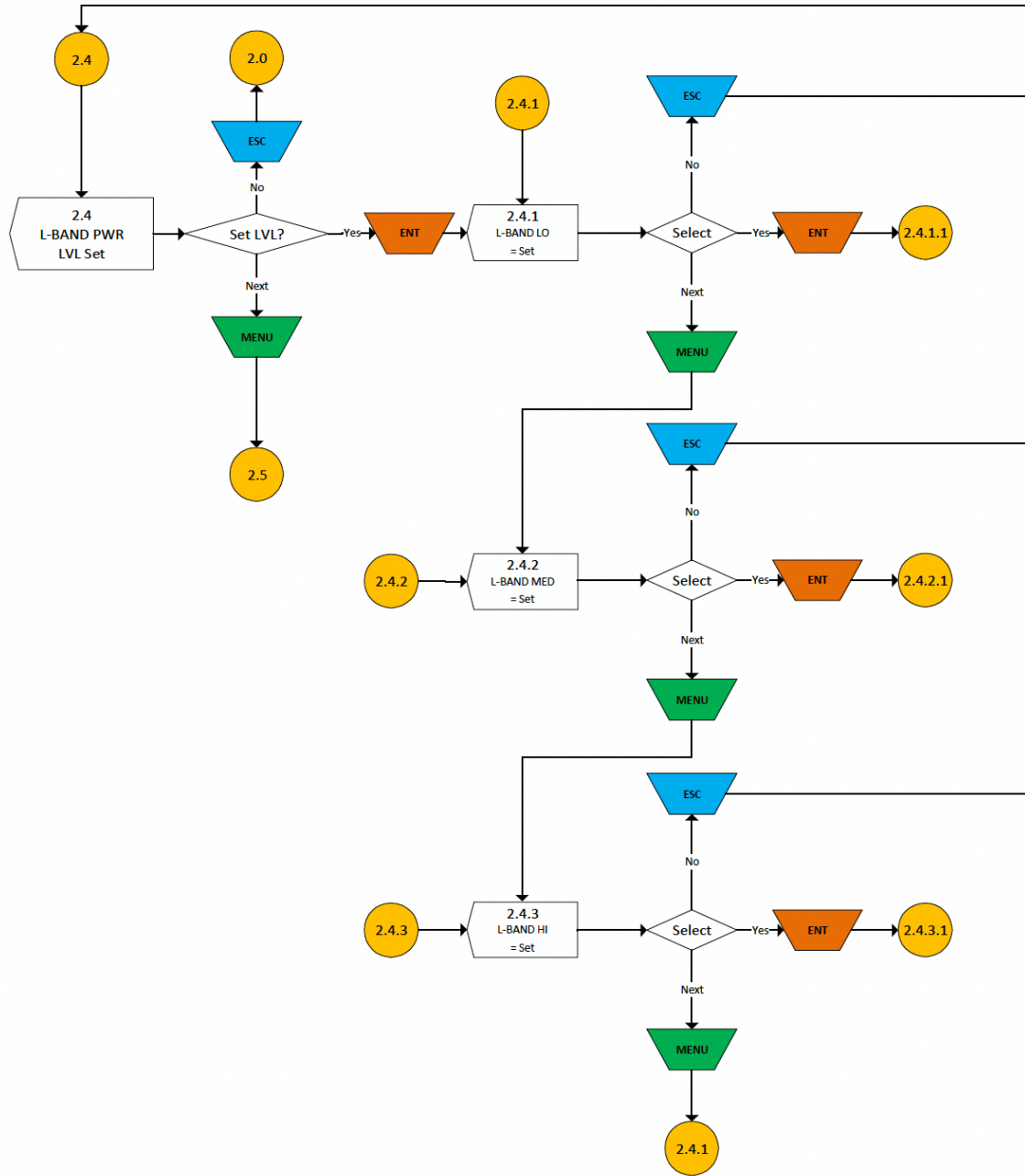


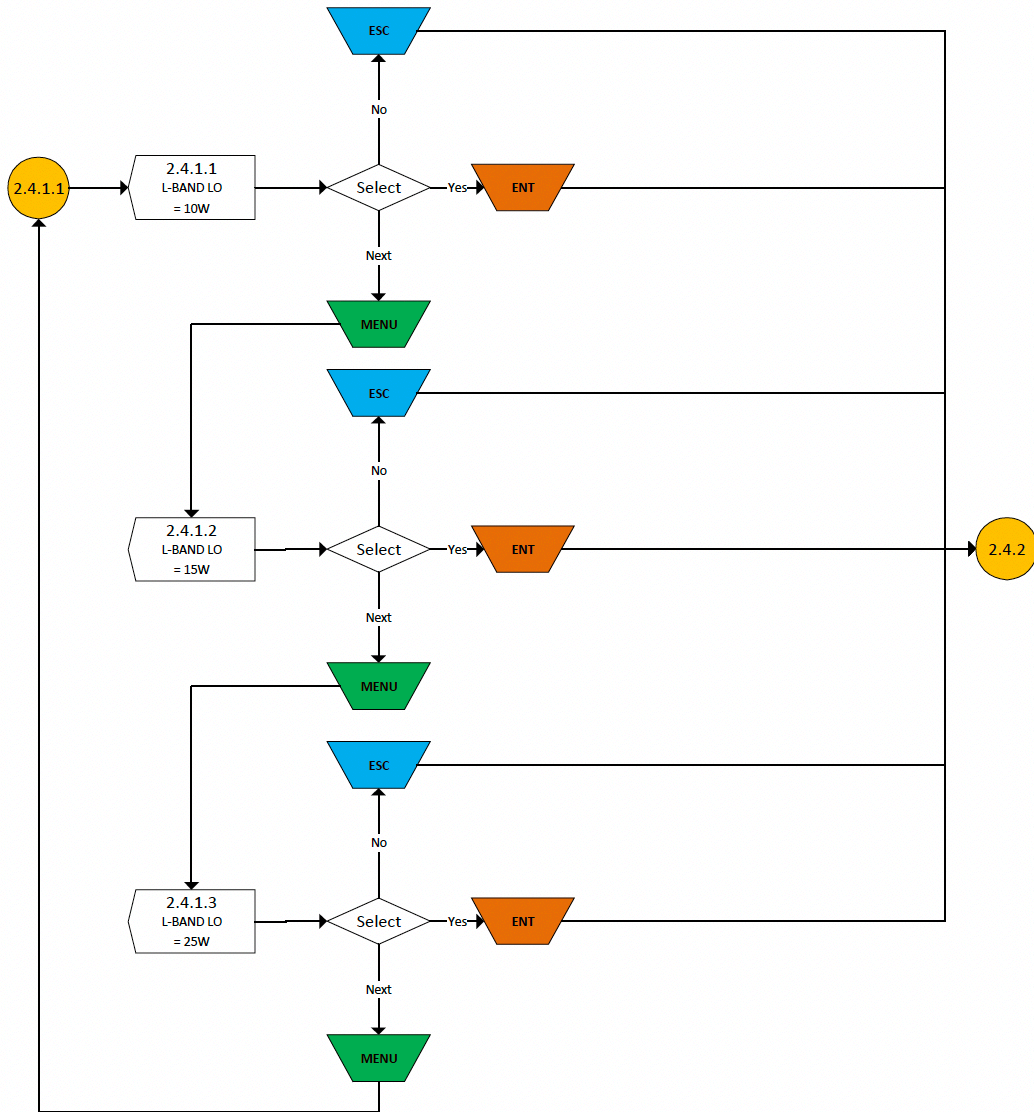


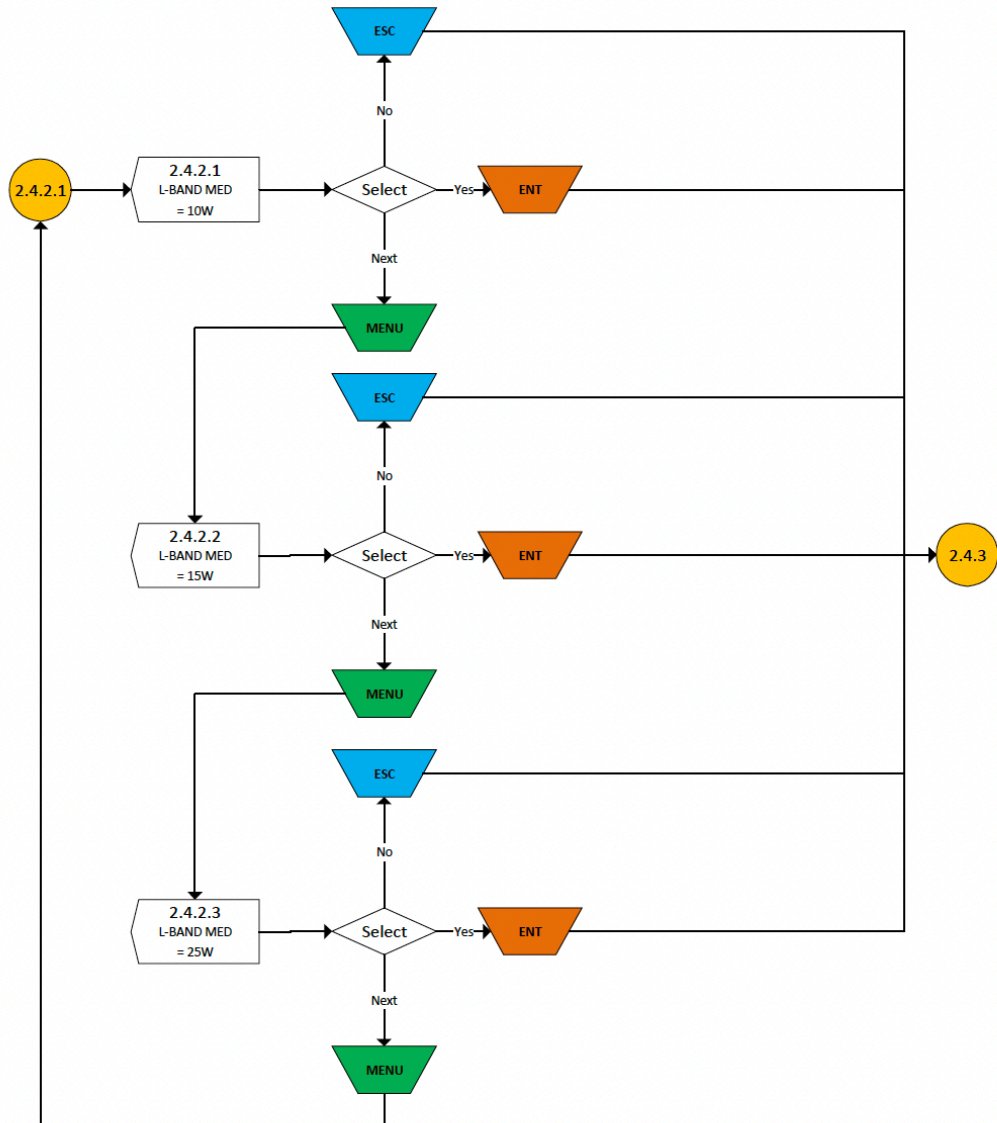


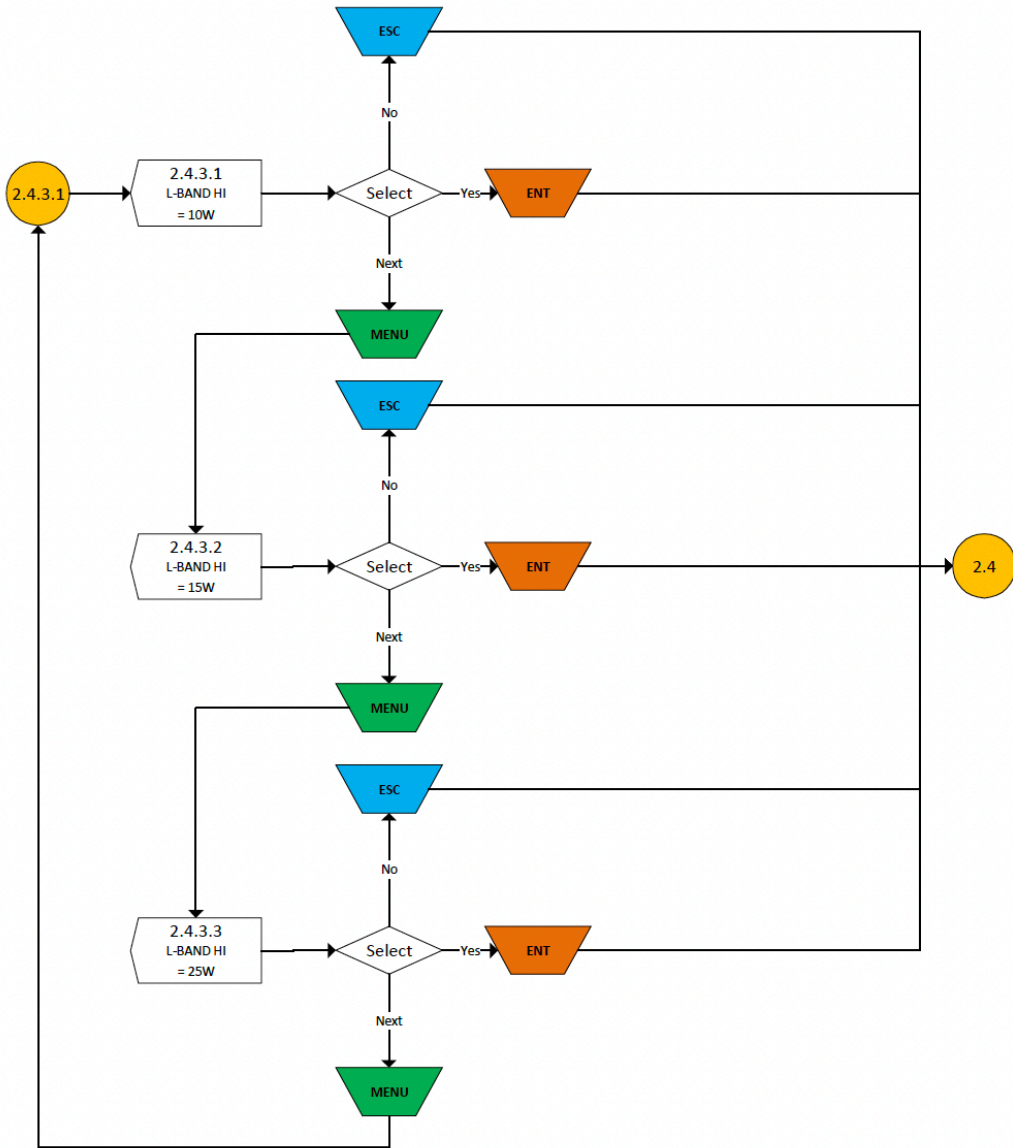




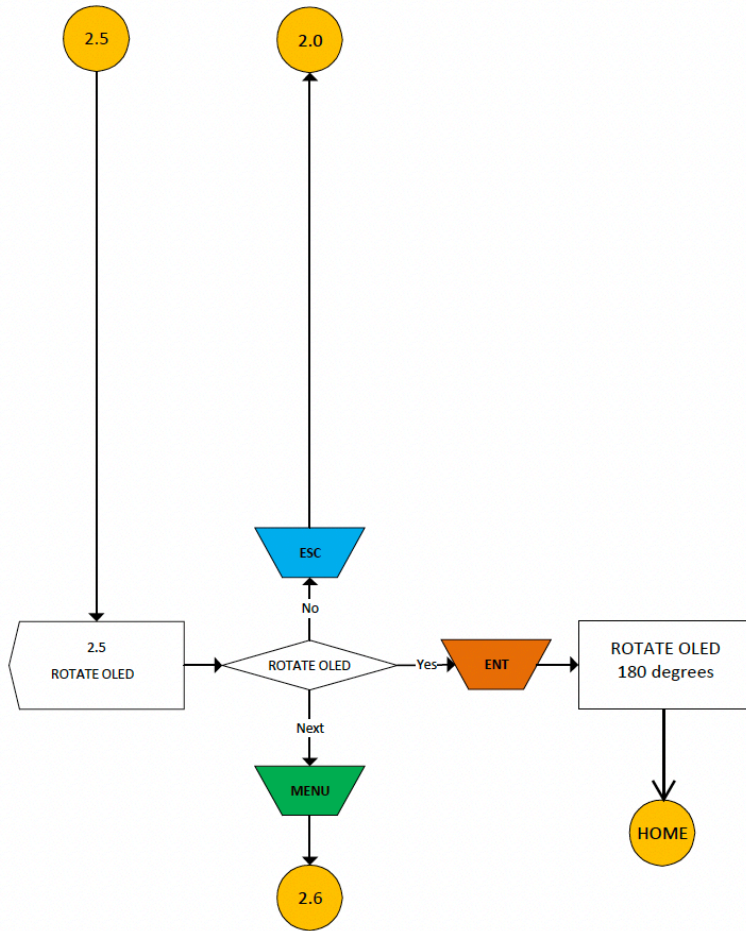








Note: Section 2.5 only available on firmware 78888-00127 Revision 2.4 or greater



Note: Section 2.6 only available on firmware 78888-00127 Revision 2.4 or greater

