Maretron

M/POWER

CLMD16

16 Channel DC Load Controller Module

User's Manual

Revision 1.6

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Notices:

All illustrations are for reference purposes only. Nothing contained in this document shall replace or modify the requirements of industry standards applicable to wire or other protection, including without limitation, those of the American Boat and Yacht Council (ABYC), the National Electric Code (NEC), and/or the National Fire Protection Association (NFPA). Failure to install the device or any components thereof in compliance with any such Industry Standard may limit the warranties made by Carling Technologies, Inc.

WARNING

- Tampering with the CLMD16 including removal of the CLMD16 cover will compromise the operation of the unit and voids warranties set forth by Carling Technologies.
- Please ensure that you read and understand this manual before undertaking installation and use.
- The CLMD16 must be wired in accordance with standards set forth by ABYC and other applicable agencies.

Introduction

Congratulations on your purchase of the Maretron MPower® CLMD16, 16 Channel DC Load Controller Module. Carling Technologies has designed and built your CLMD16 to the highest standards for years of dependable and accurate service.

The Maretron CLMD16 contains 16 output channels implemented by direct current (DC) Electronic Circuit Breakers (ECB's). Twelve breakers can switch up to 12 Amps, and four breakers can switch up 25 Amps, with a total current capacity of 125 Amps. In addition to fast switching, low-loss solid state ON/OFF switches, it provides accurate current measurement for each load as well as short circuit protection. Certain breakers can be programmed to operate in half-bridge or full-bridge mode, making them ideal for control of electric motors where a reversing polarity function is needed.

The CLMD16 additionally contains 8 input channels programmable to sense whether the input is connected to DC (+), DC (-), or connected to neither. The CLMD16 also contains two resistive input channels (250Ω and 1KΩ) and a single 4-20mA current loop input channel which could be used for indication of tank levels. The CLMD16 supplies a set of output terminals which can be connected to an external alarm light or sounder which can be activated under a wide variety of conditions. Additionally, the CLMD16 contains 4 input channels separate from other inputs reserved for digital addressing or future expansion of input capability.

The CLMD16 connects directly to one or two NMEA 2000® networks so you can control the breakers from any device running Maretron N2KView® software, such as TSM-Series multifunction displays or MBB-Series black boxes. Breakers may also be controlled directly from a VMM Switch or CKM keypad, or any other device transmitting the NMEA Binary Status Report PGN (127501) Additionally, since the CLMD16 supports standard NMEA 2000® messages for control, it can be controlled by many third-party multi-function displays.

The CLMD16 handles resistive DC loads like lights or inductive DC loads like pumps and motors as well as capacitive loads. An added benefit of the CLMD16 is that it reports the current through each of the 16 breakers. This allows you to determine if loads are drawing too little electrical current such as burnt-out bulbs, or if the loads are starting to draw too much electrical current.

The Maretron CLMD16 is designed to operate within the harsh demands of the marine environment. However, no piece of marine electronic equipment can function properly unless installed, configured, and maintained in the correct manner. Please read carefully and follow these instructions for installation, configuration, and usage of the Maretron CLMD16 to ensure optimal performance.

CLMD16 Features

Features:

- 16 Total Output Breakers
  - 12x12A, 4x25A Breaker Maximum Current Ratings (resistive, capacitive, and inductive load capable)
  - Short Circuit Protected
  - Up to 32VDC Switching Voltage
  - Voltage back feed protection (back-to-back Field Effect Transistor (FET)) for all power outputs
  - All Breaker Outputs Support Soft Start
  - Parallel Breaker Capability. (4 Groups, each group can have up to 2 breakers)
  - PWM on all breaker Outputs (frequency 200Hz on Breakers 3-10,11,12 and 2kHz on Breakers 1,2)
  - Current Measurement on all Breaker Outputs (accuracy is ± 0.5 Amps at 0.1 Amp resolution)
  - Four (4) half-bridge 12 Amps breakers: (shared output with 4 high-side 12 Amp breakers)
  - Two (2) half-bridge (Breaker 1 & Breaker 2) outputs with PWM.
  - Two (2) full-bridge (H-bridge) channel (utilizing 2 half-bridge output breakers 1 and 2, or 11 and 12)

- 125A Maximum Unit Current Capacity
- Capacitive Touch Switches for local override control of all loads
- Eight (8) Analog (VDC) / Digital Inputs (DC (-), DC (+) or “Float” sensing inputs)
- Two (2) Resistive Inputs (0 to 250 Ω) & (0 to 1000 Ω)
- One (1) Current Input (4 to 20 mA Current Loop)
- All inputs protected against short to Power and short to Ground
- Alarm output (switched power and ground (12 or 24 VDC))
- Dual Optically Isolated Controller Networks (CAN) over NMEA 2000 for zero potential of ground loops and redundant communication ability
- Ignition Protected Sealed Waterproof Enclosure and Connectors - Ingress Protection IP67
- Voltage Input: 8 to 32 VDC (reverse polarity protected)
- Power Stud: 125 DC Amps max current capacity, continuous @ 70°C
- Ground Stud: 25 DC Amps max current capacity
- *Operating Temp: -30°C to 70°C*
- Four (4) Address-input lines (Active Low, For Future Use)

For Technical Specifications please refer to page 72.

Theory of Operation

The CLMD16 provides the ability to control DC power to a load circuit using 16 independent solid-state PWM capable Electronic Circuit Breakers (ECB's). Each breaker contains protection against overcurrent, over-temperature, and short circuit.
Traditionally, a bank of mechanical circuit breakers is located on a panel from where bundles of cables lead to the various loads located throughout the vessel. As the circuit breaker panel may be some distance from the load, extensive wiring is required.
By placing a CLMD16 close to the loads being serviced, wiring becomes reduced. The CLMD16 is simply connected to a suitable local power supply and the vessel's NMEA 2000® network. The outputs on the CLMD16 are then connected to the circuits that they control, often by cables considerably shorter than those required on vessels with conventional circuit breakers. Several CLMD16's may be placed in different parts of the vessel, all controlled electronically via one of the interfacing methods described below. An added advantage is that as requirements change, circuits can be reconfigured without making any physical changes to circuit breakers as would be required with traditional mechanical circuit breakers.

Each breaker in the CLMD16 may be controlled using any of the following methods:

1) Maretron N2KView® software running on a personal computer*
2) Maretron N2KView® software running on a Maretron MBB-Series Black Box for Vessel Monitoring and Control
3) Maretron N2KView® software running on a Maretron TSM-Series Vessel Monitoring and Control Touchscreen Computer
4) Maretron N2KView® Mobile app running on an Android or iOS tablet or phone**
5) Maretron DSM-Series NMEA 2000® Multi-function Color Graphic Display
6) any NMEA 2000®-connected switch, such as an Maretron MPower® CKM-Series network-connected keypad or VMM-Series network-connected switches
7) any NMEA 2000® product that can transmit standard NMEA 2000® control messages (please refer to Appendix A for details).
8) Any of the 8 digital inputs on this CLMD16, another CLMD16 or a CLMD12.

* Requires a USB100 or IPG100 gateway with a License Key
** Requires an IPG100 gateway

The breakers can be controlled and monitored through use of the Breaker/Switch component in the Electrical Distribution category of the Maretron display products listed above. In addition, the current through each breaker may be monitored through the Breaker/Switch Current component in the Electrical Distribution category of Maretron display products.

Since the output channels are implemented by electronic circuit breakers, if the unit's Main DC(+) is removed, all breakers will revert to the open (OFF) state. The state that the breaker will be in when the unit's Main DC(+) is restored can be configured to be ON, OFF, or in the last state the breaker was in before Main DC(+) was removed. If NMEA 2000® power is lost, the breakers can be manually operated through the capacitive touch local override control panel located on the front of the unit. To place the unit into "Override Mode", the "Override key must be held for 1s.

CLMD 16 Hardware Description

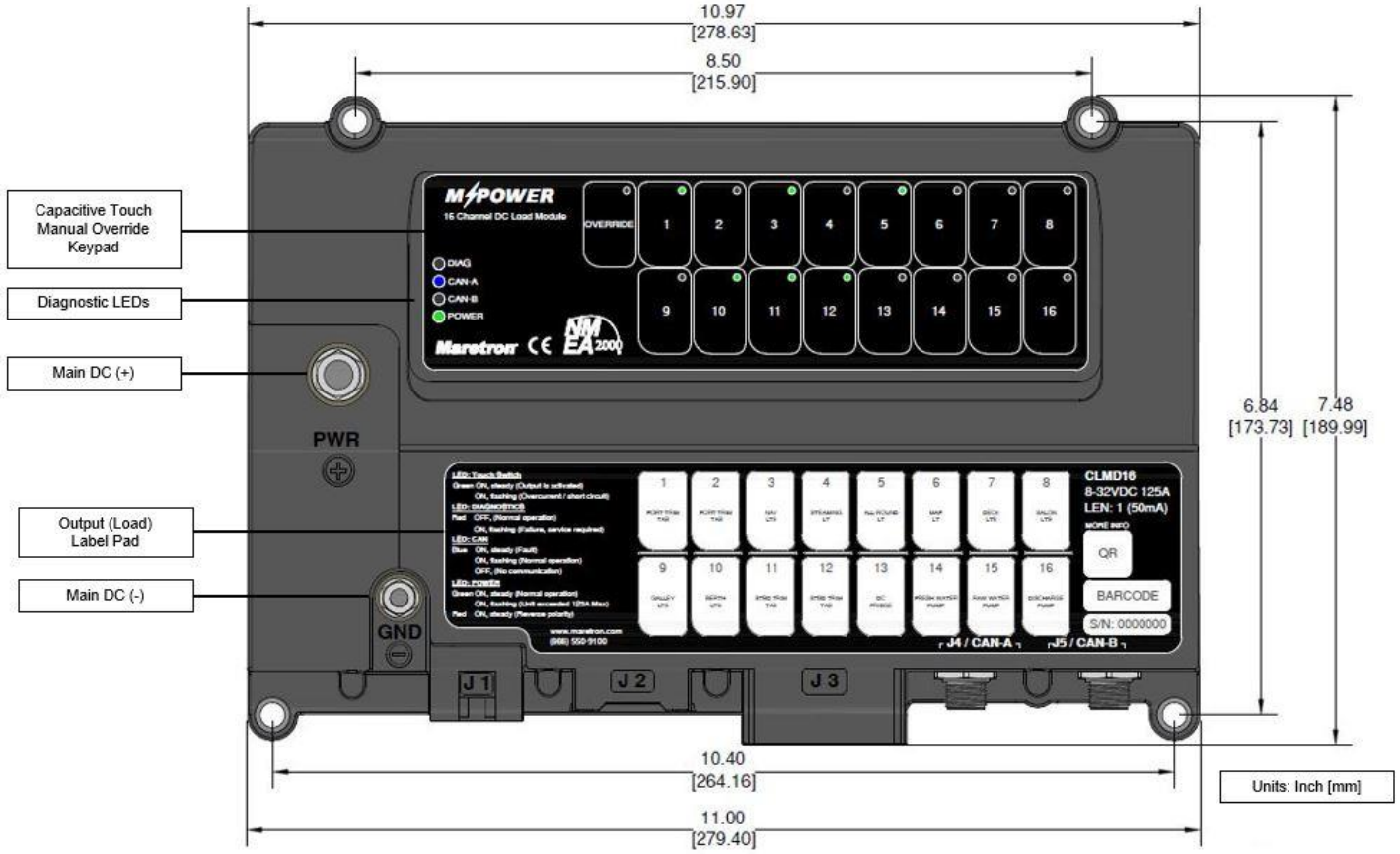


Figure 1 - Hardware Description Front View

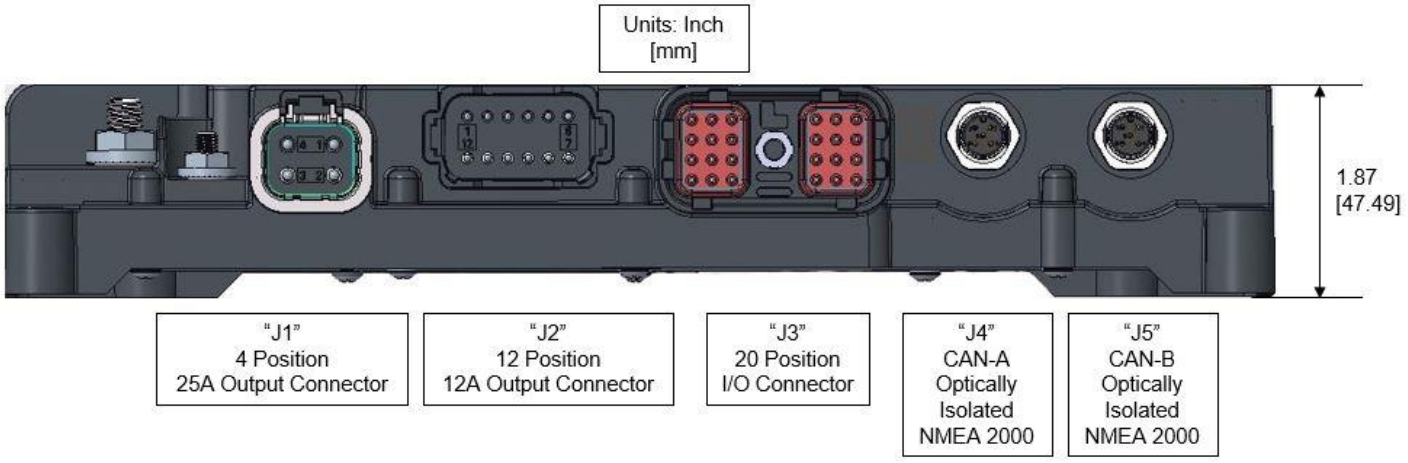


Figure 2 - Hardware Description Bottom View

Installation

Installing the Maretron CLMD16 involves the following steps.

Unpacking the Box

When unpacking the box containing the Maretron CLMD16, you should find the following items:

1 – CLMD16 – 16 Channel DC Load Controller Module
1 – CLMD16 Quick Start Guide
1 – CLMD16 Mounting Template
1 – USB Flash Drive with Maretron Documentation
1 – Warranty Registration Card

If any of these items are missing or damaged, please contact Maretron Technical Support (please refer to the Technical Support section for contact information).

Choosing a Mounting Location

Please consider the following when choosing a mounting location.

- The CLMD16 is waterproof, so it can be mounted in a damp or dry location.
- The CLMD16 is temperature-rated to 70°C (158°F), so it should be mounted away from engines or engine rooms where the operating temperature exceeds the specified limit.
- Mount the unit so that the connections are at the bottom if possible.

Mounting the CLMD16

Locate and drill mounting holes according to the mounting template supplied with the CLMD16. Attach the CLMD16 securely to the vessel using mounting screws or other fasteners through the four mounting holes at each corner of the unit. Do not use thread-locking compounds containing methacrylate ester, such as Loctite Red (271), as they will cause stress cracking of the plastic enclosure.

Connecting the CLMD16

Connecting the CLMD16 consists of making the following six connections outlined below:

- Connecting the unit's (2) main DC connections
- Connecting output and input connections (J1-J3)
- Connecting to the vessel's NMEA 2000® network

Required connections for the CLMD16 are shown in Figure 3.

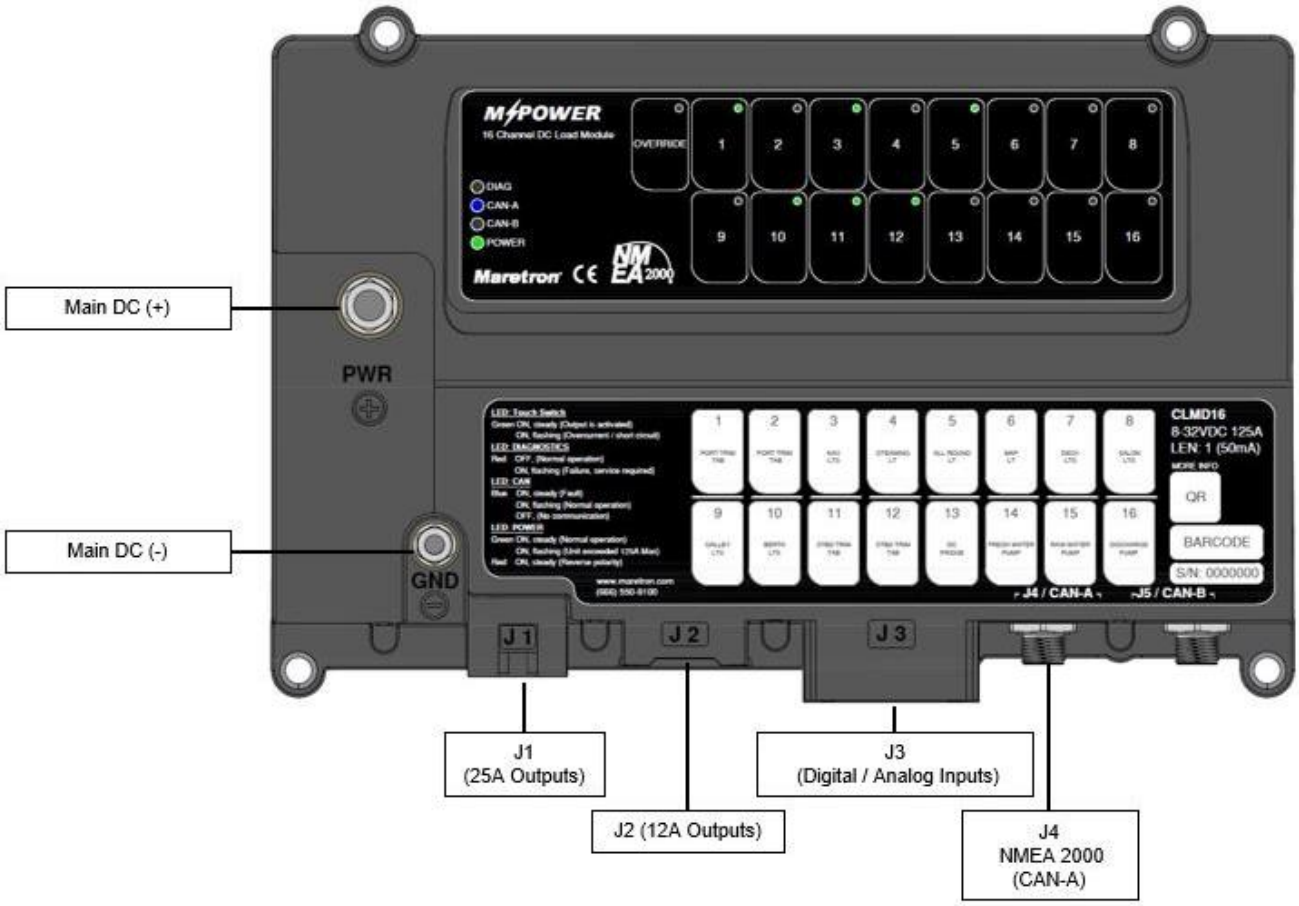


Figure 3 - Required Connections

WARNING
The CLMD16 must be wired in accordance with the regulations set forth by ABYC or other applicable agencies. If the unit is liable to get wet, ensure that cable connections incorporate a suitable drip loop where applicable.

Main DC (+) Connection

The unit's main DC (+) connection is made using commonly available components not included with the CLMD16.

Connect a source of DC (+) with a ring terminal to the 5/16"-18 stud on the front of the device and torque the connection within the specified range of 30 – 35 in-lbs. (3.39 – 3.95N·m). Ensure that the cable providing the Main DC (+) source is protected by a fuse or circuit breaker with a value appropriate to protecting the wire. Cable runs should be kept as short as possible to avoid unnecessary voltage drop. If unsure of appropriate cable sizing, the CLMD16 load calculation requirement can be found by using a load calculation reference table as outlined by ABYC 11.8.1. See Table 1 for an example of this load calculation method. Using the load table's findings, choose an appropriate feeder cable per ABYC E-11, Table 9 and 10. If unsure, consult a certified regulatory standard installer for your application type.

Note: Multiple CLMD16 units can be connected to the same Main DC (+) feeder source so long as the unit's main fuse / breaker overcurrent protection does not exceed 125A (The maximum specification of the CLMD16) and the feeder wire to each unit is sized identically.

Table 1 - Main DC (+) Load Calculation Table Example

In Column A, list the loads maximum operating current that must be available for continuous duty use during normal operation considering possible load usage during an emergency.

In Column B, list the loads maximum operating current for loads that are for intermittent use or would not be used in a continuous duty manor.

Example Load Calculation Table of (2) CLMD16's Loads with a single feeder source:

Note:

Enter current ratings of each load's actual maximum **operating current** and not In-Rush current or the device's fuse size.

Column A		Column B	
Loads:	**Current (Amps):**	**Loads:**	**Current (Amps):**
Forward Bilge Pump	12.5	Berth Lights	3
Aft Bilge Pump	12.5	Galley Lights	5.5
Navigation Lights	3.5	Salon Lights	5.5
All-Round Light	1.5	Deck Lights	8
Stern Light	1.5	Fwd Spreader Light	5
Map Light	2	Aft Spreader Lights	9
Pilothouse lights	3	Fresh Water Pump	9
Windshield Wiper	14.5	Raw Water Pump	9
Searchlight	12.5	Head	15
DC Refrigerator	18	Head Vent	4
Alarm	1	Discharge Pump	12
Service / Bilge Lights	6.5	Aerator	5
Generator Control	1	Baitwell Pump	5
		Port Trim Tab	7.5
		Stbd Trim Tab	7.5

Total Amps Column A:	90

Total Amps Column B:	110
10% of Total Amps Column B:	11
Largest Load in Column B:	15

Total Load Required Accommodation:		
Total Amps Column A:	90	
Total Amps Column B:	15	← Enter the larger Number From Column B. (10% of Total Amps or Largest Load)
Main DC (+) Feeder Sized for:	105	Amps

Example Load Calculation Table of a Single CLMD16's Loads:

Column A		Column B	
Loads:	**Current (Amps):**	**Loads:**	**Current (Amps):**
Forward Bilge Pump	7.5	Console Lights	3
Aft Bilge Pump	7.5	Deck Lights	5.5
Navigation Lights	3.5	Fwd Spreader Light	4
Anchor Light	1.5	Aft Spreader Lights	8
Map Light	1.5	Fresh Water Pump	9
Windshield Wiper	12	Raw Water Pump	9
Searchlight	13	Livewell Pump	6
DC Refrigerator	16		
Service / Bilge Lights	4.5		

Total Amps Column A:	67

Total Amps Column B:	44.5
10% of Total Amps Column B:	4.45
Largest Load in Column B:	9

Total Load Required Accommodation:		
Total Amps Column A:	67	
Total Amps Column B:	9	← Enter the larger Number From Column B. (10% of Total Amps or Largest Load)
Main DC (+) Feeder Sized for:	76	Amps

Main DC (-) Connection

The unit's main DC (-) connection is made using commonly available components and are not included with the CLMD16.

Connect the Main DC (-) connection with a ring terminal to the #10 stud on the front of the device and torque the connection within the specified value of 10 – 15 in-lbs. (1.13 – 1.69 N·m). Because the Main DC (-) connection has the potential to be a current carrying conductor, a 10 AWG minimum wire size is mandatory for this connection. Failure to adhere to this recommendation may void unit's warranty. It is recommended to increase the size of this connection if the length of the wire exceeds (20) Ft or (6.0) M. from the vessel / vehicle's main ground source. If unsure of appropriate cable sizing, use Table 2.

Table 2 - Main DC (-) Cable Length Table

12V Systems:			
≤ 30ft	≤ 40ft	≤ 60ft	≤ 100ft
10 Awg	8 Awg	6 Awg	4 Awg

24V Systems:			
≤ 40ft	≤ 60ft	≤ 80ft	≤ 100ft
10 Awg	8 Awg	6 Awg	4 Awg

Wiring J1 – J3 Connectors

The J1-J3 receptacles on the CLMD16 Unit were designed to accept Deutsch brand DTP, DT, and DRC series plugs. Maretron supplies optional premade 2m harnesses for the J1 and J2 connections and a 2m wiring kit for the J3 connection. Alternatively, the installer may choose to wire the plugs directly.

Wiring a Harness Directly to J1-J3

If connecting harnessing directly to the J1-J3 receptacles, a Deutsch HDT- 48-00 crimp tool will be needed and possibly the Deutsch DTT-12-01 crimp tool (for 10 AWG Wire connections) (see: Figure 4) A description of the Deutsch brand components that will be needed for connecting to the J1-J3 connections are outlined in Table 3.

HDT-48-00 Crimp Tool (20 AWG – 12 AWG)

DTT-12-01 Crimp Tool (10 AWG)

Figure 4 - Required Deutsch Wire Crimping Tools

Table 3 - Required Deutsch Plug Components

Part Number	Picture	Mating Receptacle	Description	Quanity Required
DTP06-4S		J1 (Output)	4 Pos. DTP Series Plug Housing	1
WP-4S		J1 (Output)	4 Pos. DTP Series Plug Wedgelock	1
0462-203-12141		J1 (Output)	12-14 Awg. Socket Contact	Match Qty. to Positions Using 12-14 Awg.
1062-12-0222		J1 (Output)	10 Awg. Socket Contact	Match Qty. to Positions Using 10 Awg.
114017-ZZ		J1 (Output)	12-16 Awg. Blanking Plug	Match Qty. to Unused Positions
DT06-12SA		J2 (Output)	12 Pos. DT Series Plug Housing	1
W12S		J2 (Output)	12 Pos. DT Series Plug Wedgelock	1
0462-209-16141		J2 (Output)	14 Awg. Socket Contact	Match Qty. to Positions Using 14 Awg.
0462-201-16141		J2 (Output)	16-18 Awg. Socket Contact	Match Qty. to Positions Using 16-18 Awg.
114017-ZZ		J2 (Output)	12-16 Awg. Blanking Plug	Match Qty. to Unused Positions
DRC26-24SA		J3 (I/O)	24 Pos. DRC Series Plug Housing	1
0462-005-20141		J3 (I/O)	16-18 Awg. Socket Contact	Match Qty. to Positions Using 16-18 Awg.
0462-201-20141		J3 (I/O)	20 Awg. Socket Contact	Match Qty. to Positions Using 20 Awg.
0413-204-2005		J3 (I/O)	20 Awg. Blanking Plug	Match Qty. to Unused Positions

Connecting J1-J3 Using Maretron Accessory Cable Assemblies

If you choose to use the premade cable assemblies, you will need to splice the ends of the cable assemblies or connect them to a terminal block See Figure 6 for terminal block connection depiction. Connectors J1 and J2 come with numbered leads, these numbers are indicators for the ECB Output number and not the pin position. For a description of the cable assemblies available from Maretron see Figure 5.

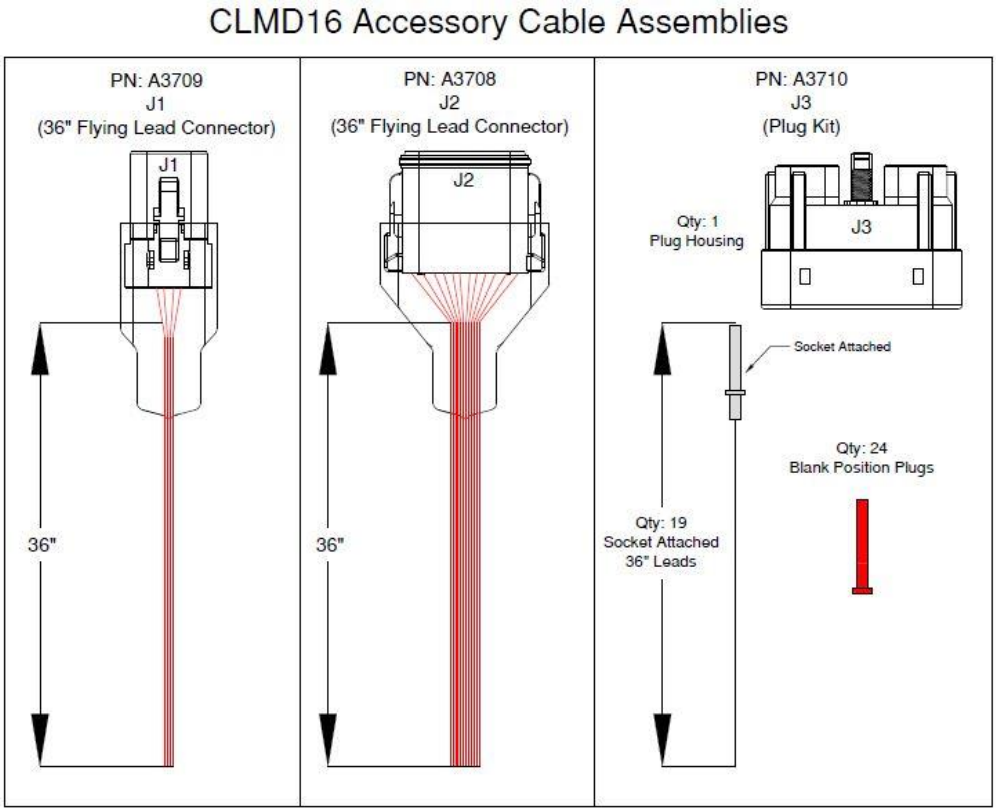


Figure 5 - Accessory Cable Assemblies

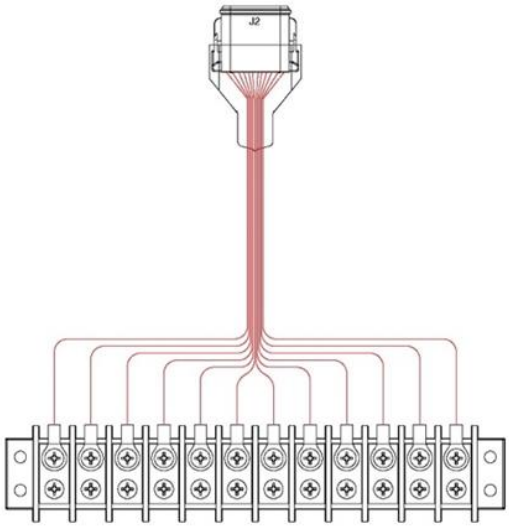
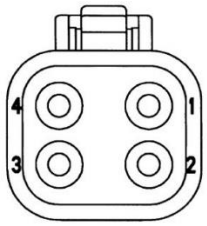


Figure 6 - Recommended Cable Assembly Connection Example

"J1" (25 Amp Breaker) Position Description

Table 4 - J1 Connector Pin Description

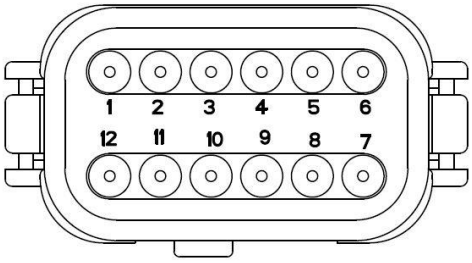
J1 Connector Pin No. (Location)	Description
1	25 A (Breaker #13)
2	25 A (Breaker #14)
3	25 A (Breaker #15)
4	25 A (Breaker #16)



"J2" (12 Amp Breaker) Position Description

Table 5 - J2 Connector Pin Description

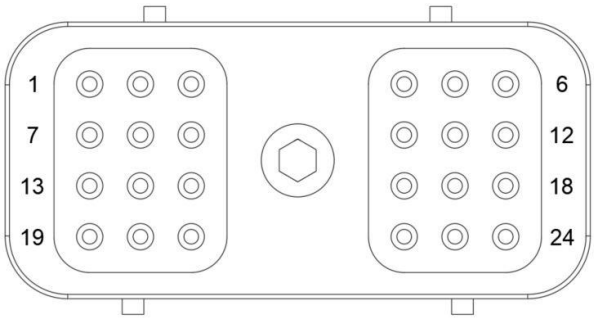
J2 Connector Pin No. (Location)	Description
1	12 A (Breaker #1 / Half Bridge #1)
2	12 A (Breaker #2 / Half Bridge #1)
3	12 A (Breaker #3)
4	12 A (Breaker #4)
5	12 A (Breaker #5)
6	12 A (Breaker #6)
7	12 A (Breaker #7)
8	12 A (Breaker #8)
9	12 A (Breaker #9)
10	12 A (Breaker #10)
11	12 A (Breaker #11 / Half Bridge #2)
12	12 A (Breaker #12 / Half Bridge #2)



"J3" (General Purpose / Analog) Position Description

Table 6 - J3 Connector Pin Description

J3 Connector Pin No. (Location)	Description
1	Address Input #1
2	Analog / Digital Input #1
3	Analog / Digital Input #5
4	4 to 20mA sense current loop Positive
5	Analog Input #9 (Resistive 0-1000 Ω)
6	Reserved for future use – do not connect
7	Address Input #2
8	Analog / Digital Input #2
9	Analog / Digital Input #6
10	4 to 20mA sense current loop Negative
11	Analog Input #10 (Resistive 0-250 Ω)
12	Analog Input Reference Negative
13	Address Input #3
14	Analog / Digital Input #3
15	Analog / Digital Input #7
16	Relay / Alarm Positive
17	Reserved for future use – do not connect
18	Reserved for future use – do not connect
19	Address Input #4
20	Analog / Digital #4
21	Analog / Digital #8
22	Relay / Alarm Negative
23	Reserved for future use – do not connect
24	Reserved for future use – do not connect



Checking Connections

Once all the connections to the CLMD16 have been completed, check to see that information is being properly transmitted by observing an appropriate NMEA 2000® display. If you do not see channel on/off status, refer to Section Troubleshooting.

NMEA 2000® Connections

The NMEA 2000® connectors are round five-pin male connectors and can be found on the bottom of the CLMD16 enclosure labeled "J4 / CAN-A" and "J5 / CAN-B". See these connectors in Figure 4. These connectors are known as DeviceNet micro connectors. Connect the CLMD16 to a NMEA 2000® network using a Maretron NMEA 2000® cable (or compatible cable) by connecting the female end of the cable to the one of the male NMEA 2000® connectors on the CLMD16 (note the key on the male connector and keyway on the female connector). Be sure the cable is connected securely and that the collar on the cable connector is tightened firmly. Connect the other end of the cable (male) to the NMEA 2000® network in the same manner. The CLMD16 is designed such that you can plug or unplug it from an NMEA 2000® network while the power to the network is connected or disconnected. Please follow recommended practices for installing NMEA 2000® network products. NOTE: It is only necessary to connect one of the NMEA 2000® connectors to a network. Two connections are included for use where two parallel networks are run side by side. If only one network is used it is recommended to cap the secondary unused network connector.

NMEA 2000® connections can be made using pre-assembled leads or may be made using field attachable connectors and cables (See: Figure 7).

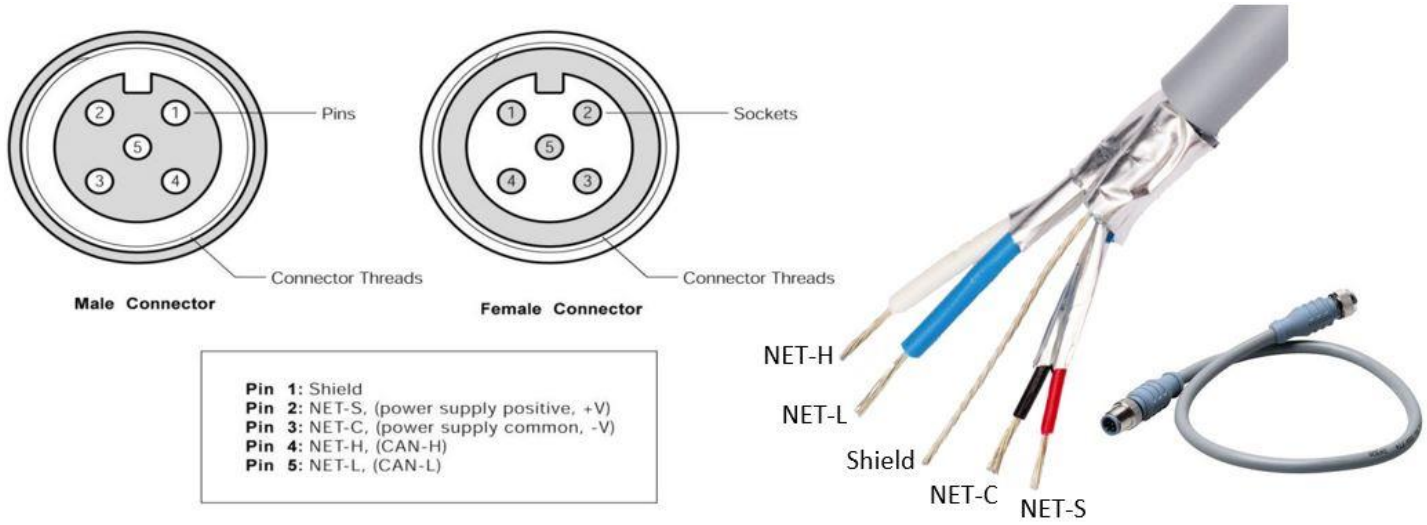


Figure 7 - NMEA 2000 Connectors

Please refer the Maretron website (www.maretron.com/products/cabling.php) for relevant products.

Breaker (Output) Features

Soft Start

Soft Start is a function that ramps up the voltage, of an output channel when it is turned on to reduce the inrush current to the device being powered. (See: Figure 8)

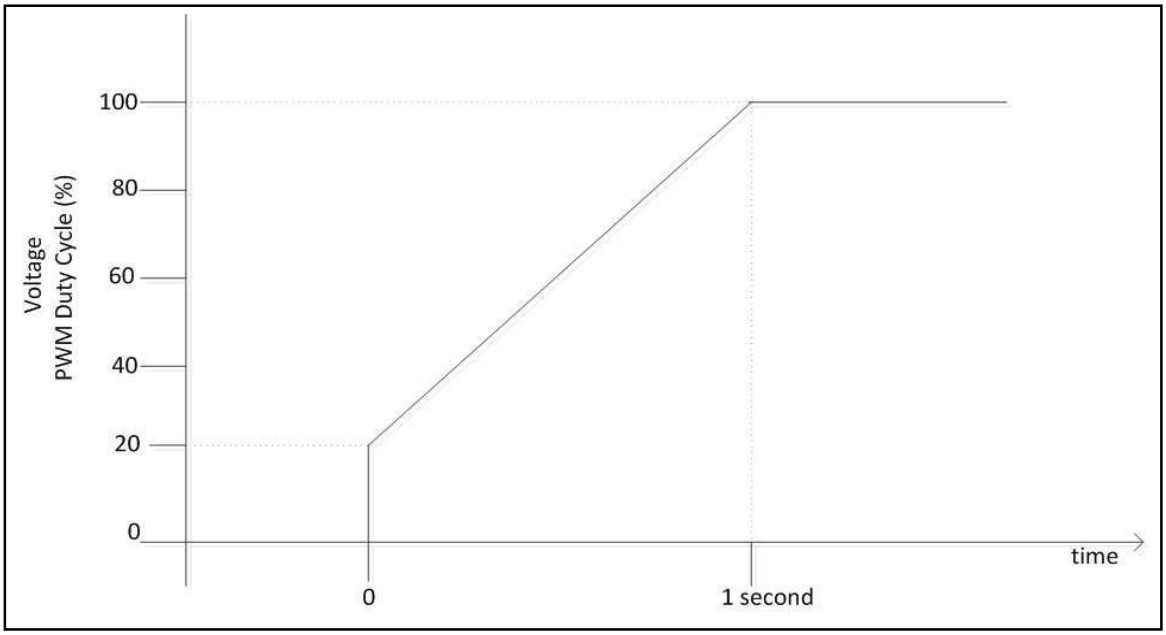


Figure 8 - Soft Start Voltage Ramp

Soft Start ramps the voltage of the load output, over a 1 second period. This is to overcome initial inertia in large systems at start-up.
Soft Start has a configurable initial voltage expressed as a percentage of the full voltage. The Soft Start Initial Duty Cycle defaults to 20%.

Pulse Width Modulation (PWM)

Some breakers can be operated in pulse width modulation (PWM) mode, also referred to as dimming, to control the brightness of incandescent or LED lighting. The breaker may be configured to any value between 5% to 100% in increments of 1%.
Please note that the dimming function is not supported on breakers that have been configured to operate in parallel with other breakers.

WARNING
The breaker being used as a dimming module will provide an active high output at full battery voltage to the LED control module. Verify that the LED control module can accept this type of input prior to use. When a breaker is configured to provide a PWM output (dimming), the PWM frequency is 200 Hz (channels 3-10) or 20 kHz (channels 1, 2, 11, 12). Use of a breaker in a PWM mode (duty cycle less than 100%) for control of motors or other inductive loads is prohibited, and may damage the CLMD16

Paralleling Breakers

Some CLMD16 breakers can be configured to operate in parallel for higher current capacity:

Breakers #1 and #2
Breakers #3 and #4
Breakers #7 and #8
Breakers #13 and #14

- When connecting paralleled breakers to a load, both cable lengths connected to the load must be equal. Rather than running twin cables, it is often easier to connect the two outputs together at a terminal block by using a jumper, and then running a suitably sized single cable to the load. This ensures a matched impedance. (see: Figure 9)

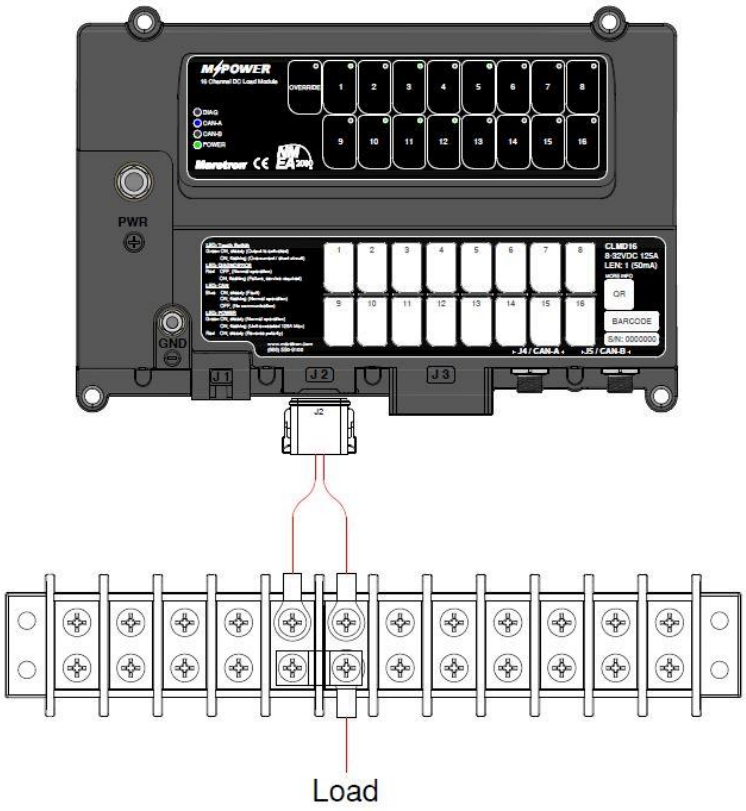


Figure 9 - Paralleled Breakers Connection Recommendation

Please note that the maximum current rating when multiple breakers are paralleled is typically, 180% of the single channel rating. (Example: 18A maximum for two 10A breakers in parallel).

- When two breakers are configured in parallel, the lowest-numbered breaker controls the pair. For example, if breakers #1 and #2 are configured to operate in parallel, commands that control breaker #1 will control the state of both paralleled breakers, and commands to breaker #2 will be ignored.
- Please note that dimming operation is not supported on breakers that have been configured to operate in parallel with other breakers.

When breakers are configured for parallel output, the lowest breaker number of the pair will set the trip current for both breakers. The trip current will need to be configured to 50% of the desired trip current value. For example, if you parallel breaker #1 and breaker #2 and wish to use them to supply power to a load rated at 22 Amps, breaker #1 will need to be set to 11 Amps. Breaker #2 will become visible to show the same trip current value as breaker #1 of 11 Amps thus the trip current for the paralleled breakers will be 22 Amps.

Half Bridge Operation

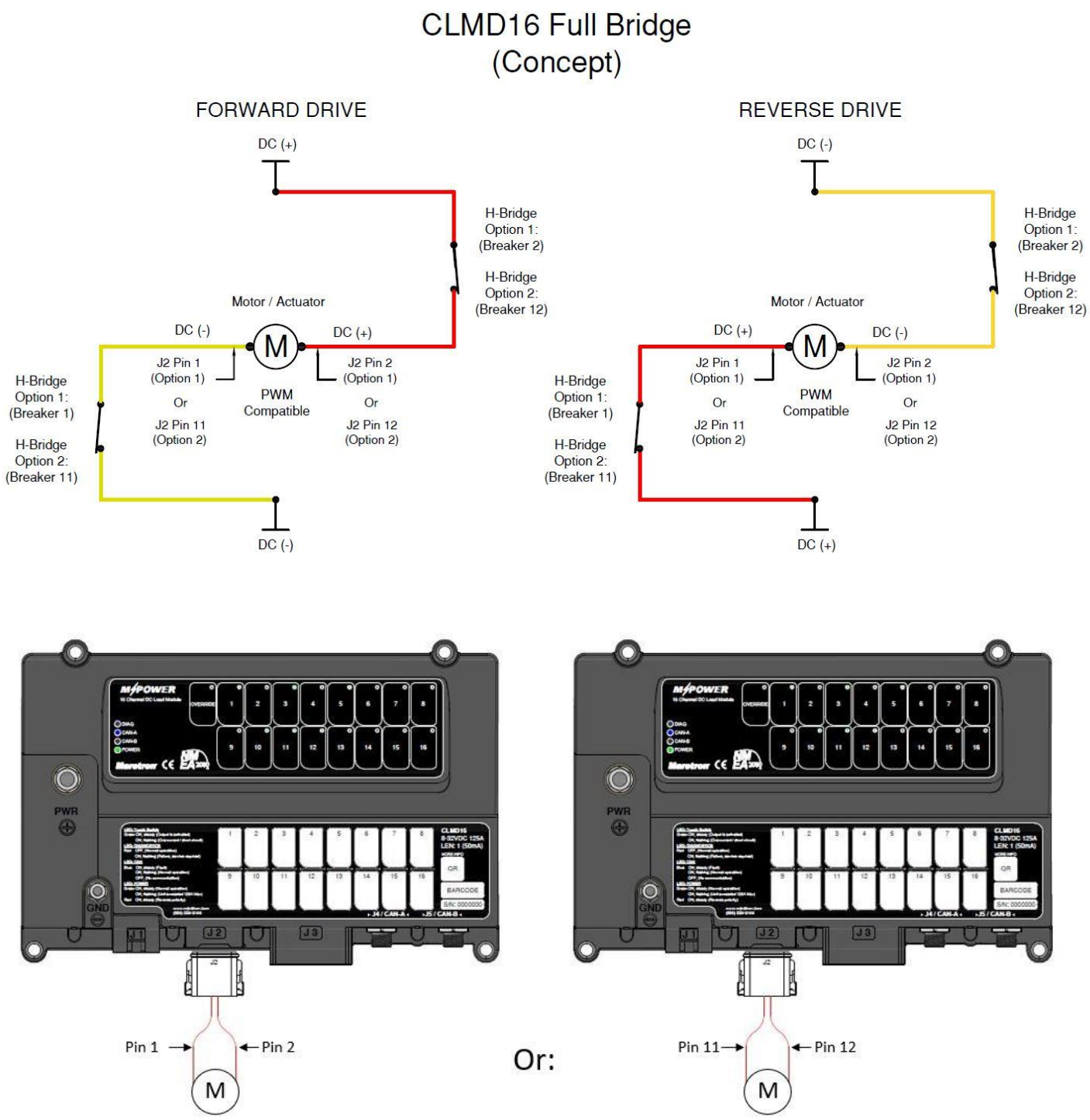
12 Amp Breakers #1, #2, #11, and #12 can be configured as half-bridge breakers. In the OFF state, they can connect the load to ground as opposed to becoming high impedance. When in half-bridge mode, the channels can be used to control electric motors and be used to perform braking on the motors by connecting the motor lead to ground when the load channel is turned off.

The PWM frequency in half-bridge operation is fixed at 20 kHz.

In half-bridge mode, Breakers #1 and #2 support PWM operation with a duty cycle of 5% to 90%, programmable in 1% increments. Breakers #11 and #12 do not support PWM operation in half-bridge mode.

Full Bridge Operation

12-amp breakers 1 and 2, and 11 and 12, can be configured to offer polarity reversing capability using the two half bridge circuits together. Loads such as actuators are a great application for this circuit type. The full bridge breakers support PWM operation with a duty cycle of 10% to 90%, programmable in 1% increments. The PWM frequency in continuous mode is 20 kHz. See: Figure 10 for Full-Bridge concept pertaining to CLMD16 and its benefits VS an analog H-Bridge requiring the use of 4 switches.


CLMD16 Full Bridge
(Concept)
FORWARD DRIVE
DC (+)
H-Bridge
Option 1:
(Breaker 2)
H-Bridge
Option 2:
(Breaker 12)
Motor / Actuator
DC (-)
DC (+)
M
J2 Pin 1
(Option 1)
Or
J2 Pin 11
(Option 2)
PWM
Compatible
J2 Pin 2
(Option 1)
Or
J2 Pin 12
(Option 2)
H-Bridge
Option 1:
(Breaker 1)
H-Bridge
Option 2:
(Breaker 11)
DC (-)
REVERSE DRIVE
DC (-)
H-Bridge
Option 1:
(Breaker 2)
H-Bridge
Option 2:
(Breaker 12)
Motor / Actuator
DC (+)
DC (-)
M
J2 Pin 1
(Option 1)
Or
J2 Pin 11
(Option 2)
PWM
Compatible
J2 Pin 2
(Option 1)
Or
J2 Pin 12
(Option 2)
H-Bridge
Option 1:
(Breaker 1)
H-Bridge
Option 2:
(Breaker 11)
DC (+)

PWR
GND
J1
J2
J3
Pin 1
Pin 2
M
Or:
PWR
GND
J1
J2
J3
Pin 11
Pin 12
M

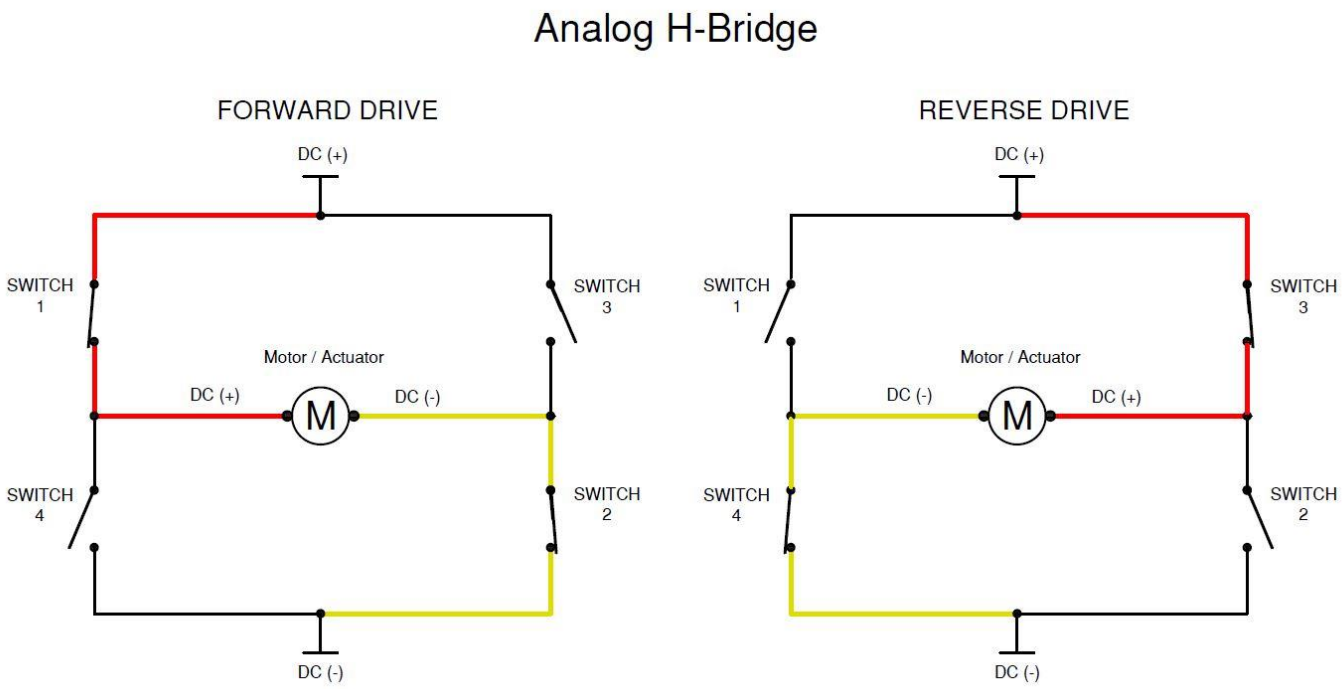


Figure 10 - Full Bridge Operation Concept

Load Shedding

Load shedding is a way to extend the time the system can keep working when the battery voltage is getting low. As the battery voltage drops, the CLMD16 will turn off low priority loads. This is based on 3 priority levels. These priority levels have configurable voltage thresholds. An example of this is depicted in the table below. As voltage rises, for instance, as batteries are recharged, loads will be reactivated in a reverse sequence of the order in which they were turned off. See Table 7 for an example of Load shedding Priority based on battery voltage.

Table 7 - Example of Load Shedding Priority Table

Battery Voltage	High Priority (always on)	Medium Priority	Low Priority
7	On	Off	Off
8	On	Off	Off
9	On	Off	Off
10	On	On	Off
11	On	On	Off
12	On	On	On
13	On	On	On

There are three load shedding levels:

- Low
- Medium
- High (default)

Each channel has a load shedding priority which is user configurable.
The Medium and Low load shedding priorities have a user-configurable deactivation threshold and an activation threshold voltage level.
The Load Shedding Medium Priority Deactivation-threshold voltages must always be lower than the Low Priority Deactivation-threshold.

Load shedding will never turn off (shed) channels assigned to the High Load Shedding Priority.

Overcurrent protection

The Electronic Circuit Breaker feature is fundamental to the CLMD16 product; the purpose of the feature is to automatically disconnect a load from the supply when an electrical fault is detected to protect the load and its supply wiring from damage.
The CLMD16 Electronic Circuit Breakers (ECB) trip behavior mimics the operation of traditional circuit breakers. The time a mechanical circuit breaker takes to trip is governed by several factors, including sensing time, unlatching time, mechanical operating time, and arcing time. In the CLMD16, this is replaced by configurable parameters.

The ECB performs the following protective functions:

- Overload Protection (long time delay trip function)
- Short circuit protection with delayed trip (short time pickup)
- Instantaneous short circuit protection (instantaneous trip function)

Each ECB uses a microprocessor to process the current signal and operate the circuit breaker opening in case of fault. By digital processing of the signal, they provide the following protection functions:

- Long Time-Delay trip function.
- Short Time-Delay trip function.
- Instantaneous trip function.

To mimic the function of traditional mechanical circuit breakers, it is possible to configure the time-delay trip function through the NMEA 2000® interface to suit connected loads. The CLMD16 can trip if there is an over-current or thermal event-based trip characterized by an Instantaneous, Short, or Long time delay curve. Each of these curves has an instant trip region, as shown in Figure 11.

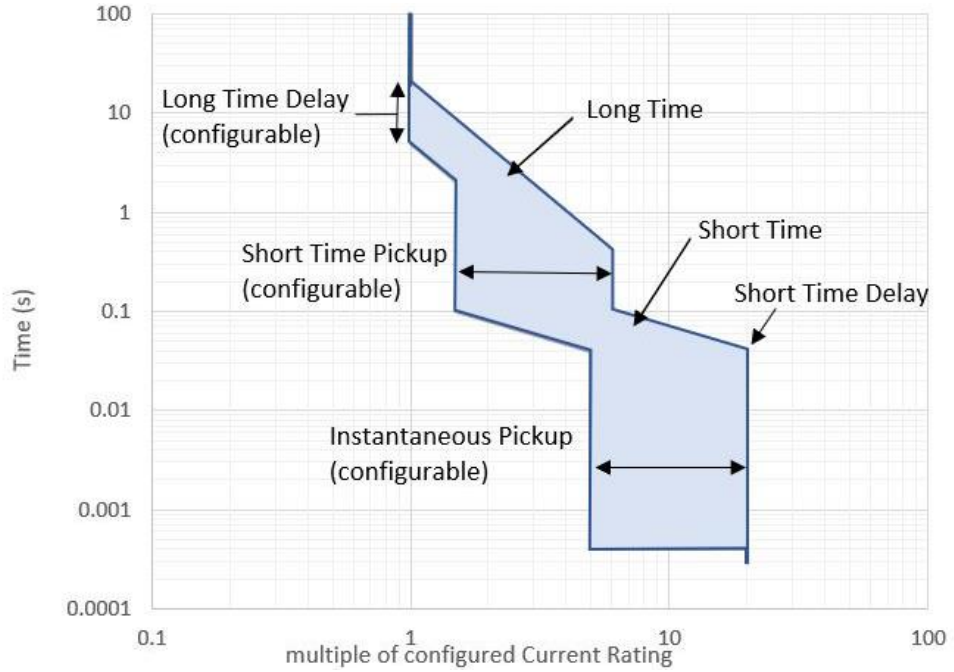


Figure 11 - Current vs Time Graph

The nominal current that can flow through an ECB is determined by the power it can dissipate continuously without exceeding its own thermal limits. When an overcurrent condition is detected, the CLMD16 will trip, turning off the current to the supplied load. The breaker can be reset by turning OFF and then ON again through the NMEA 2000® interface or at the capacitive touch local override control on the front of the unit.

The ECB's in the CLMD16 are configured so that nuisance tripping is avoided where the start-up current may be more than those experienced in a continuous duty cycle.

The system installer / configurator will need to know the current rating of the load, the maximum start-up peak current, and duration allowed for the peak in order to correctly configure the ECB settings.

Binary Event Monitor

A binary event simply means that there are only two possible outcomes, such as a light switch which is either on or off. The CLMD16 can translate the voltages measured on the eight analog/digital inputs, the resistances monitored on the two resistance inputs, and the current monitored on the current loop input for use in controlling loads or for use as inputs to the various elements in the switching application (for example, counters, tank levels, timers, etc.).

This is done by using the binary event monitor. The binary event monitor will translate the input voltage signal from a voltage level to one of three discrete states:

- *LOW* (Connected to DC-)
- *FLOAT* (No Connection)
- *HIGH* (Connection to DC +)

The voltage levels at which these discrete states are calculated are individually programmable for each of the input channels.

There are eleven binary event monitors in the CLMD16. Each of the eight analog/digital inputs, the two resistive inputs, and the current loop input has an associated binary event monitor.

There are two programmable voltage levels:

- *Low Threshold*
- *High Threshold*

The binary event monitor also implements a programmable amount of hysteresis. This is where the value of a physical property lags behind changes in the effect causing it, as for instance, when magnetic induction lags behind the magnetizing force.

Hysteresis causes the binary event monitor to behave such that the discrete input states will not quickly transition between states when the input voltage is near one of the threshold voltages. There is a separate hysteresis value for each threshold voltage:

- *Low Hysteresis*
- *High Hysteresis*

Figure 12 shows an example of how the hysteresis works.

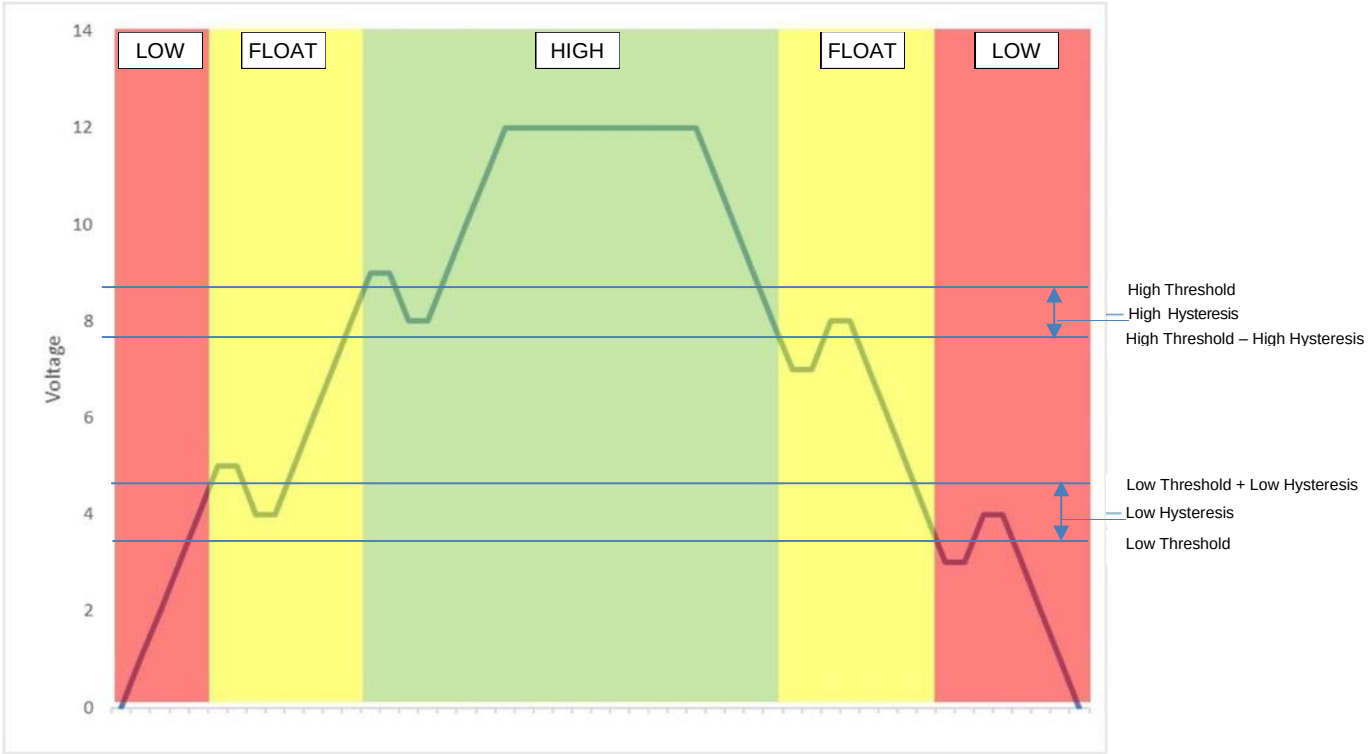


Figure 12 - Binary Event Monitor Hysteresis

Each channel of the Binary Event Monitor produces three signals that are available to the Switching Application:

Binary Event x Low – the Binary Event Monitor for channel x is in the LOW state
Binary Event x Float – the Binary Event Monitor for channel x is in the FLOAT state
Binary Event x High – the Binary Event Monitor for channel x is in the HIGH state

Switching Application

The CLMD16 contains a variety of combinatorial and sequential logic elements to allow the construction of control applications. These logic elements can be connected and configured in a wide variety of ways to create a wide variety of control applications.

Counters

The CLMD16 switching application contains eight instances of a counter function.

Each counter may be configured in one of the following modes:

- *Active High* – The counter increments or decrements as long as the increment or decrement input signal is in a high state (connected to DC (+))
- *Active Low* – The counter increments or decrements as long as the increment or decrement input signal is in a low state (connected to DC (-))
- *Rising Edge* – The counter increments or decrements once for every rising edge detected on the increment or decrement input signal (voltage rising)
- *Falling Edge* – The counter increments or decrements once for every falling edge detected on the increment or decrement input signal (voltage lowering)
- *Change Detected* – The counter increments or decrements once for every rising or falling edge detected on the increment or decrement input signal
- *One Button Smooth Scroll* – This mode is designed to allow one button power and dimming control for lighting circuit. The counter operates differently in this mode. First, the *Decrement* input is ignored. Second, the *Counter Active* output becomes a power output for the lighting circuit. Here is how to use this mode: Connect the button you want to control the light to the *Increment* input. For the breaker(s) controlling the lighting, connect the *Counter Active* output as the Input Signal, set the breaker mode to “PWM”, and select the counter you are configuring as the “PWM Counter”. In this mode, a quick press of the button (less than *Hold Period*) will cause *Counter Active* (and thus the breaker power) to toggle state. Holding the button longer than this will cause the dimming level to cycle from 5% to 100% and then back from 100% to 5% until you release the button. The dimming level is remembered when you turn the circuit ON and OFF again by quickly pressing the button.

Each counter has the following input signals:

- *Increment* – causes the counter to increase in value*
- *Decrement* – causes the counter to decrease in value*
- *Reset* – causes the counter to be set to the *Min Set Point* value

Each counter has the following output signal:

- *Counter Active* – this is asserted high (ON) when the counter value is equal to or greater than the value of the *Active Threshold* parameter*

Each counter has the following programmable parameters:

- *Press Step Size* – step size by which to increment or decrement the counter when the increment or decrement input is pressed
- *Min Set Point* – the value to which the counter is set when the Reset input is asserted high
- *Max Set Point* – the maximum value that the counter can reach
- *Active Threshold* – if the counter value is above the value of this parameter, the *Counter Active* output of the counter will be asserted high*
- *Held Step Time* – (Active High or Active Low mode) once the increment or decrement counter has been asserted high for *Hold Period* time, the counter is incremented or decremented. If the increment or decrement input signal remains asserted high for this amount of time afterwards, the counter will be incremented or decremented again.
- *Hold Period* – (Active High or Active Low mode) time after which the input signal is considered "held" if it remains active
- *Hold Step Size* – in Active High or Active Low mode, this is the value by which to increment or decrement the counter after the increment or decrement input signal has been asserted high for *Hold Period* time, and every *Held Step Time* thereafter. If the Rising Edge, Falling Edge, or Change mode, this is the value by which to increment or decrement the counter on each detected edge of the increment or decrement input signal.

* Please refer to the description of *One Button Smooth Scroll* mode to see how these items are treated differently when that mode is selected.

In *Active High* or *Active Low* mode, the increment input signal being in its active state is ignored if the decrement signal was already in its active state, and vice versa.

The signals can be used to perform many different tasks such as push to hold (Momentary state operation), hold to latch (Toggle state operation), and multi-push (Sequential state operation) etc.

The output signals from the counter elements are numbered 1 through 8

Timer Delay

The CLMD16 provides eight instances of a timer delay function.

The Timer Delay function provides the Switching Application the ability to postpone the activation of load output channels upon receiving channel activation commands up to 65,535 seconds for each. This is not to be confused with the Soft Start function as the timer delay function does not contribute to the load PWM output.

Each timer can be configured to one of the following modes:

- *ON Delay* – When the input signal is applied, the output is delayed by the delay period
- *OFF Delay* – When the input signal is removed, the output is delayed by the delay period
- *No Delay* – the output signal is a replica of the input signal

Each timer has the following input signals:

- *Input* – the signal whose delayed version will be produced on the output

Each timer has the following output signals:

- *Timer Output* – the delayed version of the Input signal

Each timer has the following programmable parameters:

- *DelayPeriod* – the amount of time by which to delay the appropriate edges of the input signal to produce the output signal.

If the timer is configured in ON Delay mode and the input signal is asserted high for less than the *DelayPeriod* time before being asserted low again, the output signal will remain asserted low Conversely, if the timer is configured in OFF Delay mode and the input signal is asserted low for less than the *DelayPeriod* time before being asserted high again, the output signal will remain asserted high.

The output signals from the timer delay elements are numbered 1 through 8

Flash

The CLMD16 provides eight instances of a flash function.

The Flash function provides the Switching Application the ability to turn an output on and off at set frequencies.

This function can be used to generate unique visual error codes using a load output channel connected to an LED such as Indication of a network or power supply low voltage state. Or to flash a mast clearance strobe, Pulse an intermittent bilge pump, or for use with intermittent ON ventilation systems.

The Flash function has the following input signals:

- *Input* – the flashing function is enabled as long as this signal is asserted (ON)

The Flash function has the following output signals:

- *Flash Output* – while the input signal is asserted this signal will be enabled allowing for the configurable parameters to take control of the *Flash Output* function.

The Flash function has the following configurable parameters:

- *Flash Cycles* – once the Input signal is detected, the Flash Output signal will cycle for this number of cycles, or until the Input signal is removed, whichever occurs first.
- *Flash On Period* – during each flash cycle, the Flash Output signal will be On for this amount of time
- *Flash Off Period* – during each flash cycle, the Flash Output signal will be Off for this amount of time

The output signals from the flash elements are numbered 1 through 8

Latches

The CLMD16 provides eight set/reset latches, which, as an example, may be used for loads which use a push on/push off function.

The Latch function has the following input signals:

- *Set Input* – This signal will cause the Latch Output signal to turn On
- *Reset Input* – This signal will cause the Latch Output signal to turn Off

The Latch function has the following output signals:

- *Latch Output* **–** On when Set Input is detected or On, and Off when the Reset Input is detected or On

The Latch function has no configurable parameters.

The output signals from the latch elements are numbered 1 through 8

Set/Reset Latch

The truth table of a Set/Reset Latch is as shown in Table 8.

Table 8 - Latch Function Truth Table

Set Input	Reset Input	Latch Output
0	0	Previous State
0	1	0
1	0	1
1	1	Undefined

Toggle

The switching application provides eight instances of a toggle latch.
Each toggle latch maintains its logic state until the single input signal to the toggle latch transitions from a On to Off.

The Toggle function has the following input signals:

- *Toggle Input* – when this signal is changed from On to Off (Usually a momentary event), it will cause the Toggle Output signal to change to the opposite of its current state; for example, if the Toggle Output signal is On, then will change to Off, and if the Toggle Output signal is Off, it will change to On

The Toggle function has no configurable parameters.
The output signals from the toggle elements are numbered 1 through 8

Toggle Latch

Where "1" is On and "0" is Off, each state change of the Toggle Input from *Off* to *On* changes the state of the Toggle Output. (see: Table 9)

Table 9 - Toggle Function Truth Table

Toggle Input	Previous Toggle Output	Toggle Output
0	0	0
0	1	1
1	0	0
1	1	1
1→0	0	0
1→0	1	1
0→1	0	1
0→1	1	0

Logic

The switching application provides eight instances of three-input logic operations.

The Logic (Combinatorial Logic) function provides the Switching Application the ability to take up to three signals and logically combine them using Boolean logic to create a logical signal. The three-input lookup table allows any binary function of three variables to be realized. The outputs of the logic functions may be used as inputs to other logic functions (allowing logic functions of more than three inputs to be realized) or as inputs to other types of functions.

Each Logic Function has the following input signals:

- *Input A* – first input to the logic function
- *Input B* – second input to the logic function
- *Input C* – third input to the logic function

Each Logic function has the following output signals:

- *Logic Output* – the logical output of the of Input A, Input B, and Input C as defined by the lookup table

Each Logic function consists of a three-input lookup table. There are eight rows in the table, one row for each possible combination of values of the three inputs. For each of the eight rows, you specify an output value for the logic function, either 0 or 1. For an example, where “1” is On and “0” is off, consider the logic function ((A and B) or not C). This function outputs a 1 value when A=1 and B=1, or when C=0. The lookup table defining this function appears in Table 10.

Table 10 - Logic Function Truth Table Example

Input A	Input B	Input C	Output
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Functions of more than three variables may be constructed by using the output of one logic element as the input to a second logic element, and so on.

The Logic Output signals are numbered 1 through 8.

Alarm Output

The CLMD16 provides a single alarm output circuit to drive an alarm or relay. There are two terminals: Alarm Power (pin J3-16), and Alarm Ground (pin J3-22). Both of these pins are switched. They are connected to power and ground, when an Alarm Input signal is detected, and both become high impedance when the Alarm Input signal is Off or not detected.

The Alarm function has the following input signals:

Alarm Enable – when the Input signal is detected, this signal will cause the alarm output circuit to be Connected.

Available Signals

There are many signals that are available to connect as inputs for the various logic elements in the switching application. The Table 11 is a complete list of the available signals.

Table 11 - Available Signal Table

Signal Name	Description
None Selected	This connects the specified input to a constant Logic '0' value
Binary Event 1 through 12 Low	The signal on binary event 1 through 12 is in the Low voltage range
Binary Event 1 through 12 Float	The signal on binary event 1 through 12 is in the Float voltage range
Binary Event 1 through 12 High	The signal on binary event for the numbered channel is in the High voltage range
Network Input 1 through 16	The state of the signal on Network Input for the numbered channel
Logic Output 1 through 8	The state of the output of Logic Element for the numbered channel
Latch Output 1 through 8	The state of the output of Latch Element for the numbered channel
Toggle Output 1 through 8	The state of the output of Toggle Element for the numbered channel
Timer Output 1 through 8	The state of the output of Delay Timer Element for the numbered channel
Flash Output 1 through 8	The state of the output of Flash Element for the numbered channel
Counter Active 1 through 8	The state of the output of Counter Element 1 through 8
Over Current Fault Ch 1 through 16	An Over Current Fault has been detected on Channel 1 through 16
Ch 1 through 16 Tripped	The circuit breaker for the numbered channel is tripped
Ch 1 through 16 Thermal Limit Hit	The circuit breaker for the numbered channel has reached its thermal limit
Discrete I/O 1 through 16	The discrete state I/O of the signal the numbered channel

Configuring the CLMD16

The CLMD16 will transmit data over the NMEA 2000® network as it is shipped from the factory; however, it may require configuration, depending on the type of switches monitored and the number of similar products on the NMEA 2000® network. There are several configurable items within the CLMD16, which are detailed in the remainder of this section.

The CLMD16 is configured using Maretron N2KAnalyzer® V3 software. The following subsections describe the configurable parameters in the CLMD16.

General Tab

The General Tab contains commonly used configuration items. Detailed descriptions of Binary Status Report messages, (127500, 127501 etc.) where these are mentioned in the text, may be found in Appendix A – NMEA 2000® Interfacing. See Figure 13 for General Tab detail.

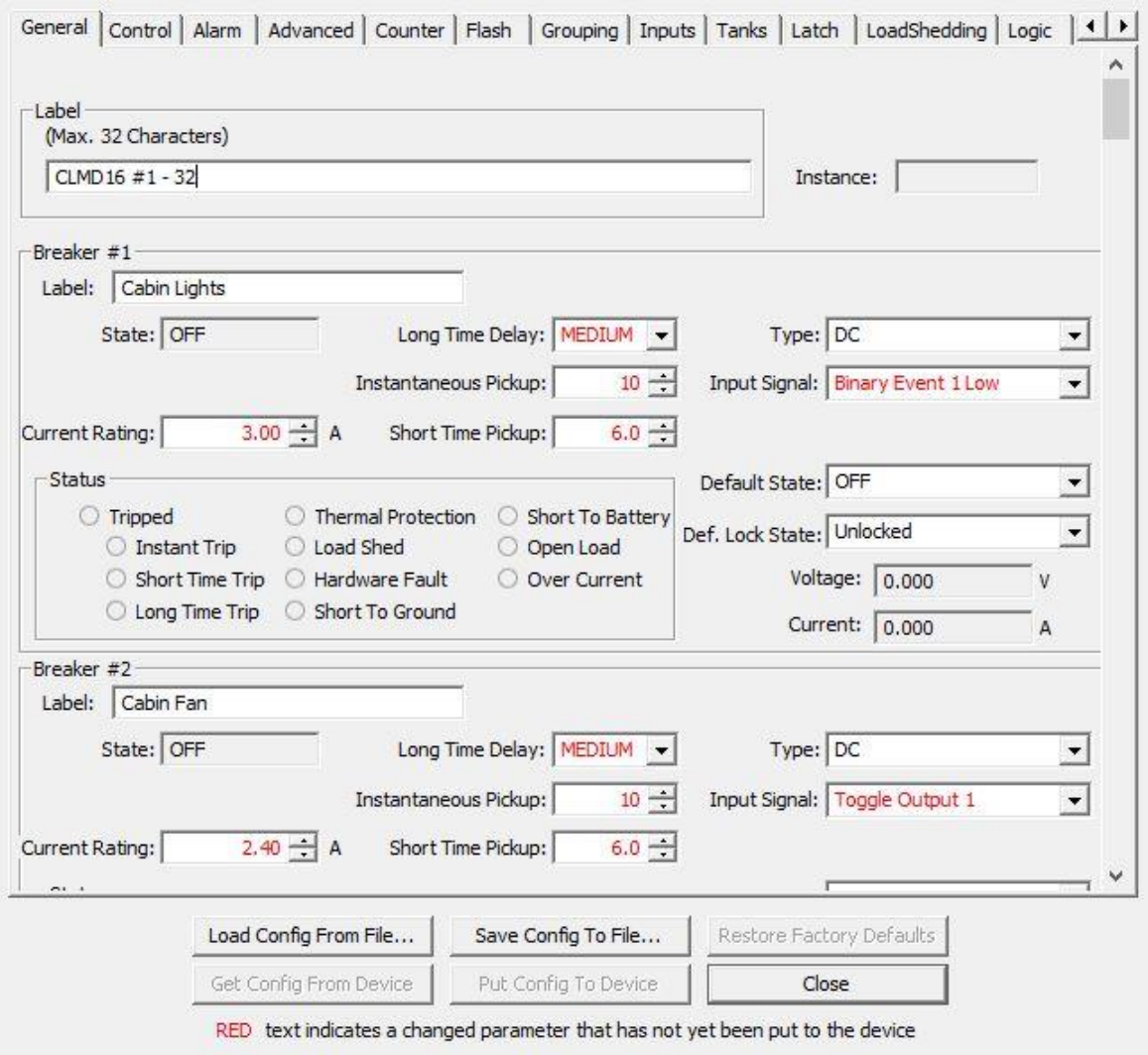


Figure 13 - General Configuration Tab Dialog Box

Label

This text box allows you to assign a text label to the device. This label is visible in Maretron analysis and supported display products and allows you to easily identify the particular device.

Instance

NMEA 2000® provides a unique instance number for each breaker box on a vessel. This read- only field shows the instance number assigned to this device. This instance number value is reflected in the 127501 Binary Status Report message. The instance number can be configured by changing the “Device Instance” field on the “Advanced” tab.

Breaker #(n)

This section contains settings for the specified electronic circuit breaker. One of these sections is present for each of the breakers in the unit.

Label

This text box allows you to configure a text label for the breaker to identify it (for example, "RUNNING LIGHTS" or "HATCH"). For each breaker, set this to a value which describes the breaker so that you can easily identify it in display devices.

State

This read-only field indicates the current state of the breaker. It will contain one of the following values:

- *OFF* – the breaker is currently off (not supplying power)
- *ON* – the breaker is currently on (supplying power)
- *TRIP/ERROR* – the breaker is currently off (not supplying power) due to an overcurrent or error condition

Default State

This allows you to configure the state of the breaker when the CLMD16 is powered on. You can set this to one of the following values:

- *OFF* – the breaker will be *OFF* after the CLMD16 is powered on
- *ON* – the breaker will be *ON* after the CLMD16 is powered on
- *LAST STATE* – after the CLMD16 is powered on, the breaker will be set to the state it was in when power was last removed

Default Lock State

This parameter allows you to configure whether the breaker is locked when the CLMD16 is powered on. You can set this to one of the following values:

- *LOCKED* – the breaker is locked, i.e., it's state will not change due to network inputs
- *UNLOCKED* – the breaker is unlocked, and its state will respond normally to network inputs

Type

This parameter allows you to configure the desired operating mode for this breaker. You can choose one of the following:

- *DC* – the breaker may be controlled OFF and ON.
- *PWM* – this breaker may be controlled OFF and ON and may be dimmed by altering the changing duty cycle of the PWM counter assigned to the breaker.
- *Soft Start DC* – the breaker may be controlled OFF and ON. When the breaker is turned ON, the power starts in PWM mode with the duty cycle set by "Soft Start %" parameter, and then ramps to fully ON over the next one second time interval.
- *Full-Bridge* – if both breakers in a full-bridge pair (i.e., 1 and 2, or 11 and 12) are configured to Full-bridge, then the two breakers will work together as a full bridge (H-bridge). The full bridge may be controlled OFF and ON, and its direction may be controlled.

- *Soft Start Full-Bridge* – if both breakers in a full-bridge pair (i.e., 1 and 2, or 11 and 12) are configured to Soft Start Full-bridge, then the two breakers will work together as a full-bridge (H-bridge) with the soft start feature enabled. The full bridge may be controlled OFF and ON, and its direction may be controlled. When the breaker is turned ON, the power starts in *PWM* mode with the duty cycle set by *Soft State %* parameter, and then ramps to full ON over the next one second time interval.

Current Rating
This parameter allows you to configure the desired trip level for this breaker. Exceeding this current for a time period set by the value of the *Long Time Delay* parameter along with the i^2t breaker model will initiate a trip.

Instantaneous Pickup
This parameter allows you to configure the *Instantaneous Pickup* for the breaker. This can be set in the range of 5 to 20 with a resolution of 1. This parameter is a multiplier of the current rating. For example, if the current rating for the breaker is set to 6 A and the *Instantaneous Pickup* parameter is set to a value of 10, then the *Instantaneous Pickup* current will be 60 A (6 A * 10).

Short Time Pickup
This parameter allows you to configure the *Short Time Pickup* for the breaker. This can be set in the range of 1.5 to 6.0 with a resolution of 0.1. This parameter is a multiplier of the current rating. For example, if the current rating for the breaker is set to 6 A and the *Short Time Pickup* parameter is set to a value of 4, then the short time pickup current will be 24 A (6 A * 4).

Input Signal
This parameter allows you to select the internal signal that determines the state of this breaker. You may choose a signal from the list in Table 11 - Available Signal Table

PWM Counter
This parameter allows you to select which *PWM Counter* controls the dimming level for this breaker. You may choose any of the eight *Counter* elements. You may also choose *No Counter*, which allows you to directly control the dimming level for this breaker from the network.

Long Time Delay
This parameter allows you to configure the long-time delay for the breaker. This can be set to one of the following values:

- *FAST* (5 seconds)
- *MEDIUM* (10 seconds)
- *SLOW* (20 seconds)

Voltage

This read-only field shows the real-time voltage at the load terminal of the breaker.

Current

This read-only field shows the real-time current passing through the breaker.

Status

This group of indicators show real-time status of the breaker.

Tripped
When lit, this read-only field shows that the breaker is in the TRIP state.

Instant Trip
When lit, this read-only field indicates that the breaker has tripped due to the instant trip feature.

Short Time Trip
When lit, this read-only field indicates that the breaker has tripped due to the short time trip feature.

Long Time Trip
When lit, this read-only field indicates that the breaker has tripped due to the long time trip feature.

Thermal Protection
When lit, this read-only field indicates that the breaker has been turned off due to the thermal protection feature.

Load Shed
When lit, this read-only field indicates that the breaker has been turned off due to the load shedding feature.

Hardware Fault
When lit, this read-only field indicates that the breaker has been turned off due to a hardware fault being detected.

Short To Ground
When lit, this read-only field indicates that the breaker has been turned off due to it being detected shorted to ground.

Short To Battery
When lit, this read-only field indicates that the breaker has been turned off due to it being detected shorted to the DC supply voltage.

Over Current
When lit, this read-only field indicates that the breaker has tripped due to an overload being detected.

Open Circuit
When lit, this read-only field indicates an Open Circuit (no load) condition. The breaker is turned ON but there is little, or no current being drawn. There are several possible reasons:

- External switch controlling load is in the OFF position
- If the connected load is a light, the bulb could be defective
- The load is incorrectly wired
- The load is very small (less than 1.0 Amps)

Breaker Locked
When lit, this read-only field indicates that the breaker has been locked and will not respond to switch commands on the network. The purpose of the lock feature is to avoid inadvertent or accidental breaker state changes. The breaker must be unlocked before the breaker state can be remotely changed again.

Control Tab

The Control tab allows you to toggle the configured *Network Input* channels of the CLMD16. Each *On / Off* control number corresponds with *Network Input* numbers 1-16. When a *Network Input* is turned on in this dialog, the associated circuit that the *Network Input* is configured to control will be controlled. See Figure 14 for Control Tab detail.

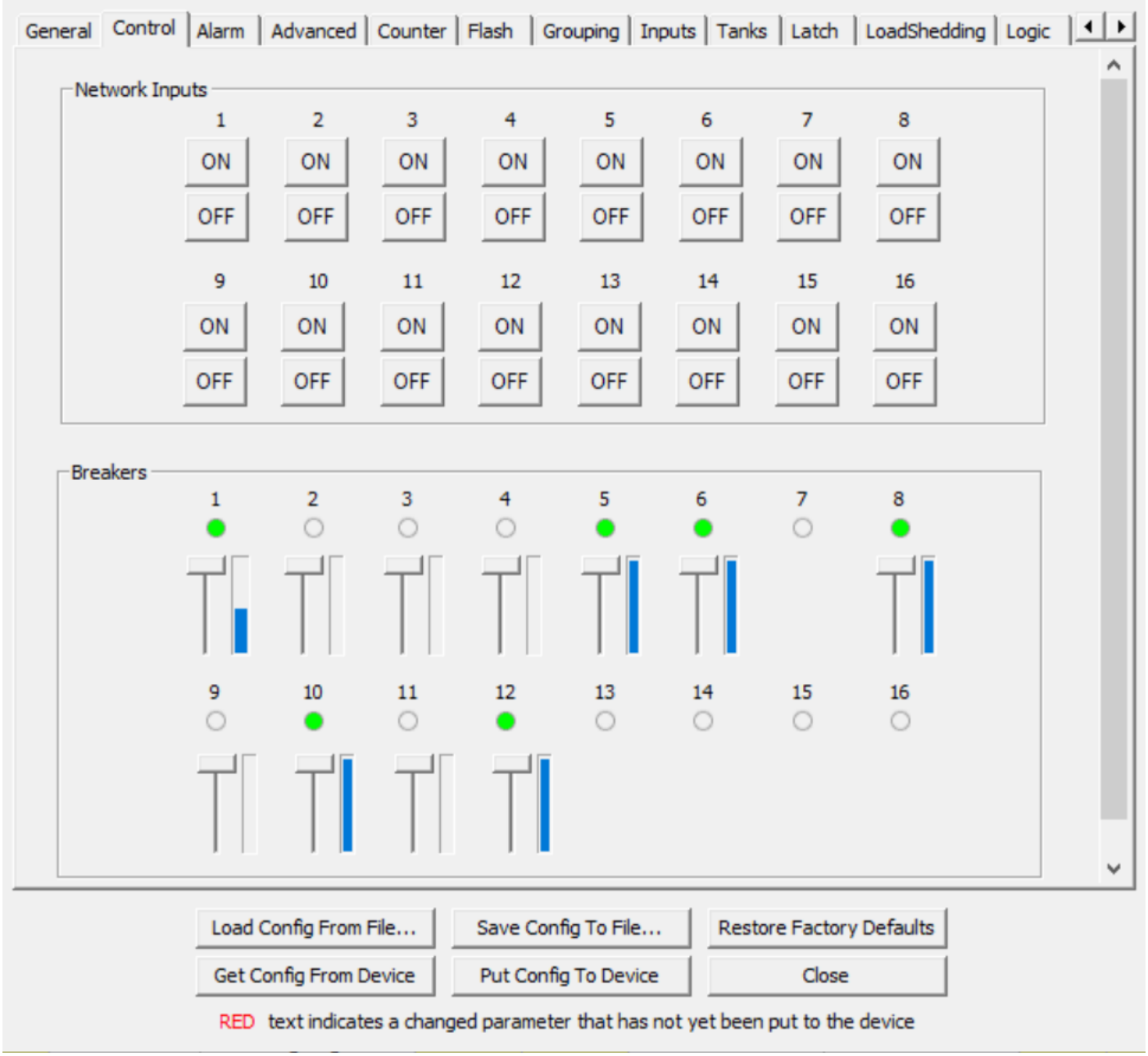


Figure 14 - Control Tab Dialog Box

Alarm Tab

The Alarm tab allows you to select an internal signal to be used to control the alarm outputs of the CLMD16. You may select from the list of signals in Table 11 - Available Signal Table. See Figure 15 for Alarm Tab detail.

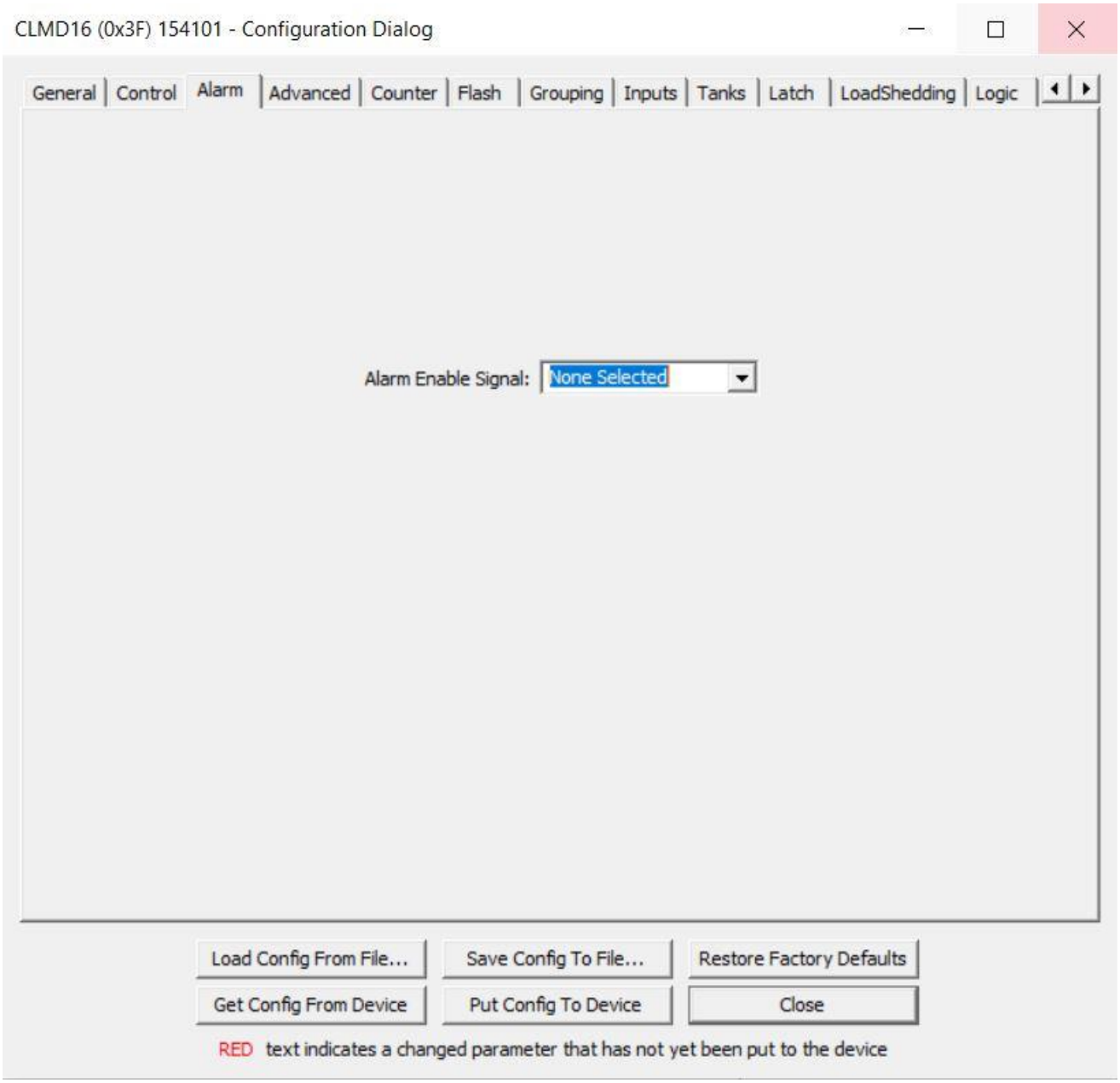


Figure 15 - Alarm Configuration Tab Dialog Box

Alarm Enable Signal
This parameter allows you to select an internal signal to control the alarm outputs. The alarm outputs are connected whenever this signal is activated. You may select from the list of signals in Table 11 - Available Signal Table.

Advanced Tab

The Advanced tab is used to configure and observe parameters that do not normally require changing. See figures Figure 16 & Figure 17 for Advanced Tab detail.

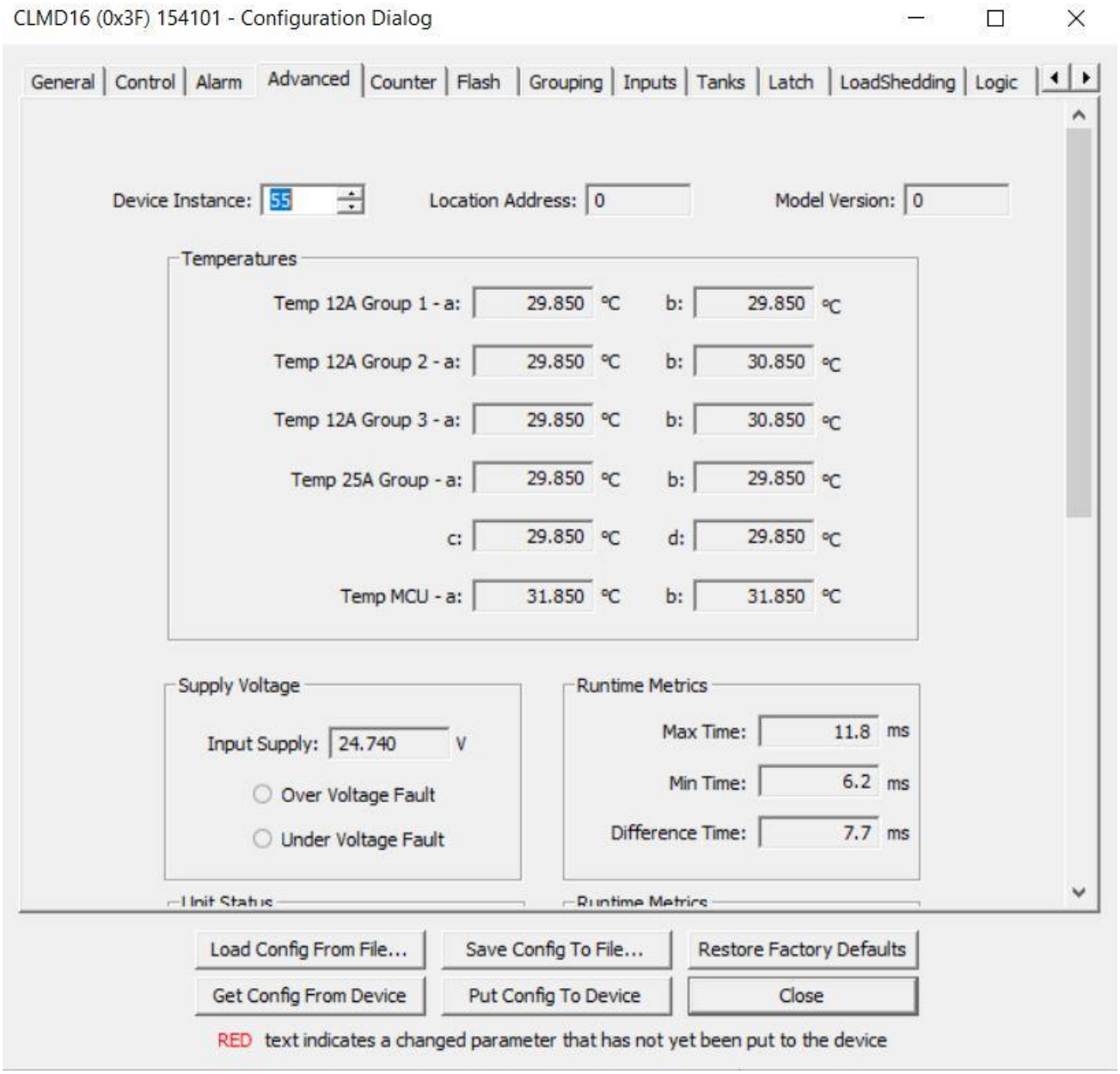


Figure 16 - Advanced Configuration Tab (Upper Portion) Dialog Box

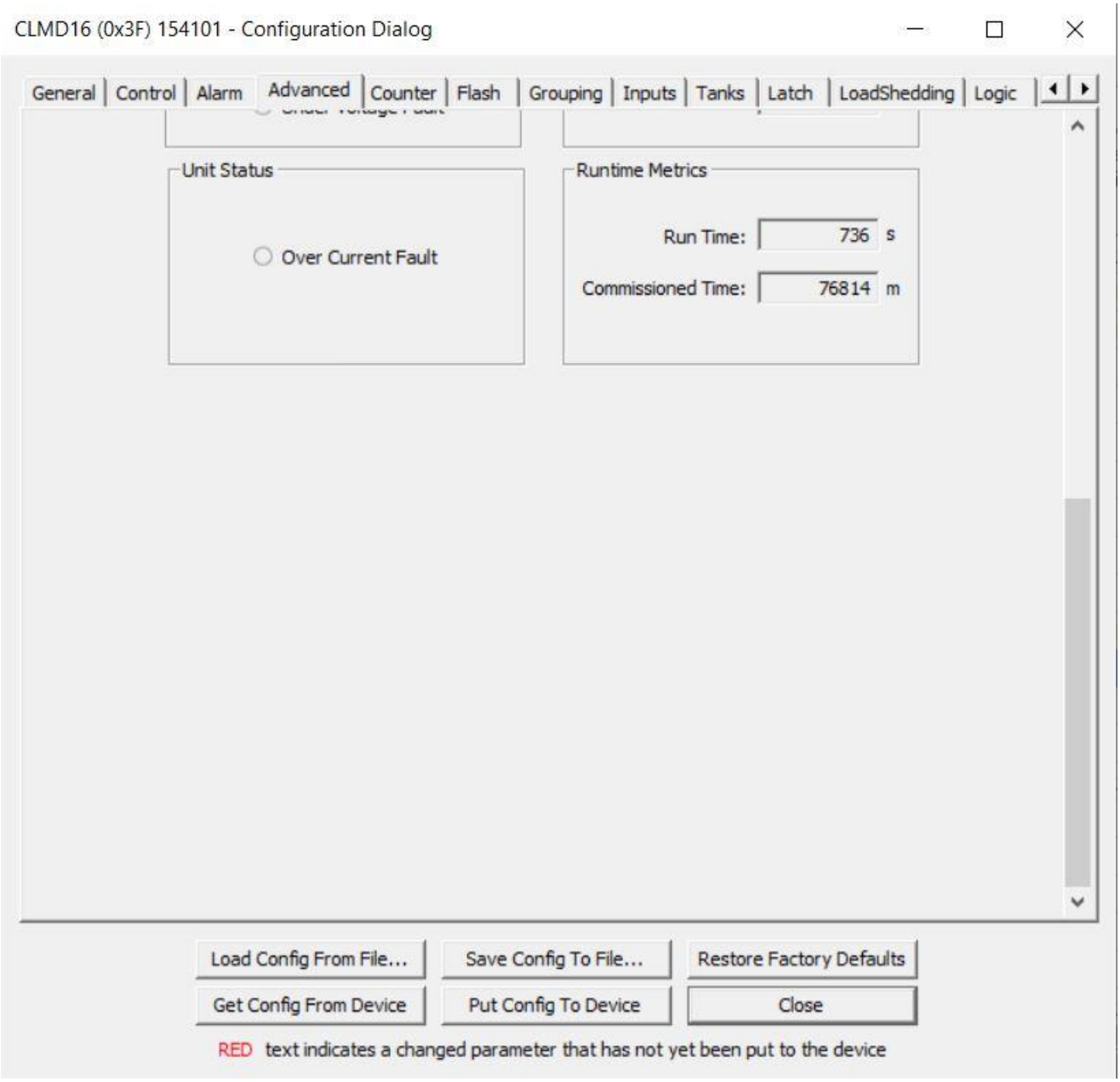


Figure 17 - Advanced Configuration Tab (Lower Portion) Dialog Box

Device Instance

This parameter allows you to configure the NMEA 2000® device instance used by the device. This value is also used as the data instance in the 127501 Binary Status Report messages transmitted by the device and can be seen on the General Tab as well as the Inputs Tab labeled as “Instance”.

Location Address

This read-only field displays the value of the four active-low Address #1 through Address #4 inputs. Address #4 is the most significant bit, and Address #1 is the least significant bit.

Model Version

This read-only field shows the internal version number of the CLMD16 application software.

Temperatures

Temp 12A Groups 1 to 3
These read-only fields (a and b) display the temperature measured by the two temperature sensors in the CLMD16 located near the 12 Amp channels 1,2, and 3.

Temp 25A Group
These four read-only fields (a, b, c, and d) display the temperature measured by the four temperature sensors in the CLMD16 located near the 25 Amp Group channels.

Temp MCU
These two read-only fields (a and b) display the temperature measured by the two temperature sensors in the CLMD16 located near the system microcontroller.

Supply Voltage

Input Supply
This read-only field displays the voltage that is present on the DC Power Connection Stud with respect to the DC Ground Connection Stud.

Over Voltage Fault
This read-only indicator is lit red if the voltage between the DC Power Connection Stud and the DC Power Ground Stud is higher than the recommended operating range.

Under Voltage Fault
This read-only indicator is lit red if the voltage between the DC Power Connection Stud and the DC Power Ground Stud is lower than the recommended operating range.

Execution Time Metrics

Max Time
This read-only field displays the longest loop time used by internal calculations.

Min Time
This read-only field displays the shortest loop time used by internal calculations.

Difference Time
This read-only field displays the average loop time used by internal calculations.

Unit Status

Over Current Fault
This read-only indicator shows steady red if the CLMD16 has been shut down because the total current through the CLMD16 is more than the 125 Amp specification.

Runtime Metrics

Run Time
This read-only field displays the total amount of time the CLMD16 has been operational since it was last powered on.

Commissioned Time
This read-only field displays the total amount of the time the CLMD16 has been operational since it was built

Counter Tab

The CLMD16 has eight counter elements. See: Figure 18 for Counter Tab detail. Please refer to "Counters" on page 24 for details on the implementation of this function.

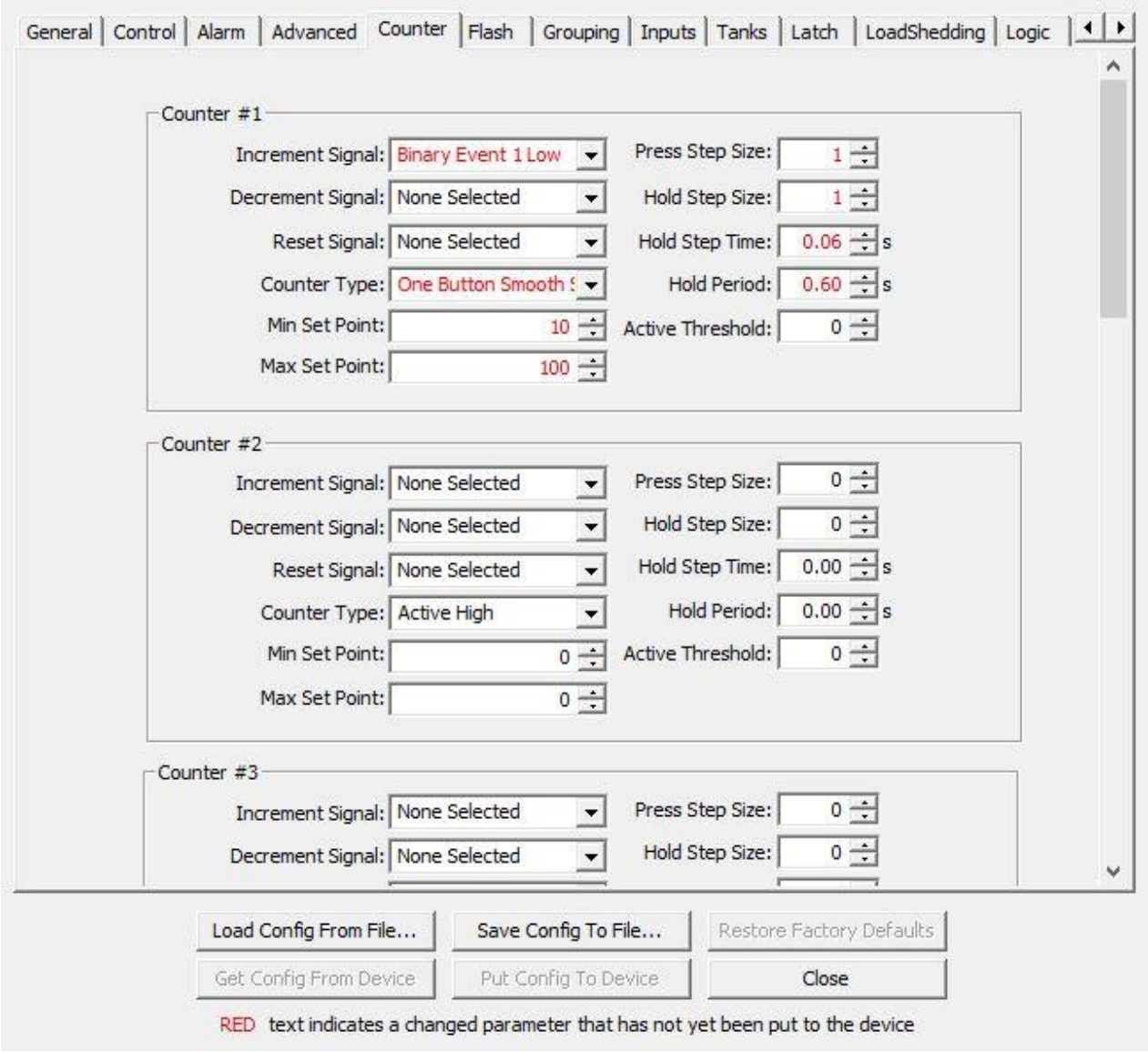


Figure 18 - Counter Configuration Tab Dialog Box

Increment Signal

This parameter allows you to select a signal to cause the counter to increment in value. You may select from the list of signals in Table 11 - Available Signal Table. When *One Button Smooth Scroll Counter Type* is selected the *Increment Signal* is used as the primary input signal for *One Button Smooth Scroll* operation.

Decrement Signal
This parameter allows you to select a signal to cause the counter to decrement in value. You may select from the list of signals in Table 11 - Available Signal Table. When *One Button Smooth Scroll Counter Type* is selected the *Decrement Signal* is ignored as a control input.

Reset Signal
This parameter allows you to select a signal to cause the counter to reset to a chosen value as selected in the Min Set Point field. You may select from the list of signals in Table 11 - Available Signal Table.

Counter Type
This field allows you to configure the operating mode of the counter. Each counter may be configured in one of the following modes:

- *Active High* – The counter increments or decrements as long as the increment or decrement input signal is in a high state
  (Connected to DC (+))
- *Active Low* – The counter increments or decrements as long as the increment or decrement input signal is in a low state
  (Connected to DC (-))
- *Rising Edge* – The counter increments or decrements once for every rising edge detected on the increment or decrement input signal
- *Falling Edge* – The counter increments or decrements once for every falling edge detected on the increment or decrement input signal
- *Change* – The counter increments or decrements once for every rising or falling edge detected on the increment or decrement input signal

- *One Button Smooth Scroll* – The *Increment Signal* input controls *One Button Smooth Scroll*, The *Decrement Signal* input is ignored in the *One Button Smooth Scroll* *Counter Type* selection.
  Function:
  An input signal shorter than *Hold Period* will turn the assigned breaker's load on to last PWM state, with the next input signal shorter than *Hold Period* the breaker's load will turn off.
  An input signal longer than the *Hold Period* time will temporarily disable the decrement function and increment the counter and will continue to increment the counter on the next input signal detected longer than *Hold Period* time until *Maximum Set Point* is reached.

  Once *Maximum Set Point* is reached, an input signal longer than the *Hold Period* time will temporarily disable the increment function and decrement the counter and will continue to decrement the counter on the next input signal detected longer than *Hold Period* time until *Minimum Set Point* is reached.
  (Once *Maximum or Minimum Set Point* in the counter cycle is reached the system will toggle from ascending (increment) PWM to descending (decrement) PWM or vise versa. For definition of *Hold Period* see "*Hold Period"* on following page.

Min Set Point
This parameter allows you to configure the minimum value that the counter can reach. This is also the value to which the counter is set when the Reset input is asserted high

Max Set Point
This parameter allows you to configure the maximum value that the counter can reach.

Press Step Size
This parameter allows you to configure the step size by which to increment or decrement the counter when the increment or decrement input is pressed.

Hold Step Size
This parameter allows you to configure in Active High or Active Low mode, the value by which to increment or decrement the counter after the increment or decrement input signal has been asserted high (On) for *Hold Period* time, and every *Held Step Time* thereafter. In the Rising Edge, Falling Edge, or Change mode, this is the value by which to increment or decrement the counter on each detected edge of the increment or decrement input signal.

Hold Step Time
This parameter allows you to configure, in *Active High* or *Active Low* mode, the time interval after which the action performed by a "held" input signal repeats while it remains active.

Hold Period
This parameter allows you to configure, in *Active High* or *Active Low* mode, the time after which the input signal is considered "held" if it remains active.

Active Threshold
This parameter allows you to configure the counter value above which the *Counter Active* output of the counter will be asserted high (On).

Flash Tab

The CLMD16 has eight flash elements. See: Figure 19 for Flash Tab detail. Please refer to “Flash” on page 26 for details on the implementation of this function.

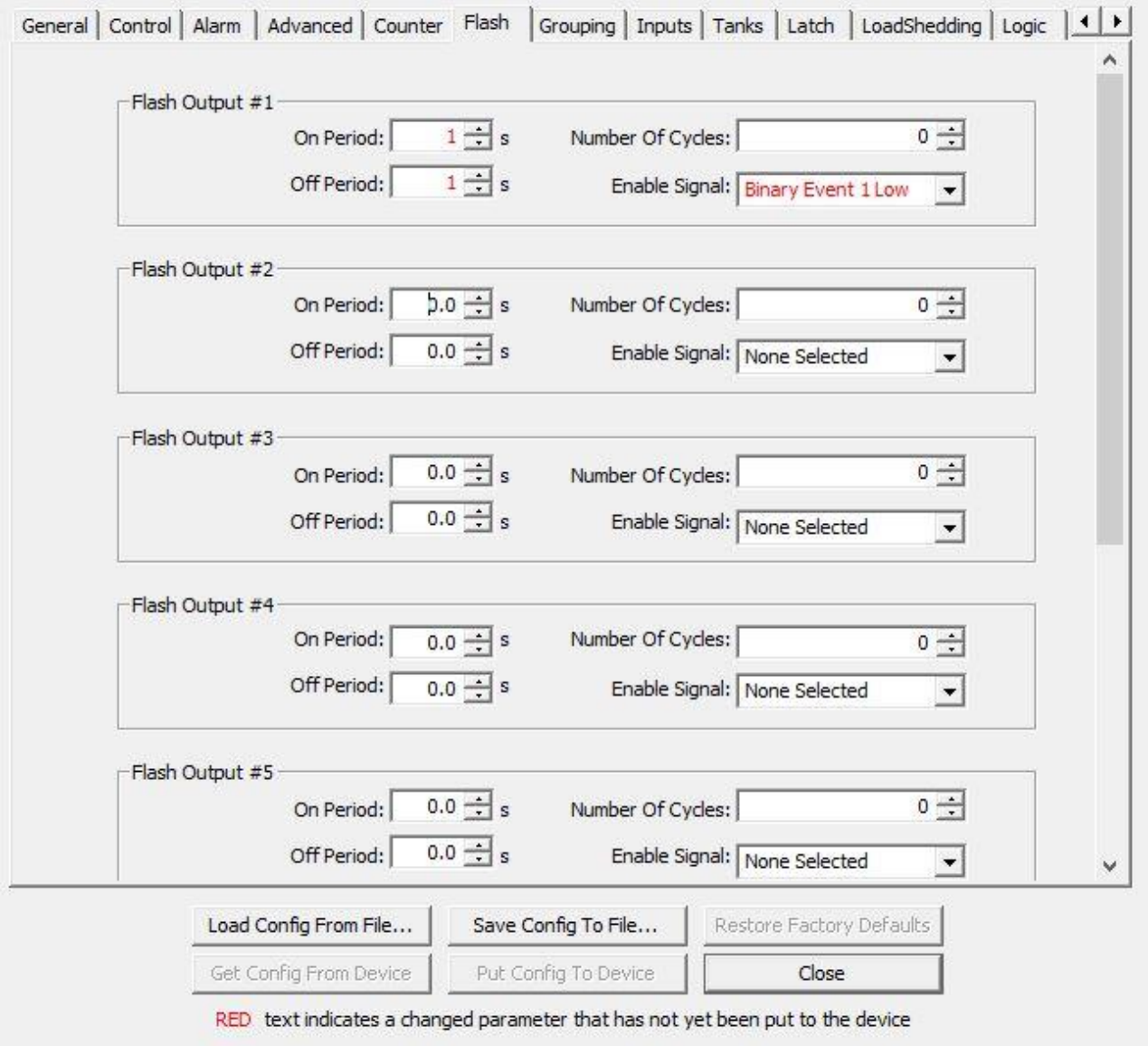


Figure 19 - Flash Configuration Tab Dialog Box

On Period
This parameter allows you to configure the time period during which the Flash output signal will be asserted high (ON) for each flash cycle.

Off Period
This parameter allows you to configure the time period during which the Flash output signal will be asserted low (Off) for each flash cycle.

Number of Cycles
This parameter allows you to configure the number of cycles that the Flash element will run once the input signal is turned on. If the Flash input is turned off before this number of cycles has been run, then the Flash output signal will stop changing.

Enable Signal
This parameter allows you to configure which internal signal will enable the Flash function as long as this signal is turned on. You may select from the list of signals in Table 11 - Available Signal Table.

Grouping Tab

Various combinations of the breakers in the CLMD16 can be paralleled together to enable the paralleled breakers to handle higher currents than a single breaker can handle. See Figure 20 for channel grouping tab detail. See Paralleling Breakers on page 17 for additional details.

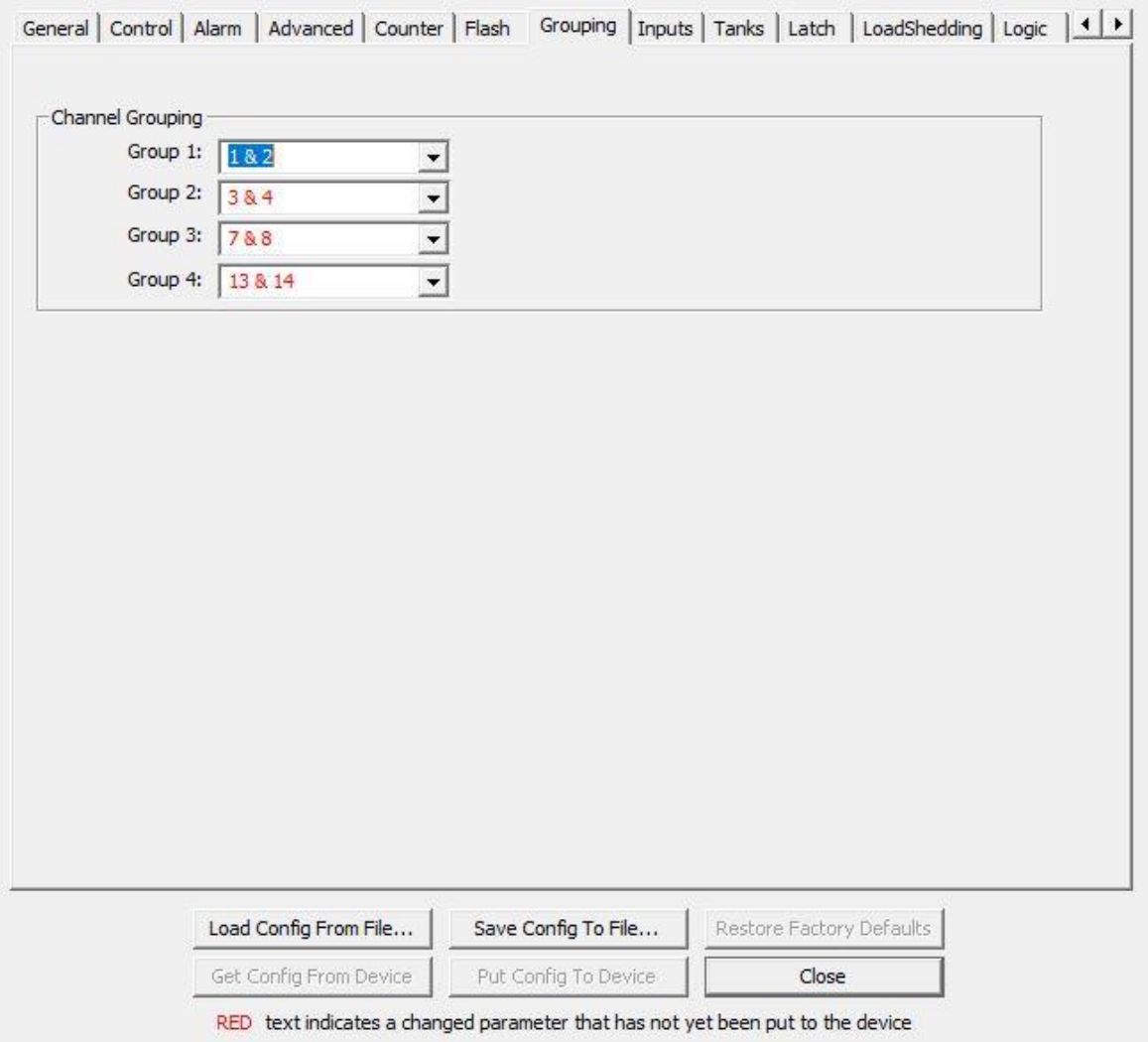


Figure 20 - Grouping Configuration Tab Dialog Box

Groups 1 through 4

This parameter allows to configure which breakers operate in parallel.

Group 1
You may choose from the following:

- No Parallel Outputs – All four breakers operate independently.
- 1 & 2 – Breakers 1 and 2 operate in parallel, while breakers 11 and 12 operate independently.

Group 2
You may choose from the following:

- No Parallel Outputs – All four breakers operate independently.
- 3 & 4 – Breakers 3 and 4 operate in parallel, while breakers 5 and 6 operate independently.

Group 3
You may choose from the following:

- No Parallel Outputs – All four breakers operate independently.
- 7 & 8 – Breakers 7 and 8 operate in parallel, while breakers 9 and 10 operate independently.

Group 4
You may choose from the following:

- No Parallel Outputs – All four breakers operate independently.
- 13 & 14 – Breakers 13 and 14 operate in parallel, while breakers 15 and 16 operate independently.

Inputs Tab

This tab allows you to configure the operation of the analog/digital input signals.
See: Figure 21 & Figure 22 for Inputs Tab details.

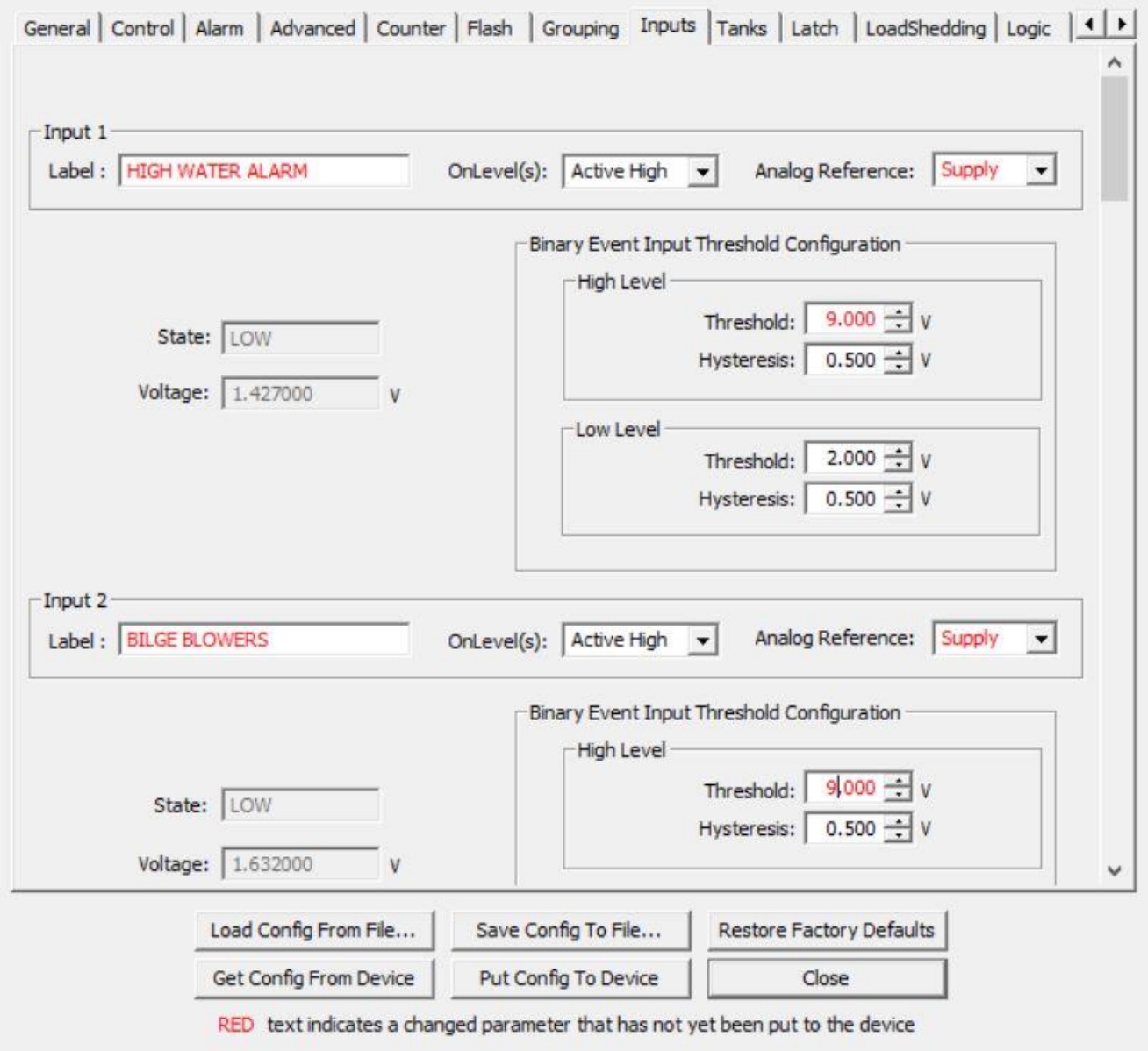


Figure 21 - Inputs Configuration Tab (Active High/ Low/ Float Channels) Dialog Box

Figure 22 - Inputs Configuration Tab (Resistive Input and Current Loop Channels Dialog Box)

Input # (n)

Label
This box allows you to configure a text label to identify the input signal, (for example, "HIGH WATER ALARM" or "BILGE BLOWERS"). It is suggested that a descriptive name is chosen so that you can easily identify it on display devices.

On Level(s)
This field allows you to select the input signal level that causes the corresponding field in the 127501 Binary Status Report message to be set to ON. You may select from one of the following values:

- *LOW*

  When the digital input is set to active low the corresponding field in the 127501 Binary Status Report message will be set to ON when the input signal level is less than the Low Threshold.

- *HIGH*

  When the digital input is set to active low the corresponding field in the 127501 Binary Status Report message will be set to On when the input signal level is greater than the High Threshold.

Analog Reference
This field allows you to select the reference voltage for the input. You may select from one of the following values:

- 5 VDC – select this option if the input signal will be limited to voltages between 0 – 5 VDC. This will allow higher resolution measurements over this limited voltage range.
- Supply – select this option if the input signal will have voltages ranging from 0 VDC to the supply voltage. This will allow the signal to be measured over the entire voltage range at the expense of lower resolution.

State
This read-only field reflects the current state of the corresponding binary input signal. This field will take one of the following three values:

- *LOW* – the input signal voltage is between 0 V and the set Low Threshold
- *FLOAT* – the input signal voltage is between the set Low and the High Thresholds
- *HIGH* – the input signal voltage is between the High Threshold and the Supply Voltage

Voltage/Resistance/Current
This read-only field reflects the present measured voltage (for channels 1-8), resistance (for channels 9-10), or current (channel 11).

High Threshold
This numeric field allows you to program a voltage, resistance, or current value such that when the detected value on the input signal transitions from below this value to above this value, the state of the signal shall change from *FLOAT* to *HIGH*.

High Hysteresis
This numeric field allows you to program a hysteresis voltage, resistance, or current value such that when the detected value on the corresponding input signal transitions from above the High Threshold minus this value, the state of the output signal shall change from *HIGH* to *FLOAT*.

Low Threshold
This numeric field allows you to program a voltage, resistance, or current value such that when the detected value on the input signal transitions from below this value to above this value, the state of the signal shall change from *LOW* to *FLOAT*.

Low Hysteresis
This numeric field allows you to program a hysteresis voltage, resistance, or current value such that when the detected voltage on the corresponding input signal transitions from above the Low Threshold plus this value, the state of the output signal shall change from *FLOAT* to *LOW*.

Tanks Tab

This Tanks Tab contains parameters for configuring tank measurement via the two resistive channels and the current loop channel. See Figure 23 for Tanks Tab detail.

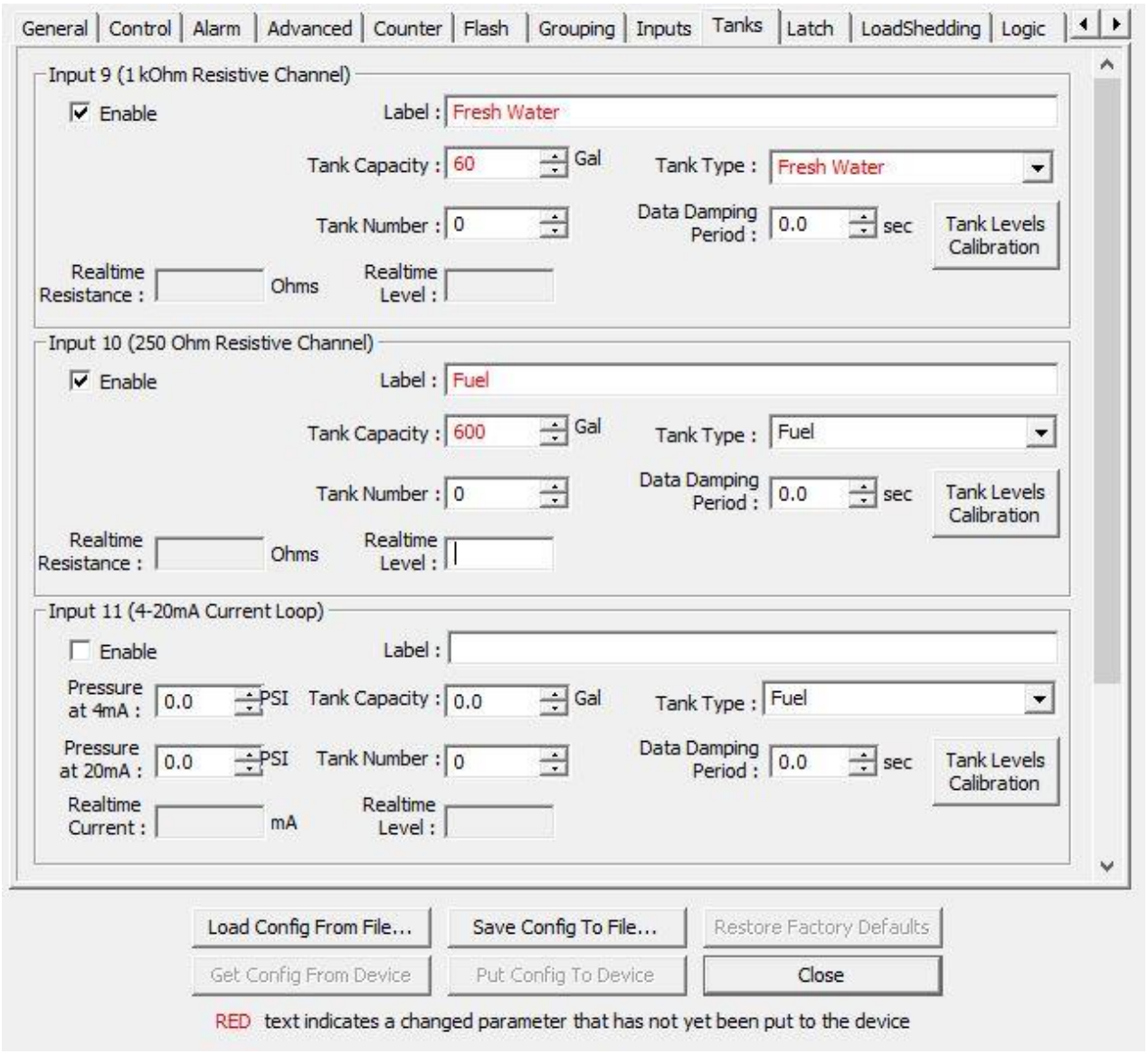


Figure 23 - Tanks Configuration Tab Dialog Box

Enable
Each resistive/current loop measurement tool can be enabled or disabled. If this box is checked, the tank level corresponding to this channel will be shown. If this box is unchecked, no tank level will be shown. As shipped from the factory, tank level channels are disabled.

The following sections describe in detail the configuration of the current loop measurement channel when it is enabled.

Label
Type a description of the tank being monitored in the field marked Label. Maretron display products will display this label text when you are selecting data to display. If the channel is disabled, no further configuration is required.

Pressure
Pressure at 4mA (Current Loop channel only)
Program this parameter to match the pressure reading of the current loop pressure transducer when it is sourcing a current of 4mA. You can determine this value by examining the specification of the pressure transducer being used.

Pressure at 20mA (Current Loop channel only)
Program this parameter to match the pressure reading of the current loop pressure transducer when it is sourcing a current of 20mA. You can determine this value by examining the specification of the pressure transducer being used.

Tank Capacity
In addition to indicating the fluid level within a tank, the channel also can be configured or programmed with the attached tank's capacity. This way, you will be able to view the tank's capacity as well as the amount of liquid remaining anywhere on the vessel where there is an NMEA 2000® compatible display.

Tank Number
Use this parameter to set the tank number for the tank level channel being configured.
The channel supports up to sixteen potential tank numbers (0 through 15) for a given type of tank.

Tank Type
This parameter allows you to set the fluid type in the tank for identification by display devices. You can configure the channel for any of these tank types:

- Fuel
- Fresh Water
- Waste Water
- Live Well
- Oil
- Black Water
- Reserved-1 through Reserved-7 (if none of the above types apply)

Data Damping Period
You can configure a damping parameter to smooth the tank level or pressure/vacuum readings or make them more responsive. The data damping is configurable between 0.2 – 25.0 seconds. The default data damping for a channel is 15.0 seconds.

Realtime Resistance
(Resistive Channels Only)
This read-only field shows the resistance currently being measured on the applicable resistive input signal.

Realtime Current
(Current Loop Channel Only)
This read-only field shows the current being measured on the current loop input signal.

Tank Levels Calibration

Pressing this button opens the Tank Calibration dialog, shown in Figure 23.
There are two methods of calibration: Manual Table and Step Fill Table

Manual Table

Using the manual table method, you enter each entry of the measured parameter (depth) and the level of fluid in the tank. The table may have as few as 2 entries (for a tank with rectangular cross-section) or as many as 16 entries (for a tank with a complex cross-section).

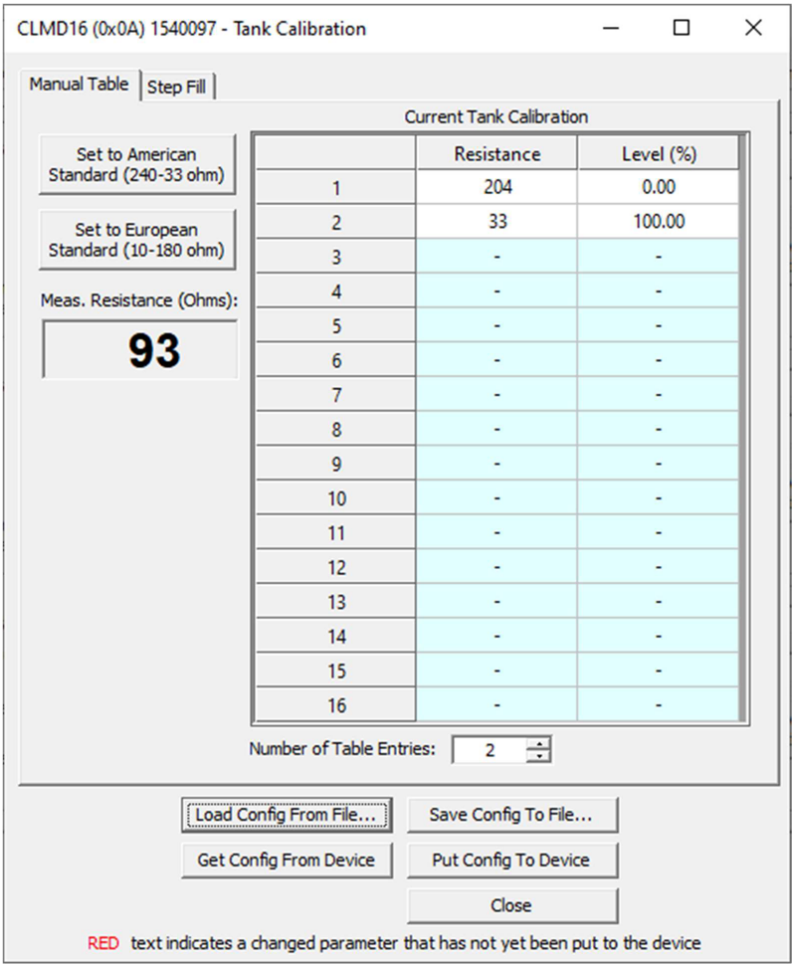


Figure 24 - Current Loop Manual Table Calibration Tank, Initial Window Dialog Box

Fluid Density
To convert the pressure measured the channel must know the density of the fluid being measured. This control allows you to program the channel with the proper fluid density. You may choose from Diesel Fuel 20, Diesel Fuel 60, Fresh Water, or you may enter a different numeric density value appropriate to the fluid whose depth is being measured.

Number of Table Entries
You may choose the number of entries to be in the calibration table. Two is sufficient for a tank with a rectangular cross-section. The channel supports up to 16 table entries for supporting tanks with more complex cross-sections.

Current Tank Calibration
This grid shows the values of the tank calibration table. Each line of the grid has two entries:

1) Tank Depth – this is the height of the fluid above the pressure sensor port
2) Level (%) – this is the percent full the tank is at the specific tank depth

Step Fill Table

In the Step Fill Table method, you start with an empty tank, and then fill the tank with fluid, stopping at intermediate points to enter the amount of fluid put into the tank thus far, ending once the tank is full. You may enter between two and sixteen calibration points. (see: Figure 25, Figure 26 & Figure 27),

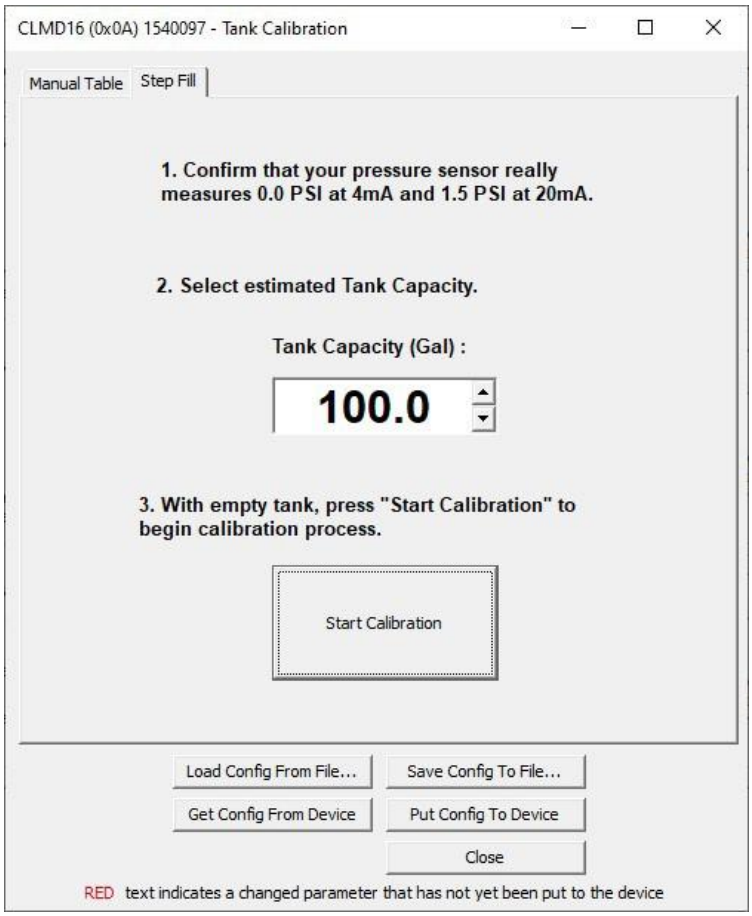


Figure 25 - Current Loop Step Fill Calibration Tank, Initial Window Dialog Box

To use this method, use the following steps:

1) Enter the estimated total capacity of the tank into the "Total Capacity" text box.
2) Press the "Start Calibration" button. You will now see the Step Fill Calibration window displayed, as shown below.

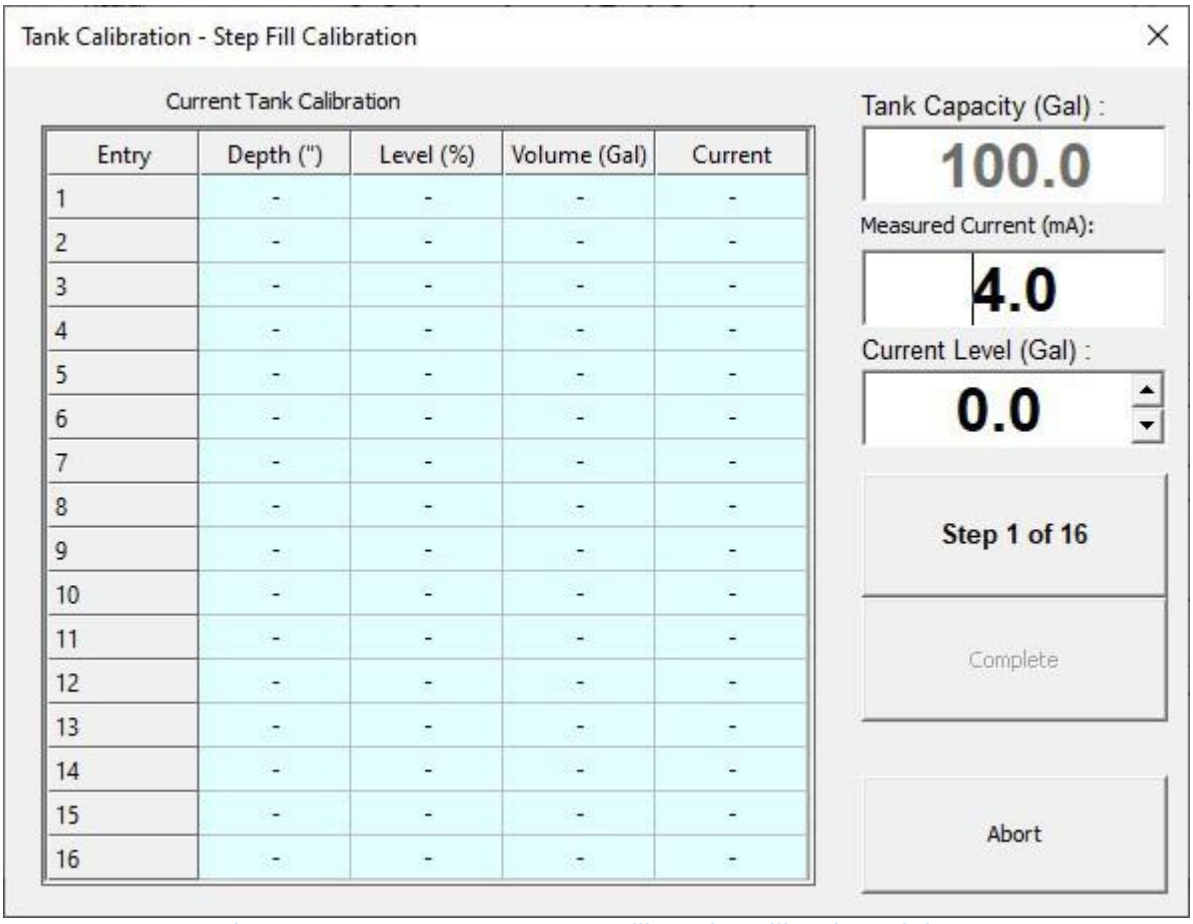


Figure 26 - Current Loop Step Fill Tank Calibration Dialog Box

3) Enter “0” into the Current Level text box, and press “Step”. You have now entered the first point of the table.
4) Partially fill the tank. Enter the amount of fluid pumped into the tank into the “Current Level” text box, and press “Step” (if you make a mistake entering a level, you can press “Back” and re-enter the level. If you want to cancel the process, press the “Abort” button).
5) Repeat the previous step until the tank is filled.

Once you have entered the last point, where the tank is 100% full, press “Complete”. This will cause the table to be stored in the device.

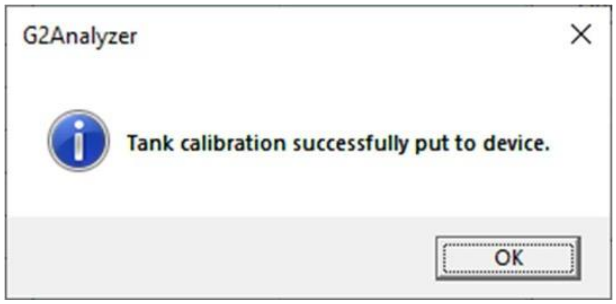


Figure 27 - Current Loop Tank Fill Confirmation Dialog Box

Latch Tab

The CLMD16 provides eight latches for use in the development of switching applications. Each latch element consists of a single SET-RESET latch. Please refer to "Latches" on page 27 for details on the implementation of this function. See Figure 28 for Latch Tab detail.

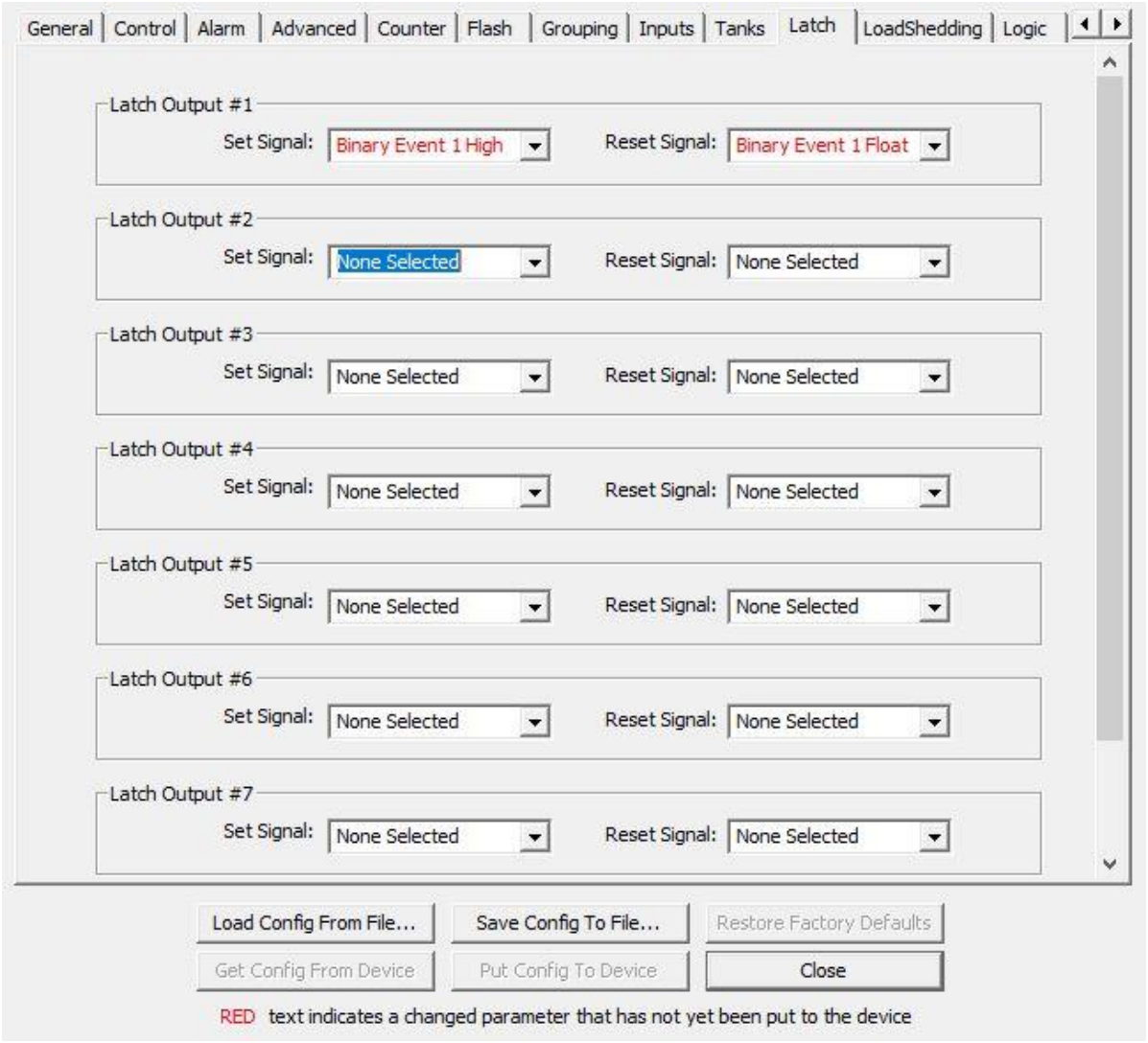


Figure 28 - Latch Configuration Tab Dialog Box

Set Signal
This parameter allows you to select the internal signal to be connected to the SET input of the latch element. You may select from the list of signals in Table 11 - Available Signal Table.

Reset Signal
This parameter allows you to select the internal signal to be connected to the RESET input of the latch element. You may select from the list of signals in Table 11 - Available Signal Table.

Load Shedding Tab

The CLMD16 implements load shedding, which allows specified loads to be turned off when the DC supply voltage drops below programmed levels. Please refer to “Load Shedding” on page 20 for details on the implementation of load shedding. See Figure 29 for Load Shedding tab detail.

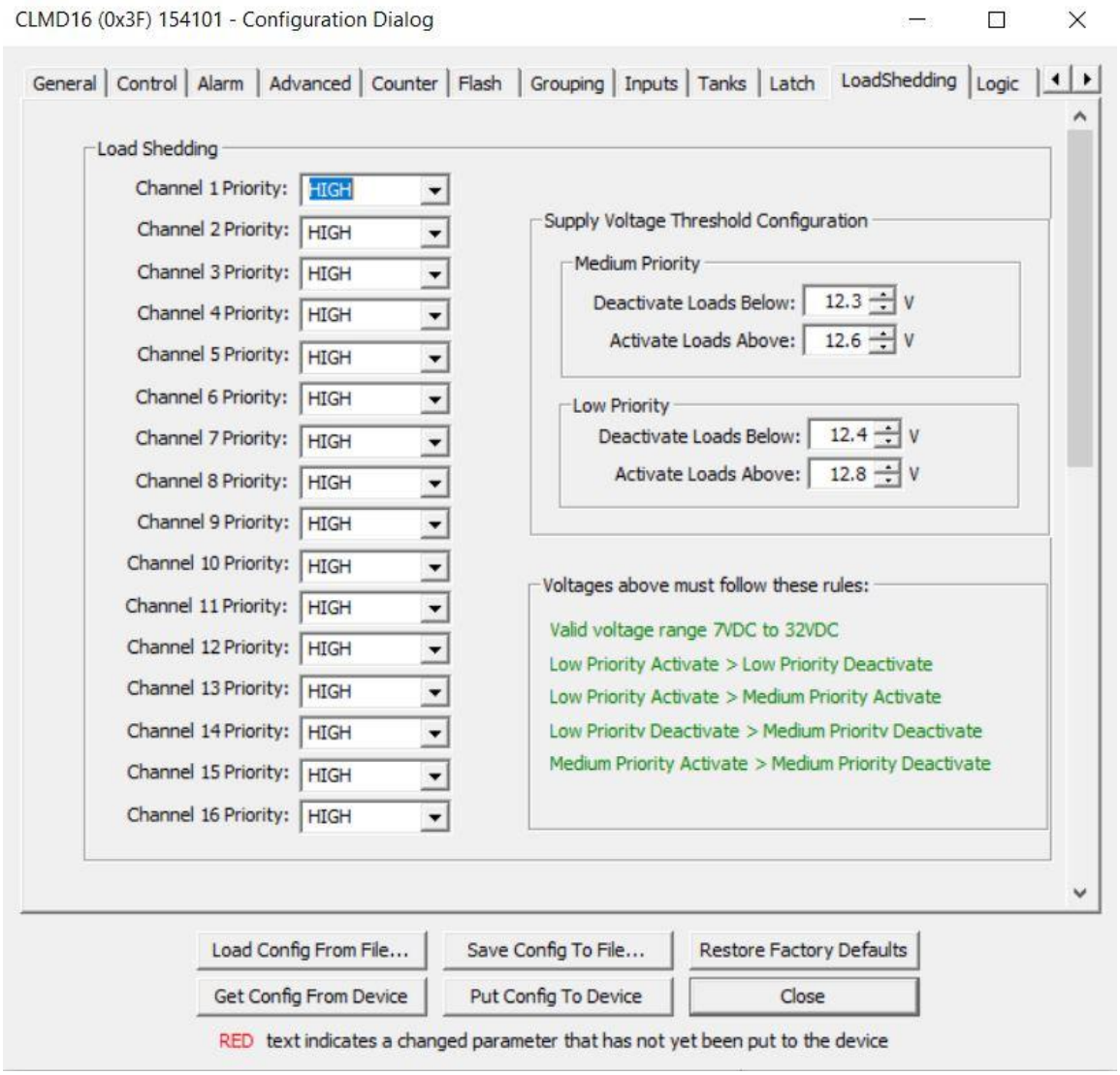


Figure 29 - Load Shedding Configuration Tab Dialog Box

Channel (x) Priority

This programmable parameter allows you to specify the priority level of the breaker channel. You may select from one of the following values:

- *HIGH* – channels with this priority are never turned off
- *MEDIUM*
- *LOW*

Medium Priority Deactivate Loads Below
This programmable parameter allows you to specify a voltage value such that when the DC supply voltage drops below this level, channels with MEDIUM priority will be disabled.

Medium Priority Activate Loads Above
This programmable parameter allows you to specify a voltage value such that when the DC supply voltage rises above this level, channels with MEDIUM priority will be enabled.

Low Priority Deactivate Loads Below
This programmable parameter allows you to specify a voltage value such that when the DC supply voltage drops below this level, channels with LOW priority will be disabled.

Low Priority Active Loads Above
This programmable parameter allows you to specify a voltage value such that when the DC supply voltage rises above this level, channels with LOW priority will be enabled.

Voltages above must follow these rules
There are several rules the voltage settings must adhere to. Each rule is highlighted in green when the rule is satisfied, and in red when the rule is not satisfied. Please ensure that all fields are highlighted in green before putting the configuration to the device or saving the configuration to a file.

Logic Tab

The CLMD16 provides eight logic elements for use in development of applications. Each logic element consists of a three-input lookup table, enabling any three-input Boolean logic function to be realized. See Figure 30 for Logic Tab detail. Please refer to “Logic” on page 29 for details on the implementation of this function.

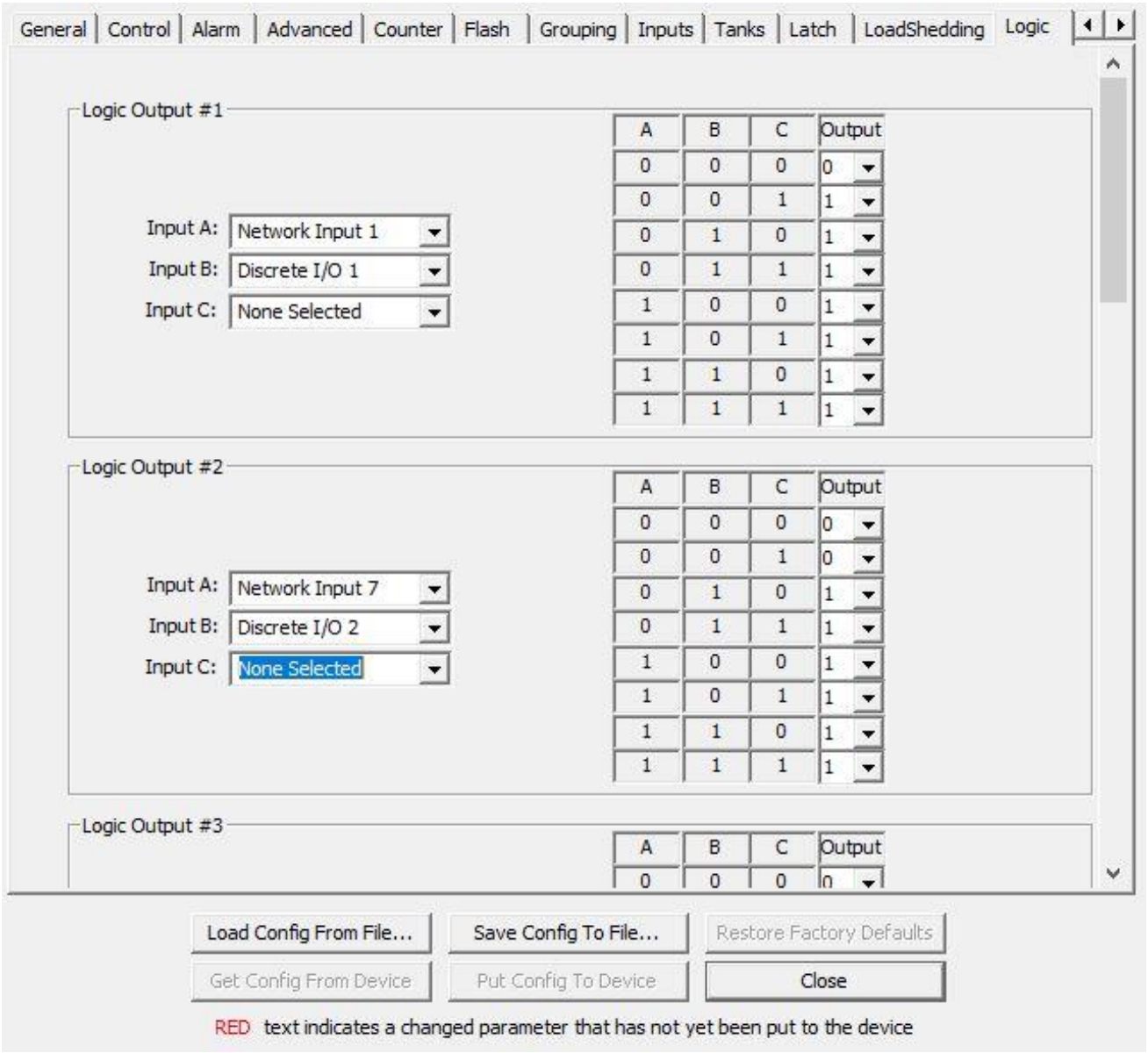


Figure 30- Logic Confirmation Tab Dialog Box

Input A
This signal is connected to the first input of the lookup table for this logic element. You may select from the list of signals in Table 11 - Available Signal Table.

Input B
This signal is connected to the second input of the lookup table for this logic element. You may select from the list of signals in Table 11 - Available Signal Table.

Input C
This signal is connected to the third input of the *lookup table* for this logic element. You may select from the list of signals in Table 11 - Available Signal Table.

Lookup Table
The lookup table consists of eight rows, one for each possible combination of values for the three input signals. Set the value in the *Output* row of the table to the desired output signal value corresponding to the *A*, *B*, and *C* signal values for that row.

Timer Tab

The CLMD16 provides eight timer elements for use in constructing switching applications. Please refer to “Timer Delay” on page 26 for details on the implementation of this function. See Figure 31 for Timer Tab detail.

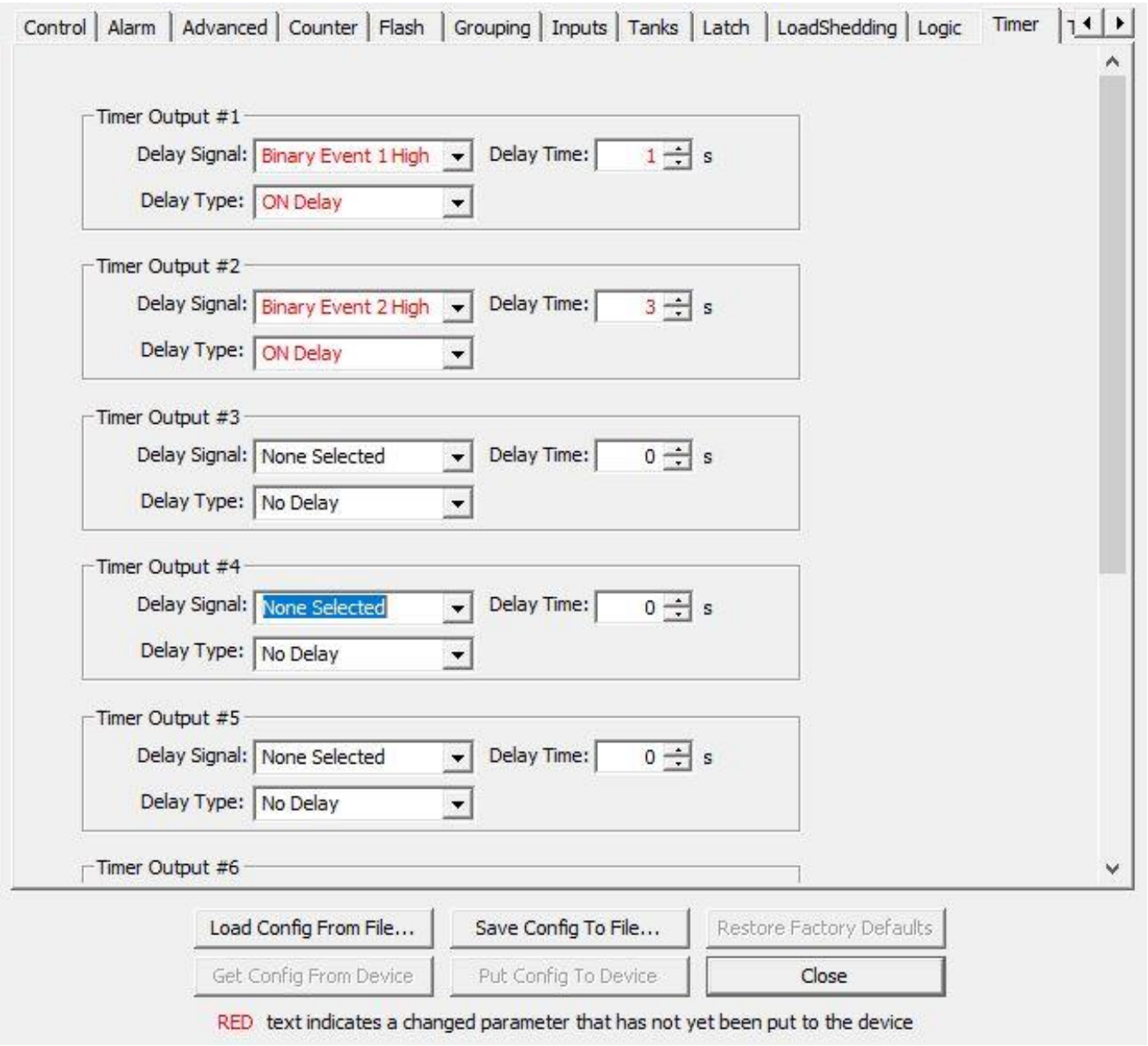


Figure 31 - Timer Configuration Tab Dialog Box

Delay Signal
This parameter allows you to select the internal signal to connect to the input of the timer element. You may select from the list of signals in Table 11 - Available Signal Table.

Delay Type
This parameter allows you to select the type of delay implemented by this timer function. You may select from one of the following choices:

- No Delay – the input signal is passed through to the output signal with no delay introduced.
- OFF Delay – the input signal is passed through to the output signal with ON to OFF transitions delayed by the time specified by the Delay Time parameter.
- ON Delay – the input signal is passed through to the output signal with OFF to ON transitions delayed by the time specified by the Delay Time parameter.

Delay Time
This parameter allows you to select the amount of time by which to delay the appropriate edges of the input signal to produce the output signal.

Toggle Tab

The CLMD16 provides eight toggle flip-flop elements for use in developing switching applications. Please refer to
Toggle on page 28 for details on the implementation of this function. See Figure 32 for Toggle Tab detail.

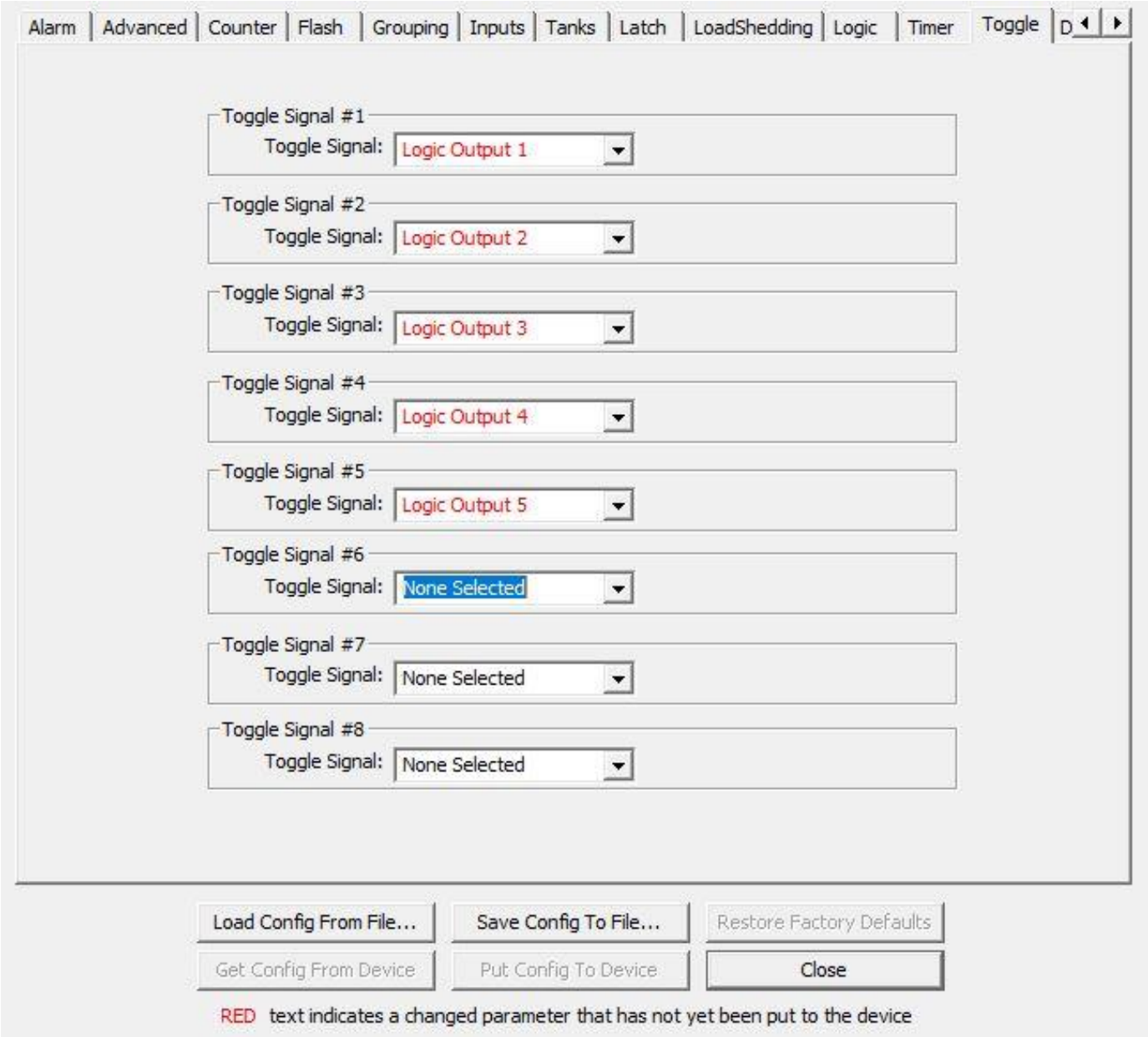


Figure 32 - Toggle Configuration Tab Dialog Box

Toggle Signal
This parameter allows you to select the internal signal to connect to the input of the timer element. You may select from the list of signals in Table 11 - Available Signal Table.

Discrete I/O Tab

When a device transmitting the 127501 Binary Status Report message is part of the installation, it can be configured to create an input signal for the CLMD16. Up to sixteen Discrete I/O signals can be programmed.
See Figure 33 for Discrete I/O Tab detail.

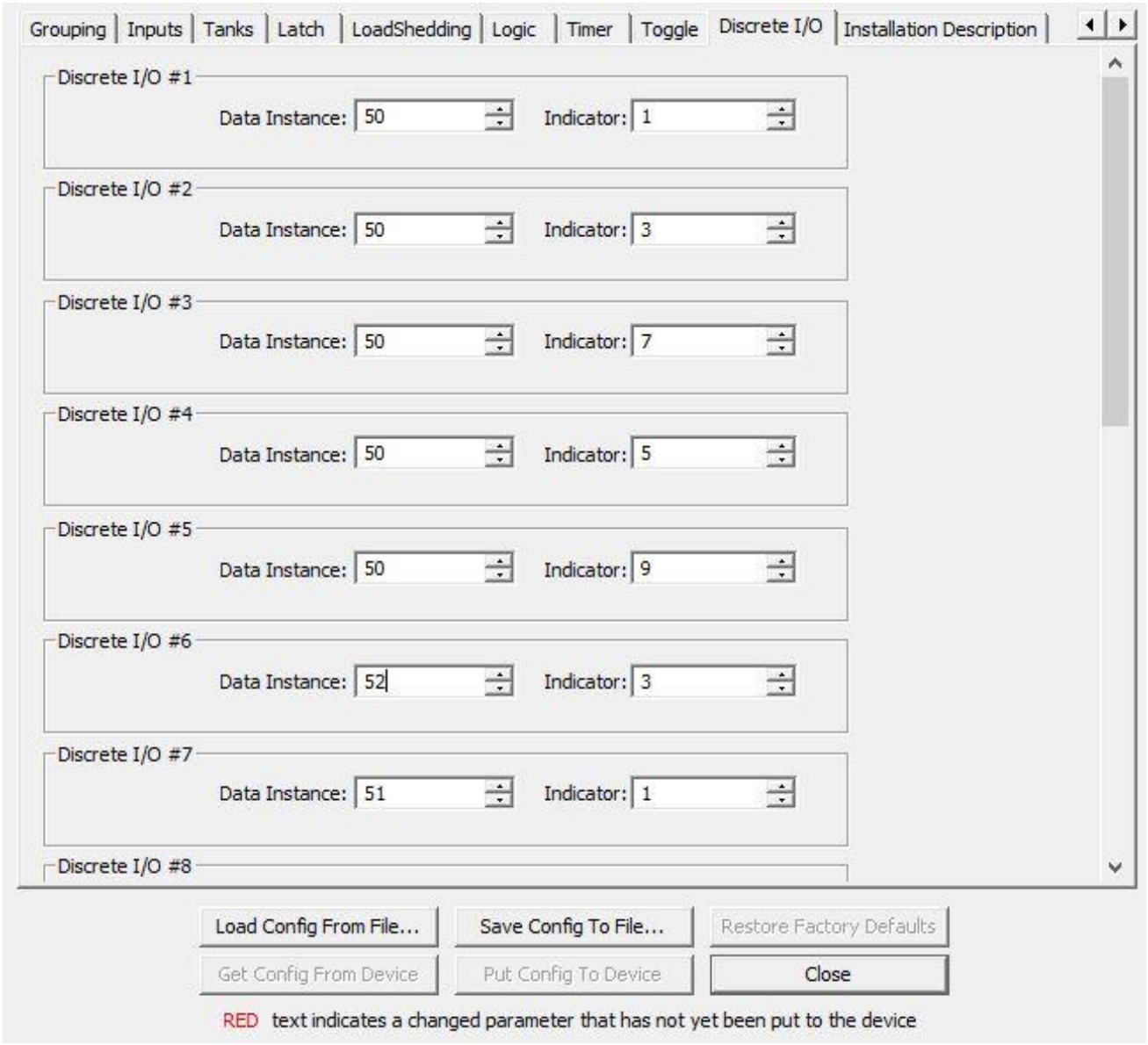


Figure 33 - Discrete I/O Configuration Tab Dialog Box

Data Instance
This parameter allows you to configure the data instance of the 127501 Binary Status Report message that will be used to create this discrete I/O signals. To assign a discrete input from this device to this discrete I/O signal, enter the instance value assign to this device (the value of the "Instance" field on the "General" tab).

Indicator
This parameter allows you to configure the indicator number within the 127501 Binary Status Report status message whose instance field matches the “Data Instance” parameter for this channel that will be used to create this discrete I/O signal.

Installation Description Tab

This tab allows you to set values for the installation description properties of the device. See Figure 34 for Installation Description Tab detail.

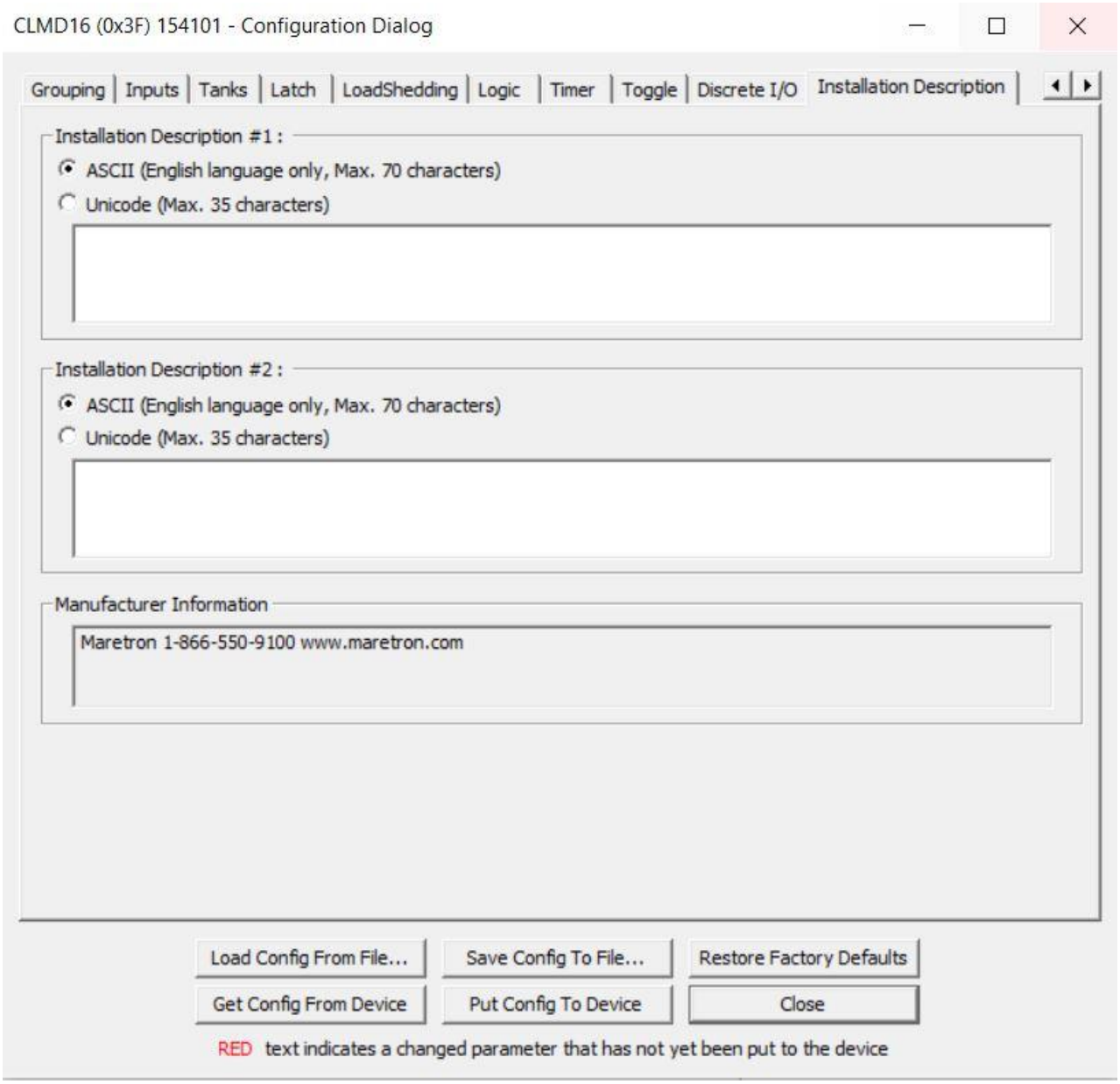


Figure 34 - Installation Description Tab Dialog Box

This device, along with all other certified NMEA devices, has two user-programmable installation description fields. You may program these fields with information specific to the device, such as date installed, the initials/name of the installer, the physical location of the device, etc. This configuration option will allow you to program the values of these fields.

Operating the CLMD16

LED Indicators

The CLMD16 has four LED indicators to show system status.

DIAG

This LED is used to indicate the state of operation of the touch controls. It can be in one of the following states:

- Dark: this indicates normal operation
- Flashing red: this indicates a failure requiring service

CAN-A

This LED indicates the state of the NMEA 2000 network connected to the connector labelled "J4 / CAN-A". It can be in one of the following states:

- Flashing blue: this indicates normal operation
- Dark: this indicates no communication is taking place
- Steady Blue: this indicates a fault on the NMEA 2000 network

CAN-B

This LED indicates the state of the NMEA 2000 network connected to the connector labelled "J5 / CAN-B". It can be in one of the following states

- Flashing blue: this indicates normal operation
- Dark: this indicates no communication is taking place
- Steady blue: this indicates a fault on the NMEA 2000 network

POWER

This Bicolor LED indicates the condition of the power being supplied to the CLMD16

- Steady green: this indicates normal operation
- Flashing green: this indicates that the unit's 125A total current limit has been exceeded
- Steady red: this indicates that the power and ground connections to the unit have been connected with reverse polarity

Breaker Status LED Indicators

Each breaker in the CLMD16 has a green LED indicator that is located on the correspondingly numbered switch on the touch panel. This LED can be in one of the following states:

- Dark: the breaker is turned OFF
- Steady green: the breaker is turned ON
- Flashing green: the breaker has been commanded to turn ON, but is turned OFF due to an overcurrent or short circuit condition

Override Switches

The CLMD16 includes a touch panel made up of capacitive touch switches to allow you to manually control the state of the breakers in the CLMD16 in the event of loss of NMEA 2000 network communication or for service purposes.

To enter override mode, press and hold the OVERRIDE switch until the green LED on the OVERRIDE switch is lit (1-2 seconds). While the green LED on the OVERRIDE switch is lit, the state of the CLMD16 breakers is controlled only by the individually numbered switches on the control panel, and all network control inputs are ignored.

Each switch has an LED that will be dark when the corresponding breaker is turned OFF and will be lit green when the corresponding breaker is turned ON. To toggle the state of a breaker, press and hold the corresponding breaker control switch until the LED changes state (about 0.5 seconds).

To exit override mode, press and hold the OVERRIDE switch until the green LED on the OVERRIDE switch is dark (about 1 second). The breakers will immediately revert to their automatically controlled state.

WARNING

The CLMD16 DC 16 Channel Load Module is operated under remote control. Before servicing any load-device connected to the CLMD16, you must first disconnect the wire between the CLMD16 load terminal and the load device. Failure to do so can result in serious bodily harm.

Maintenance

Regular maintenance is important to ensure continued proper operation of the Maretron CLMD16. Perform the following tasks periodically:

- Clean the unit with a soft cloth. Do not use chemical cleaners as they may remove paint or markings or may corrode the CLMD16 enclosure or seals. Do not use any cleaners containing acetone, as they will deteriorate the plastic enclosure.
- Ensure that the unit is mounted securely and cannot be moved relative to the mounting surface. If the unit is loose, tighten the mounting screws.

- Check the security of the cable connected to the NMEA 2000® connector and tighten if necessary.
- Check the security of all input and output connections to the unit and tighten if necessary.

Troubleshooting

If you notice unexpected operation of the Maretron CLMD16, follow the troubleshooting procedures in this section to remedy simple problems. If these steps do not solve your problem, please contact Maretron Technical Support. Refer to page 75 for contact information.

Table 12 - Troubleshooting Symptoms and Check Procedure

Symptom	Troubleshooting Procedure
No breaker/switch data visible on NMEA 2000® network.	• Ensure that the CLMD16 is properly connected to the NMEA 2000® network. • Ensure that the CLMD16 instance of the breaker/switch component matches the instance programmed into the CLMD16, as described in Advanced Tab on page 39
A breaker/switch always reads "Error"	The CLMD16 may have shut down the affected channel due to an over-temperature or over-current condition detected on the CLMD16 breaker itself. • Ensure that the current drawn by the load is less than the current rating for the connected channel. • Ensure that no short circuits or other wiring problems exist on the load circuit, and reset the channel by turning it OFF, then ON. • If the breaker or switch control returns to the error state, closely examine the load wiring for problems and ensure that the load draws the appropriate amount of current.
A breaker/switch is "ON", but the load is not powered.	• Ensure that the load is connected to the load terminal of the same CLMD16 channel that the breaker/switch component is controlling. • Ensure that the load's terminal which is not connected to the CLMD16 is connected to vessel ground. • Ensure that the connection between the breaker and the channel's power terminal is good. • Ensure that the breaker supplying power to the channel is not tripped.

You can see, but not control, the state of a breaker/switch	• If you are controlling the load via a DSM-Series display, ensure that it is running at least firmware revision 1.4.10. • If you are controlling the load via N2KView software, ensure that you have a switch control license for the software.
Any other problems	• Please refer to the CLMD16 product page on the Maretron website for additional troubleshooting suggestions.

Technical Specifications

As Carling is constantly improving its products, all specifications are subject to change without notice.

Certifications

Parameter	Comment
NMEA 2000® Standard	Certified
CE Mark	Recreational Craft Directive 2014/35/EU ISO 8846 Ignition Protection

NMEA 2000® Parameter Group Numbers (PGNs)

Description	PGN #	PGN Name	Default Rate
Periodic Data PGNs	127500	Load Controller Connection State & Control	1 time / 1.5 seconds and on switch change
	127501	Binary Status Report	1 time / 15 seconds and on switch change
	127505	Fluid Level	1 time / 2.5 seconds
	127751	DC Voltage / Current	1 time / 1.5 seconds
Response to Requested PGNs	126464	PGN List (Transmit and Receive)	N/A
	126996	Product Information	N/A
	126998	Configuration Information	N/A
	130060	Label	N/A
	126720	Proprietary	N/A
	130818	Proprietary	N/A
	130825	Proprietary	N/A
Protocol PGNs	059392	ISO Acknowledge	N/A
	059904	ISO Request	N/A
	060928	ISO Address Claim	N/A
	065240	ISO Address Command	N/A
	126208	NMEA Request/Command/Acknowledge	N/A
	126993	Heartbeat	1 time / 60 seconds

Electrical

Parameter	Value	Comment
Voltage Input Range	8 to 32 VDC	DC Voltage
Power Consumption	50 mA	NMEA 2000® Interface
Load Equivalence Number (LEN)	1	NMEA 2000® Spec. (1LEN = 50 mA)
Reverse Battery Protection	Yes	5 minutes
Load Dump Protection	Yes	12V: 87V, 200ms pulse, 1Ω impedance 24V: 173V, 100ms pulse, 2Ω impedance
12 A ECB peak current capacity	120 A	Peak Duration 400 uS
25 A ECB peak current capacity	250 A	Peak Duration 400 uS
Channel Current Measurement Accuracy	+/- 0.5 Amps	Typical
Channel Current Measurement Resolution	0.1 Amps	
Minimum Channel Current Measurement	0.5 Amps	
PWM Frequency	200 Hz	3,4,5,6,7,8,9,10,13,14,15,16
	2 kHz	1,2,11,12
Load	Inductive load interface	
Duty Cycle Range	5% - 100%	
Duty Cycle Resolution	1%	
Programmable Trip Level Resolution	1 Amp	
Analog/Digital Input Channels		
Absolute Voltage Limits	-2.3 – 36 VDC	
Input Resistance	1kΩ	
Input Voltage, Open Circuit	2.75 V	
Alarm Output		
Maximum Supplied Current	300mA	
Resistive Input Measurement Accuracy	5 Ω	
Resistive Input Measurement Precision	2 Ω	
Resistive Input Measurement Resolution	1 Ω	

Mechanical

Parameter	Value	Comment
Size	11.0" x 7.48" x 1.871" (279.4mm x 190.0mm x 47.5mm)	Including Flanges for Mounting
Weight	2.5 lb. (1.2 kg)	
Material	Polybutylene Terephthalate (PBT) (Housing) 6061 Aluminum (Back Plate)	
Power Stud Torque Value	30 to 35 in-lbs. (3.39 – 3.95 N·m)	
Ground Stud Torque Value	10 to 15 in-lbs. (1.13 – 1.69 N·m)	

Environmental

Parameter	Value
IEC 60945 Classification	Exposed
Degree of Protection	IP67
Operating Temperature	-30°C to 70°C
Storage Temperature	-40°C to 70°C
Electric Field	30V/m
Ignition Protection	Ignition Protected

Environmental Testing

Parameter	Standard	Conditions
High Temperature Soak	EN 60068-2-2:2007	Duration 96hrs, Tmax = 70°C
Low Temperature Soak	EN 60068-2-1:2007	96 hrs, Tmin = -30°C
Temperature Cycling (Operating)	IEC 60068-2-14:2009	Tmin = -30°C, Tmax = 70°C
Temperature Shock (Storage)	IEC 60068-2-14:2009	Tmin = -40°C, Tmax =70°C
External Surface Temperature Test	ISO 8846	Paragraph 4
Simulated Solar Radiation	EN 60068-2-5:2010	Procedure = B, 10 days @ 40°C
Ignition Protection	ISO 8846	
Humidity (Soak)	EN 60068-2-78:2002	RH = 93% +/-3%, Exposure 10 days
Humidity - Cyclic	EN 60068-2-30:2005	RH (> 90%), 6 cycles of 24hrs
Dust Ingress	IEC 60529:2001	Method EN60529 Section 13 Result IP6X
Water Ingress	DIN 40050-9:1993 IEC 60529:2001	Method as DIN 40050-9 Result IPX7
Mechanical Shock - Drop Test	EN 60068-2-32:1993	1000mm free-fall, all faces of 3 axes
Mechanical - Shock	60068-2-27:2009	500m/s^2, pulse duration 11ms
Mechanical - Bump	60068-2-29:1993	400m/s^2 6ms shock pulses, 3 axes
Vibration (General)	60068-2-6: 1996	Sine shaped sweep 5 Hz to 500 Hz
Vibration (Random)	EN 60068-2-64:1995	Method 1
Vibration (Resonant Search)	60068-2-6: 1996	frequency range 10 Hz – 2 kHz @ 5G
Chemical Resistance	EN 60068-2-74:2000	Test method = B
Salt Spray	EN 60068-2-52: 1996	Severity=4, Duration: 96 hours
Electrical (Operating Voltage)	SAE J1455:2011 Sect 4.13.1	Test for impaired function
Electrical (Over Voltage)	SAE J1455:2011 Sect 4.13.1	Test for impaired function +24V, +36V
Electrical (Reverse Polarity)	SAE J1455:2011 Sect 4.13.1	Test for impaired function -24V, -36V
Electrostatic Discharge (ESD)	ISO 13766:2006	+/- 8 kV (Direct), +/- 15 kV (Air)

Technical Support

If you require technical support for Maretron products, you can reach us in any of the following ways:

Telephone: 1-866-550-9100
Fax: 1-602-861-1777
E-mail:marine.support@carlingtech.com
World Wide Web: http://www.maretron.com
Mail: Carling Technologies, Inc.
Attn: Maretron Technical Support 120 Intracoastal Pointe Dr.
Jupiter, FL 33477 USA

Figure 35 - Product Manual QR Code

Scan this QR code with your smartphone for full technical information and a copy of this installation manual.

Maretron (2 Year) Limited Warranty

Carling Technologies warrants the Maretron® CLMD16 to be free from defects in materials and workmanship for two (2) years from the date of original purchase. If within the applicable period any such products shall be proved to Carling's satisfaction to fail to meet the above limited warranty, such products shall be repaired or replaced at Carling's option. Purchaser's exclusive remedy and Carling's sole obligation hereunder, provided product is returned pursuant to the return requirements below, shall be limited to the repair or replacement, at Carling's option, of any product not meeting the above limited warranty and which is returned to Carling; or if Carling is unable to deliver a replacement that is free from defects in materials or workmanship, Purchaser's payment for such product will be refunded. Carling assumes no liability whatsoever for expenses of removing any defective product or part or for installing the repaired product or part or a replacement therefore or for any loss or damage to equipment in connection with which Maretron® products or parts shall be used. With respect to products not manufactured by Carling, Carling's warranty obligation shall in all respects conform to and be limited to the warranty actually extended to Carling by its supplier. The foregoing warranties shall not apply with respect to products subjected to negligence, misuse, misapplication, accident, damages by circumstances beyond Carling's control, to improper installation, operation, maintenance, or storage, or to other than normal use or service.

THE FOREGOING WARRANTIES ARE EXPRESSLY IN LIEU OF AND EXCLUDES ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE.

Statements made by any person, including representatives of Carling, which are inconsistent or in conflict with the terms of this Limited Warranty, shall not be binding upon Carling unless reduced to writing and approved by an officer of Carling.

IN NO CASE WILL CARLING BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, DAMAGES FOR LOSS OF USE, LOSS OF ANTICIPATED PROFITS OR SAVINGS, OR ANY OTHER LOSS INCURRED BECAUSE OF INTERRUPTION OF SERVICE. IN NO EVENT SHALL CARLING'S AGGREGATE LIABILITY EXCEED THE PURCHASE PRICE OF THE PRODUCT(S) INVOLVED. CARLING SHALL NOT BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES, WHETHER ARISING OUT OF BREACH OF CONTRACT OR WARRANTY, TORT (INCLUDING NEGLIGENCE), OR OTHER THEORIES OF LAW WITH RESPECT TO PRODUCTS SOLD OR SERVICES RENDERED BY CARLING, OR ANY UNDERTAKINGS, ACTS OR OMISSIONS RELATING THERETO.

Carling does not warrant that the functions contained in any software programs or products will meet purchaser's requirements or that the operation of the software programs or products will be uninterrupted or error free. Purchaser assumes responsibility for the selection of the software programs or products to achieve the intended results, and for the installation, use and results obtained from said programs or products. No specifications, samples, descriptions, or illustrations provided Carling to Purchaser, whether directly, in trade literature, brochures or other documentation shall be construed as warranties of any kind, and any failure to conform with such specifications, samples, descriptions, or illustrations shall not constitute any breach of Carling's limited warranty.

Warranty Return Procedure:

To apply for warranty claims, contact Carling Technologies or one of its Maretron dealers to describe the problem and determine the appropriate course of action. If a return is necessary, place the product in its original packaging together with proof of purchase and complete a Return Merchandise Authorization (RMA) on the following web page:

https://www.maretron.com/rma_request.php

You will be contacted by email with instructions on where to send the unit for repair / evaluation. You are responsible for all shipping and insurance charges. Carling will return the replaced or repaired product with all shipping and handling prepaid except for requests requiring expedited shipping (i.e., overnight shipments). Failure to follow this warranty return procedure could result in the product's warranty becoming null and void.

Carling reserves the right to modify or replace, at its sole discretion, without prior notification, the warranty listed above. To obtain a copy of the then current warranty policy for Maretron® products, please go to the following web page:

http://www.maretron.com/company/warranty.php

Appendix A – NMEA 2000® Interfacing

This appendix is intended to relate specific characteristics of the CLMD16 to how they are communicated via NMEA 2000® messages in order to help ascertain whether the messaging implemented by the CLMD16 is compatible with other NMEA 2000® products. It is not a complete description of the messages. If you require detailed information on the messages, please obtain a copy of the NMEA 2000® standard documents from the National Marine Electronics Association (www.nmea.org).

CLMD16 NMEA 2000® Periodic Data Transmitted PGNs

PGN 127500 – Load Controller Connection State/Control

The CLMD16 uses this PGN to transmit the state of each of the breakers. A separate occurrence of this message will be transmitted for each breaker. The state of each breaker may be controlled by issuing a 126208 NMEA Command for this message addressed to this device.

Field 1: Sequence ID – This field is transmitted with a value of 255.
2: Connection ID – This field identifies the output channel (breaker) whose status is being reported in this message. The value of this field will be in the range of 0 (Breaker #1) through 15 (Breaker #16).
3: State – This field indicates the state of the solid-state breaker.
4: Status – This field indicates the status of the solid-state breaker.
5: Operational Status & Control – This field is used to lock and unlock the solid-state breaker.
6: PWM Duty Cycle – This field is used to control and report the PWM duty cycle of the solid-state breaker.
7: Time ON – This field is used to report the ON time if the solid-state breaker is running under the control of a flash element.
8: Time OFF – This field is used to report the OFF time if the solid-state breaker is running under the control of a flash element.

PGN 127501 – Binary Status Report

The CLMD16 uses this PGN to transmit the state of each of the breakers and connected switch inputs. The state of the breakers may be controlled by issuing a 126208 NMEA Command for this message addressed to this device.

Field 1: Indicator Bank Instance – This field identifies the particular switch bank to which this PGN applies. Please refer to Instance on page 32 for instructions on how to program the value of this field.
2: Indicator #1 – This field indicates the state of the solid-state breaker on output channel #1. The state will be one of the following values:
- "OFF" – The breaker is open – no current is supplied to the load.
- "ON" – The breaker is closed – current is supplied to the load.
- "Error" – The breaker is open due to an error condition.

3 to 16: indicates the state of the solid-state breaker on outputs on channels 2 to 16 respectively.
18: Indicator #17 – This field indicates the state sensed by the digital input on input channel #1.

The state will be one of the following values:
"OFF" – The digital input voltage level is outside the range(s) programmed for "ON" levels
"ON" – The digital input voltage level is inside the range(s) programmed for "ON" levels
Please refer to Binary Event Monitor on page 22 for details

19 to 25: Indicates the state sensed by the digital input on input channel 2 to 8 respectively.

PGN 130314 – Actual Pressure

The CLMD16 uses this PGN to provide a regular transmission of various pressures. The factory default for periodic transmission rate is once every two seconds. The transmission of this PGN can be disabled (see PGN 126208 – NMEA Request Group Function – Transmission Periodic Rate).

Field 1: SID – The sequence identifier field is used to tie related PGNs together. For example, the CLMD16 will transmit identical SIDs for 130312 (Temperature) and 130311 (Environmental Parameters) to indicate that the readings are linked together (i.e., the data from each PGN was taken at the same time although they are reported at slightly different times).

2: Pressure Instance – The CLMD16 sets this field to identify a particular pressure measurement from the source specified in Field 3. Every pressure measurement from a given source type on the network should have a distinct instance value, so that monitoring devices and displays can identify which measurement is which.

3: Pressure Source – This field is used to indicate the type of pressure measurement being taken. Possible values for this field include Atmospheric Pressure, Water Pressure, Steam Pressure, Compressed Air Pressure, Hydraulic Pressure, and 16 User Defined pressure sources.

4: Pressure – This field is used to indicate the pressure, whose source is specified in field 2, in units of 0.1 Pa.

6: Reserved bits – The CLMD16 sets all bits in this field to a value of "1".

PGN 127505 – Fluid Level

The CLMD16 uses this PGN to indicate the attached tank's fluid instance, fluid type, fluid level, and tank capacity.

Field 1: Fluid Instance – This field is used to identify the tank number and ranges between 0 and 15. There can be up to 16 tanks of a given type as defined by the Fluid Type field. This field is programmable through the NMEA command PGN. The CLMD16 ships from the factory with a default value of zero.

2: Fluid Type – This field identifies the type of fluid contained within the tank. Currently the defined fluid types are fuel, fresh water, wastewater, live well, oil, and black water. This field is programmable through the NMEA command PGN. The CLMD16 ships from the factory with a default value of 0x0 indicating "Fuel".

3: Fluid Level – This field is used to indicate the current fluid level in percentage. The value transmitted in this field depends on the distance from the sender to the top of the fluid or tank bottom.

4: Tank Capacity – This field is used to indicate the tank capacity. This field is programmable through the NMEA command PGN. The CLMD16 ships from the factory with a default value of 0xFFFFFFFF indicating "Data Not Available".
5: Reserved – This field is reserved by NMEA; therefore, the CLMD16 sets all bits to a logic 1.

PGN 127751 – DC Voltage/Current

The CLMD16 uses this PGN to transmit DC voltage and current information.

Field 1: Sequence ID – This field is transmitted with a value of 255.
2: Connection ID – This field identifies the output channel (breaker) whose status is being reported in this message. The value of this field will be in the range of 0 (Breaker #1) through 15 (Breaker #16) or 16 (Analog / Digital Input #1) through 23 (Analog / Digital Input #8)
3: DC Voltage – This field indicates the DC voltage sensed on the load or analog/digital input pin
4: DC Current – This field indicates the DC current sourced by the load (this field shall be set to "Data Not Available" for analog/digital inputs
5: Reserved bits – The CLMD16 sets all bits in this field to a value of "1"