Cattron™ CBMCU

User Manual

9M02-9345-A001-EN

CONNECT. CONTROL. PROTECT.

Revision History

VERSION	DATE	NOTES
1.0	08-01-23	Initial Release per ECO-23-0315
2.0	06-10-24	Updated with additional information on LED indication and CANbus Interface

Contents

1. Introduction

This manual relates to Cattron's CBMCU a CAN Based Machine Control Unit. The information is of a general nature and does not include system-specific configuration data. System-specific data is provided in the technical documentation accompanying the delivery of the system or in the relevant 'Standard Configuration Sheet'.

For information pertaining to any matching Operator Control Unit (OCU), please refer to the separate OCU user manual.

1.1 Terminology

The following represents important acronyms and long form names used in this document:

- OCU – Operator Control Unit, historically referred to as a *transmitter*
- MCU – Machine Control Unit, historically referred to as a *receiver*
- ASO – Automatic Safety Override; in this unit, fully automatic system shutdown made possible by the use category 3 architecture coupled with cascading digital outputs with multi-stage monitoring and a CAN data system handled and verified by both microcontrollers to ensure 100% accuracy on data handling.
- OTA – Over The Air primarily related to RF communication
- Firmware – The Operating system or embedded programming responsible for the devices core safety and feature set.
- Configuration – The parameters used by the firmware to the set the functionality such as RF Frequency, Addressing, CAN and digital mapping etc.
- UI – User interface
- Software – The program running on the PC used to interface with the device and providing the UI for programming, configuration and data-log download.

2 Warnings and Cautions

2.1 Warnings

WARNING statements have been strategically placed throughout all text prior to operating or maintenance procedures, practices, or conditions considered essential to the protection of personnel or equipment and property. A WARNING applies each time the related step is repeated. Before starting any task, the WARNINGS included in the text for the task should be reviewed and understood.

WARNINGS appearing in this manual follow the general format below.

	**WARNING**
	Description of warning Possible consequence of non-compliance

2.2 General Safety Information

- Persons under the influence of drugs, alcohol and/or other medicine that impairs reaction may not assemble, disassemble, install, put into operation, repair or operate the product.
- All conversions and modifications of an installation or system must conform to the relevant safety requirements.
- Only qualified, trained, authorized personnel may perform work on the equipment, in accordance with the relevant safety requirements.
- In the event of malfunction and/or visible defects or irregularities, the product must be stopped, switched off, and isolated.

	**WARNING**
	Observe the statutory regulations and directives applicable for the intended purpose, e.g.: Accident prevention regulations Safety rules and directives Standards Generally applicable statutory and other binding regulations for accident prevention and environmental protection, and general safety and health requirements.

- Ensure that users have access to the user manual.
- The personnel assigned to work on/with the product must have read and understood this operating manual and the safety instructions.
- The safety instructions must, if necessary, be supplemented by the user with instructions concerning the work organization, work sequences, qualified personnel, etc.
- All repairs made during the warranty period must be carried out by the manufacturer or appointed authorized service center; failure to comply will invalidate the warranty.
- All repairs made should be carried out in a suitably clean static-safe environment, free from contaminants such as metal filings, water, oil, etc.

- It is the user's responsibility to ensure that the product always operates in good condition and that all applicable safety requirements and regulations are observed.
- Product modifications may not be carried out without the consent of the manufacturer.
- Original spare parts from the manufacturer must be used.
- Carry out periodic inspections and/or maintenance either required by law or prescribed in the user manual within the required intervals.

2.3 Improper Use

Ensure compliance with equipment ratings and operate only as intended, in particular:

- Ensure the machine is in a safe state before installation/maintenance
- Check that power supply voltage / polarity is correct
- Do not misuse or exceed operating specifications
- Ensure periodic maintenance routines are observed

	**CAUTION** Damage to the device: Do not exceed the units ratings including its environmental ratings, for environments harsher than rated, use an appropriate secondary enclosure. Neglecting the above can result in danger for life and limb and/or cause physical damage to the product or the environment.

2.4 Safety Instructions for Assembly / Disassembly

- Isolate the system from the electrical power.
- Observe user-specific regulations.
- Only use suitable tools.
- Secure the installation area.

2.5 System Addressing

To ensure safe operation, systems are configured with a unique address, this may be automatic or manually assigned.

	**CAUTION** Conflict of Addresses: Addresses are never repeated and must be System Unique. The user must ensure that the system address and addressing mode is used as designed. If the address has been manually assigned it must be ensured that there is never a duplication of address on any other systems in the operating area over the entire life of the system. In the event of a breach of this undertaking, the user is liable for any resulting damage/loss and shall indemnify the manufacturer against all third-party liability claims.

3 What is CBMCU

The CBMCU is in effect a mid-complexity level Safety PLC that incorporates dual CAN (J1939 or CANopen or CANopen Safety) and solid-state digital outputs.

The Architecture and operation of these interfaces meet a functional safety level PLd according to EN ISO 13849.

CBMCU can operate either in conjunction with one or more compatible Operator Control Units, (OCUs), or in conjunction with one or more other CBMCUs, or combination thereof, or in isolation as a machine control PLC.

CBMCU achieves its Functional Safety level by employing a full category 3 architecture, dual cross channel handling and monitoring of all CAN data and digital output states.

4 Typical System Overview

While many variations are possible, a typical system comprises a CBMCU plus one or two OCUs plus accessories.

Additionally, systems may include more than one CBMCU that allow for example tandem (dual machine) control.

Compatible OCUs include the 411, 611, 325 and Safe-D-Stop OCUs as well as CattronControl™ LRC-S, LRC-M and LRC-L but this list is being continuously expanded, refer to Cattron's website for the most up to date information.

Any OCUs and the CBMCU are linked by a secure RF communication system and the CBMCU drives the machine via the chosen interface (CAN, digital or both). Therefore, the machine is under the direct control of the OCU and hence operator.

The CBMCU is available with standard configurations or custom designed configurations tailored to control most applications, this provides a great deal of flexibility to make the solution exactly fit your needs.

Standard Systems configurations, and other media are available on the www.Cattron.com website under the specific product resources tab.

These systems feature an ability to wirelessly connect to the OCU or CBMCU over Bluetooth® and upgrade firmware to take advantage of new features as they are released as well as the ability to wirelessly change configuration items such as frequency, address, digital or CAN functionality, or examine data-logs etc.

5 CBMCU Overview

These MCUs have been designed with the latest generation safety electronics and firmware and exceed the safety related systems requirements for ISO13849 Category 3 PLd for the stop function and control functions.

The CBMCU is equipped with two antenna ports, that provide antenna diversity for the operating frequency to provide the best possible RF communication, the typical operating range is dependent on the regulatory restrictions associated with the operating frequency and local environment, typically for sub-GHz this is 150-180m (500-600ft) and for 2.4GHz 180-240m (600-800ft).

The MCU incorporates a wide range 9-36VDC supply designed to operate in a harsh mobile environment.

Status and feedback are provided by multiple Tri and Bi colored LEDs for power and general status.

The CBMCU is housed in a compact fully screened aluminum enclosure to meet the challenging environmental and electromagnetic standards required for mobile applications.

Approved to comply with the appropriate Safety standards applicable to the region or country of use.

5.1 CBMCU Key Features

Next generation design meeting performance Level d (PL-d) according to EN ISO13849 for all digital outputs, additionally CAN support is realized in a full category 3 architecture ensuring total fidelity of the CAN messaging independently of the CAN protocol.

RF diversity and a carefully designed matching set of antennas provide ultra-reliable communication in the required operating frequency band.

A Wide-range power supply covering 9-36VDC, engineered for mobile applications.

Bluetooth® closed box link for wireless uploads and downloads.
Providing access to.

- Firmware upgrades.
- Unit Configuration such as frequency, address, CAN setup etc.
- Functional Configuration changes such as digital mapping, CAN mapping etc.
- Downloads of Diagnostics and Logged Data.

Diagnostics and data logging are built in and record warnings, faults, changes, totalizers, durations etc., with real time clock onto an internal SD card able to store an extensive amount of data. Data analytics can be linked to enable planned maintenance of system and machine.

Two tri-color and six bi-color LEDS provide quick and intuitive status information.

Eight 9-36VDC Solid State PLd outputs, two at 10A and six at 4A, all support hit and hold PWM functionality and up to two may be defined as main power control outputs.

Dual category 3 PLd CAN ports each supporting either J1939 2.0B 250-500kbs, CANopen or CANopen Safety at data rates of 10kbs to 1MBs.

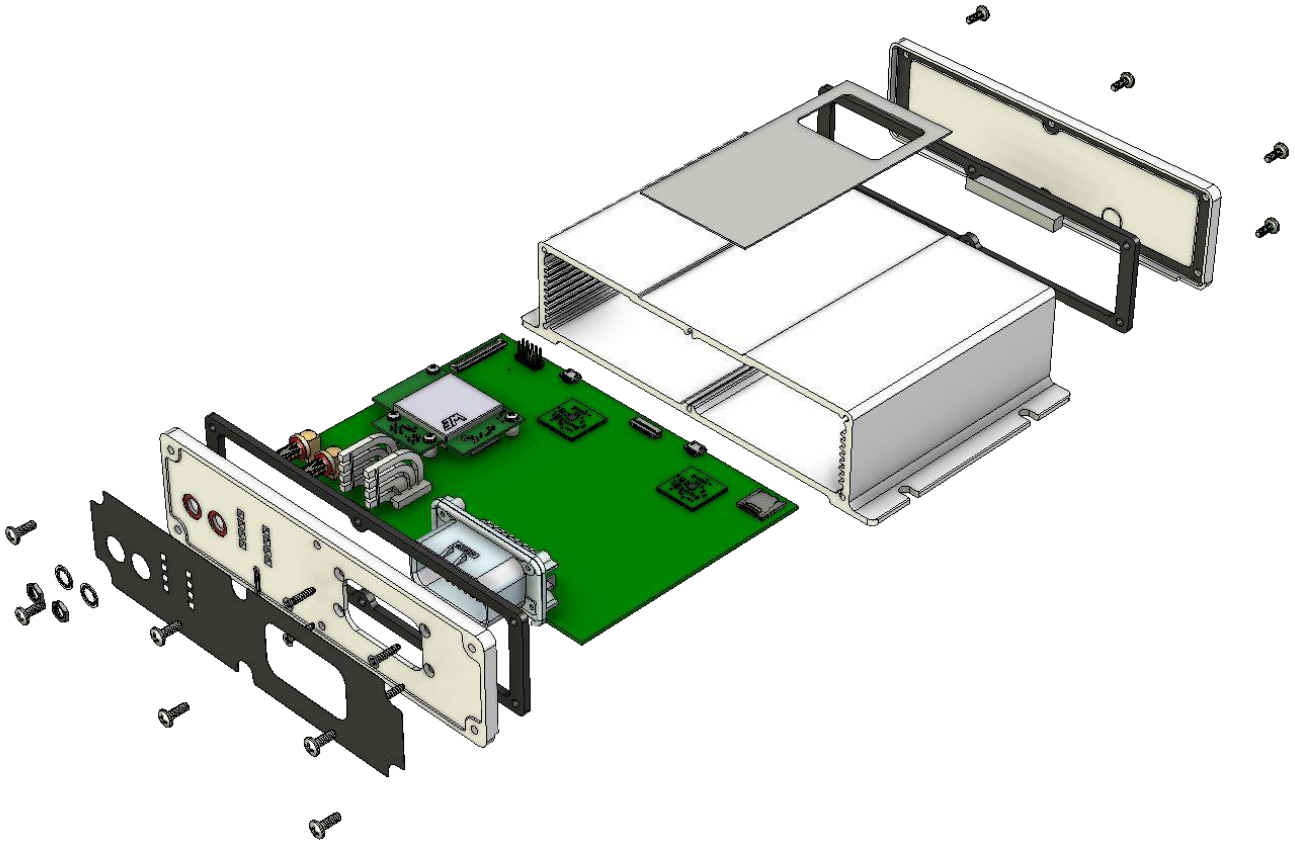
A 23 pin AMP connector PROVIDES all interface connections, each unit is provided with a pre-wired matching Plug and 2m cable.

The compact fully screened aluminum enclosure is rated at IP66 and is pre-drilled for four easy to access mounting attachment points. The full aluminum housing ensures that the electronics are fully protected from high levels of electromagnetic interference.

6 CBMCU Mechanical and Installation

6.1 Main Assembly

Figure 1 Exploded view



The MCU is a sealed assembly and because configuration is mostly via Bluetooth® opening the enclosure is not normally required.
The main body is an aluminum extrusion, and it has two sealed end caps, the rear end cap is secured by 6 screws and would not normally need to be accessed.
The front-end cap is directly attached to the printed circuit assembly, if it is necessary to access the electronics then remove the front 6 screws and slide the electronic assembly out, this should only be done in a clean dry environment. The MCU has two side flanges with slots for securing the MCU to a fixing location with screws.

6.2 Mounting Details

Figure 2 Mounting dimensions main enclosure

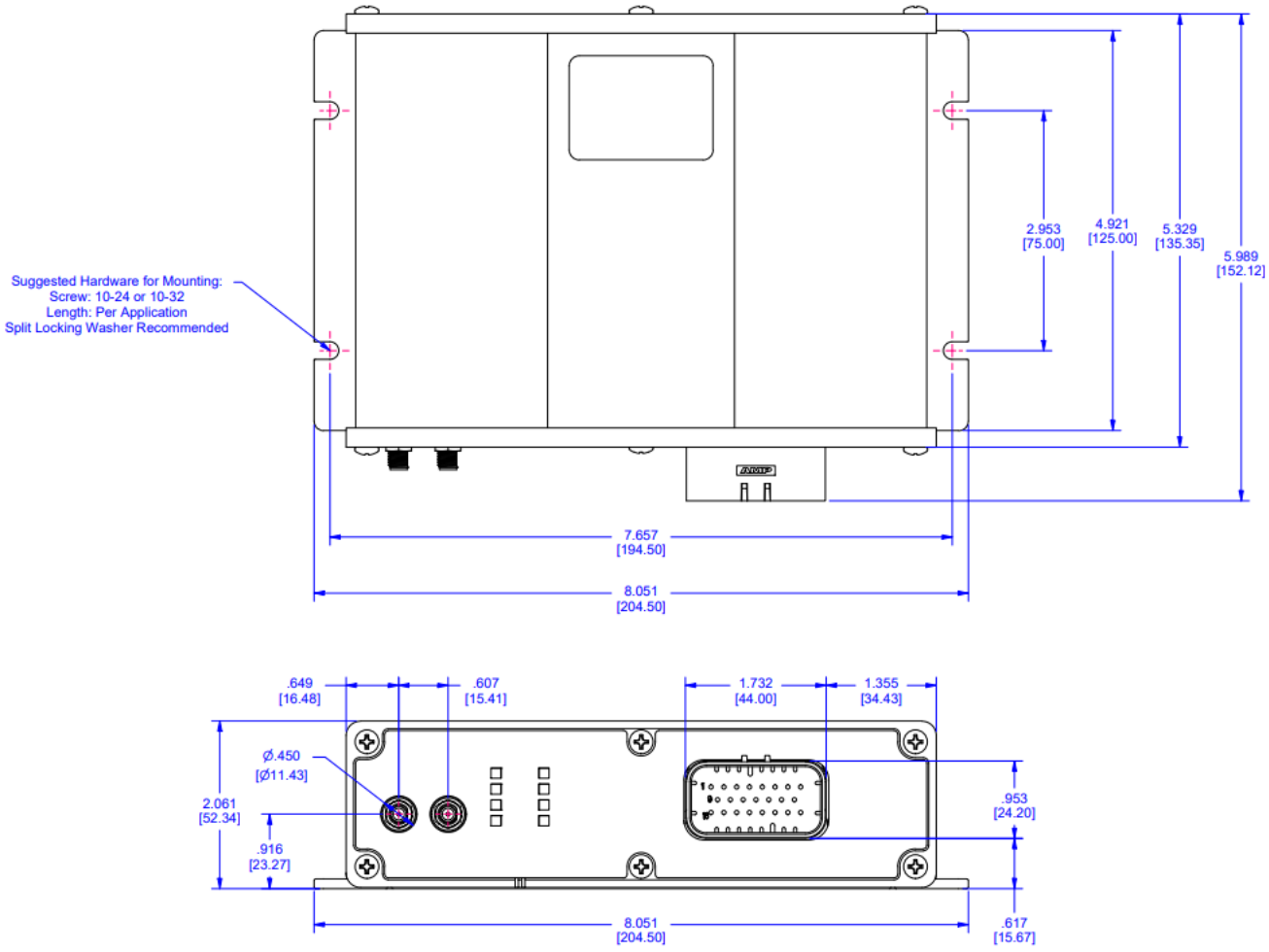
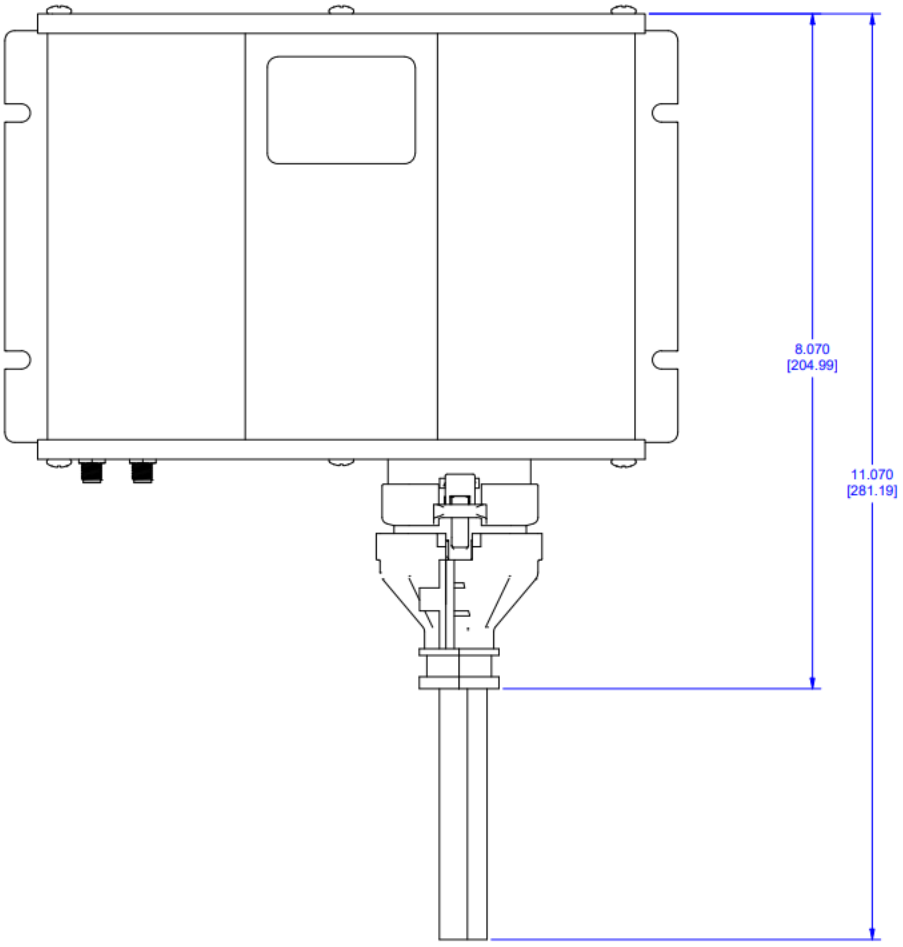


Figure 3 Mounting dimensions multi-IO connector



6.3 Module Installation

The MCU should ideally be mounted in a location that is protected from heat and constant vibration, in all cases ensure the unit does not exceed its environmental specifications. Allow clearance for the antenna and multi-pin connector cables, ensure the antenna cables are not kinked.
Positioning that allows the LEDs to be viewed can be advantageous when checking status.
There are 4 slots in the mounting flanges, each slot is 5mm (3/16 inch) wide so able to take M4, M4.5 or size 10 screws, A spring and flat washer should be used above the flange.

6.4 Antenna(s) Installation

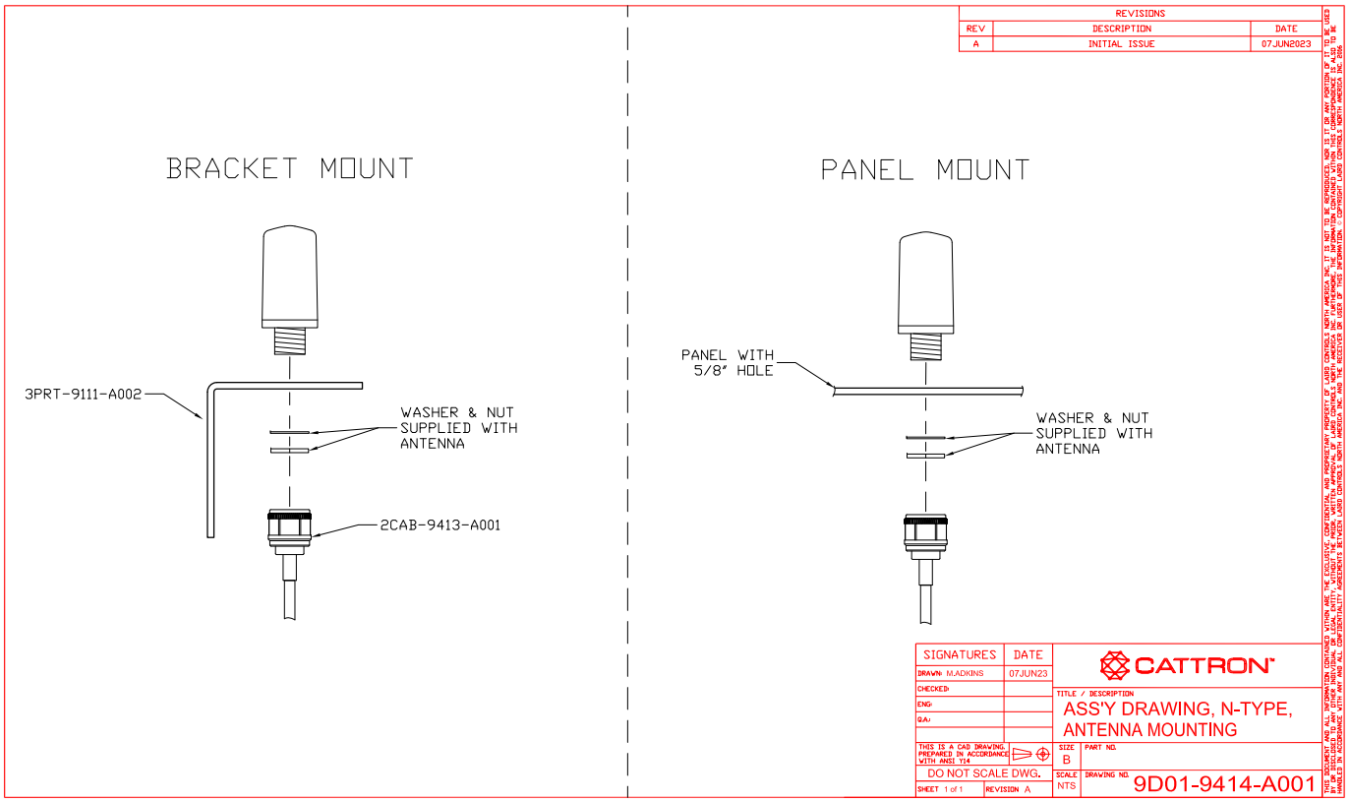
The CBMCU system is supplied as standard with two antennas and line kits.

To ensure optimum communication, the OCU and MCU antennas should ideally maintain line of sight for best operating distance and any solid obstacles such as solid walls or dirt mounds avoided.

The antennas are normally mounted directly on the machine or on the angle brackets provided as shown below.

The Coaxial cables should be securely connected to the antennas and the two connectors on the MCU, if only using one antenna the other unused antenna connector on the MCU should be capped.

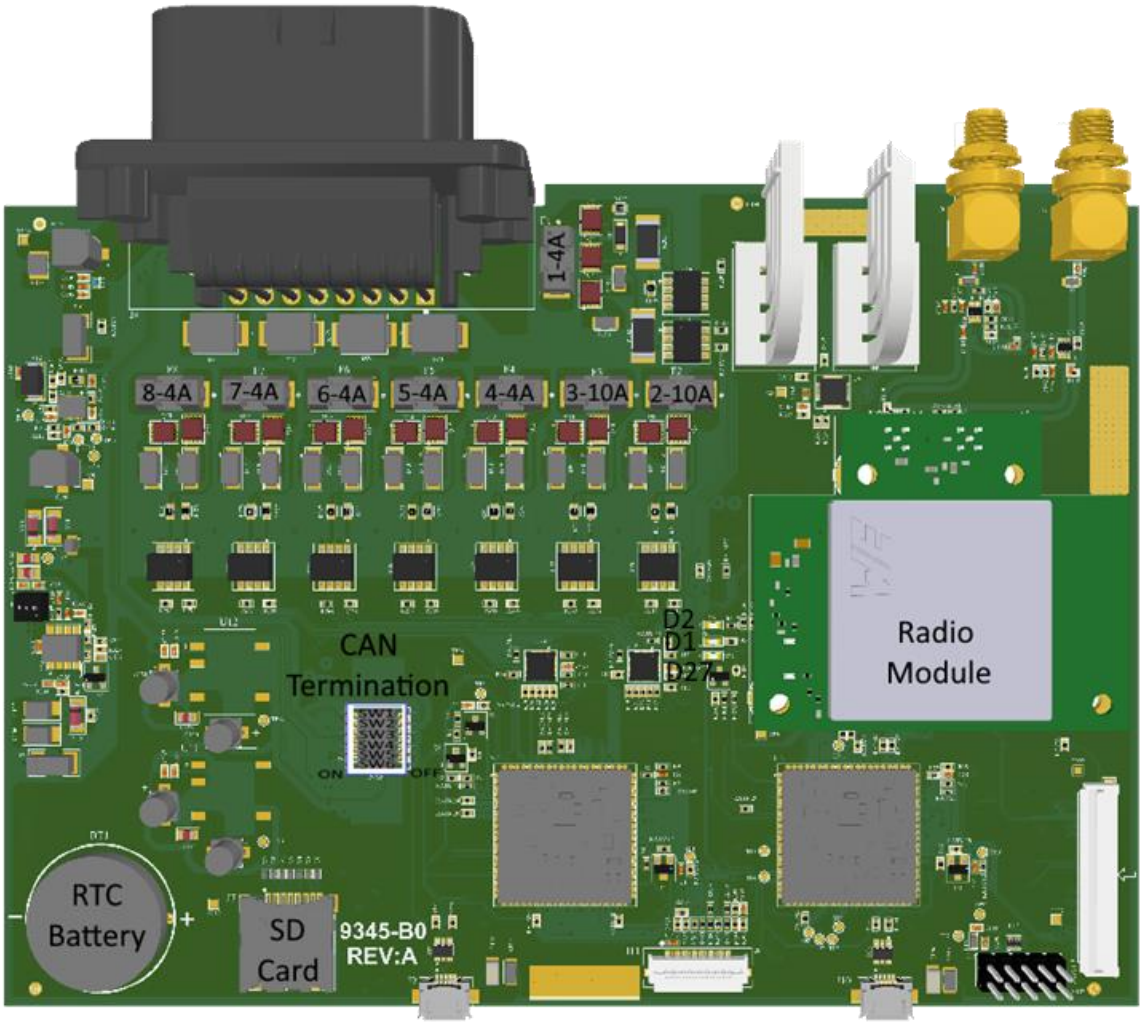
Figure 4 Antenna Mounting



7 Module Features

7.1 Main Assembly

Figure 5 PCA Primary Components



In the above image the primary serviceable and adjustable components are marked,

Fuses are marked by channel and rating, (e.g. 5-4A is channel 5 rating 4A). See below for more information.

7.2 Radio Module

The Radio module is frequency band specific so a 915MHz radio for instance will not operate in the 450MHz band, but all radios support 2.4GHz if appropriate radio firmware is installed.

The radio module is secured in place with 4 screws and anti-vibration washers, the RF connections to the main board should be aligned and engaged before screwing the module down.

7.3 SD Card

The CBMCU will accept a microSD or microSDHC card of up to 32GB capacity, although a 2GB card will be adequate.

The card can be removed by pushing the top cover toward the center of the PCB until it unlatches, then lift cover.

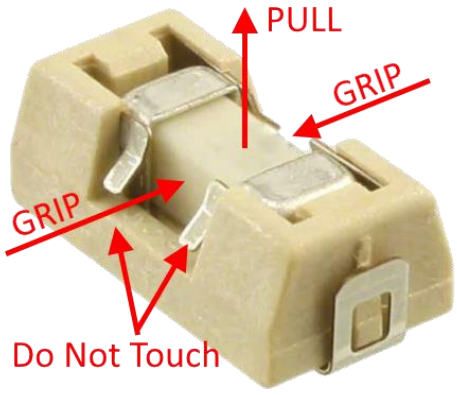
The card slides into the lid / raised section with the connectors facing up at the hinge end.

To close the holder, fold the top down and slide toward the board edge.

7.4 Digital (SSR) Outputs

There are eight digital outputs each with multi-stage category 3 drive and monitoring, all rated for 9-36VDC, two at 10A and six at 4A, all support hit and hold PWM functionality and up to two may be defined as main power control outputs.
All outputs meet a PLd Functional Safety Level according to ISO13849

Figure 6 Fuses



The Fuses for the eight Digital Outputs are inserted into a carrier as seen above, to remove the fuse, carefully grip the center of the fuse with needle nosed pliers and pull up, DO NOT GRIP THE SPRING RETAINERS or the carrier will be damaged. The new fuse can be pushed into the retainer, again being careful not to push on the spring retainers.
The fuses are 0453 series and either 4A (0453004.MR) or 10A (0453010.MR) as identified in the PCA Image above.

7.5 CAN Interfaces

CAN Bus data handling is implemented in a category 3 PLd architecture so that both microcontrollers handle and cross verify the data ensuring that total fidelity is maintained. Additional protocols such as CANopen SAFETY may be implemented on top of this fundamentally safe architecture.

Both CAN interfaces feature full voltage isolation.

CANbus Interface

The system supports two isolated CANbus interfaces. The CANbus Interface block diagram is shown below.
CANbus Interface Block Diagram (each CANbus interface is connected to one processor, providing the capability for CANbus side self-monitoring).

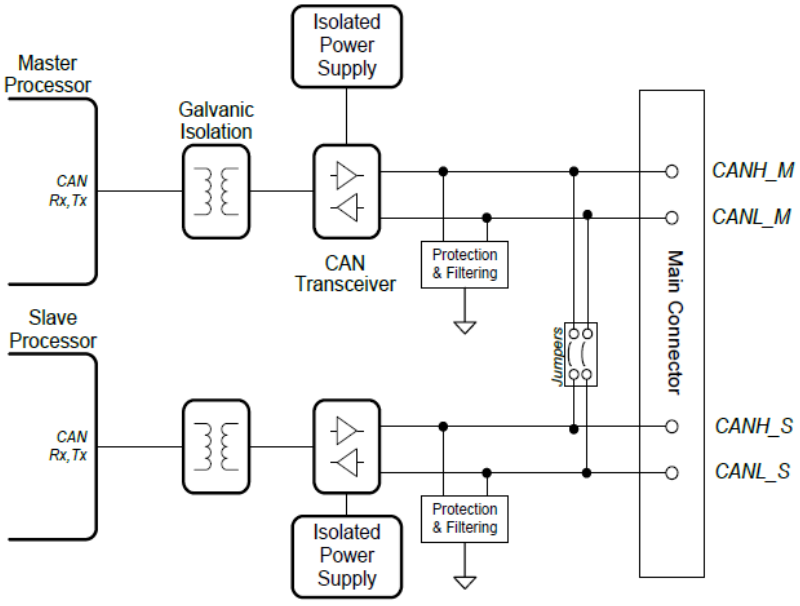


Figure 7 CANBus Interface Block Diagram

The interfaces can be used in different configurations, as follows:

• **Redundant CANbus interface – Type I**: The two interfaces are connected on the same bus This provides the capability for the SEC processor to monitor CAN frames sent by the PRI processor, or to compare the frames received. It appears as a single node on the network.

• **Redundant CANbus interface – Type II**: The two interfaces are connected outside the CBMCU to the same bus or to two NMT masters. The same information is sent on the two channels. In this configuration, the external NMT master is responsible of redundancy verifications.
The CBMCU appears as two distinct nodes on the network.

• **Independent CANbus interfaces**: Where the PRI and SEC run different applications, safety measures on the CANbus side should be evaluated, apart from the security features that would be implemented in the payload itself. In this context, both channels can even run different protocols. For example, CANopen for PRI, J1939 for SEC.

Currently, Redundant interface Type I is supported.

CAN INTERFACE CHARACTERISTICS	DESCRIPTION
CAN format	CAN 2.0A and CAN 2.0B
Bus speed	250, 500 and 1000 kbps
Standard	ISO 11898-2
Isolation	Each port is individually isolated for signals and power supply
Configuration	NodeID and baudrate are configurable through CattronLink Software

J1939 Operation

Maximum J1939 Transmit PGNs set to 8.
Maximum J1939 Receive PGNs set to 8.
Standard and Custom PGNs are supported.

CANOpen Operation

Maximum CANOpen Transmit PDOs set to 4.
Maximum CANOpen Receive PDOs set to 4.
Maximum CANOpen Safety PDOs set to 4.

The CBMCU operates as a CANopen NMT slave with fixed NodeID and fixed baud rate.
The CANopen operation state is independent from the RF connection status.
If the CBMCU is in Passive mode (before a RF connection, after an active STOP, or after a passive STOP) or in Error mode, all commands are reset to their safe values (zero)

CANOPEN SAFETY IMPLEMENTATION (SRDO)

SRDOs data length range from 1 to 8-byte. Multiple sub-indexes of different objects can be mapped and transferred on the same SRDO. The SRDO protocol follows the Producer/Consumer model.

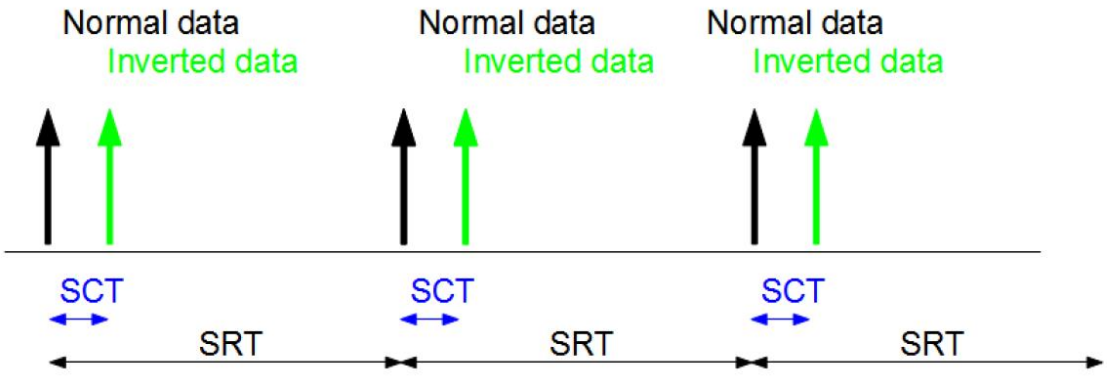


Figure 8 SRDO Transmission Protocol

SRDO

Two types of SRDOs are distinguished:

- SRDO producer shall be used to transmit Safety Related application data.

- SRDO consumer shall be used to receive Safety Related application data.

Secure transmission via the CAN bus

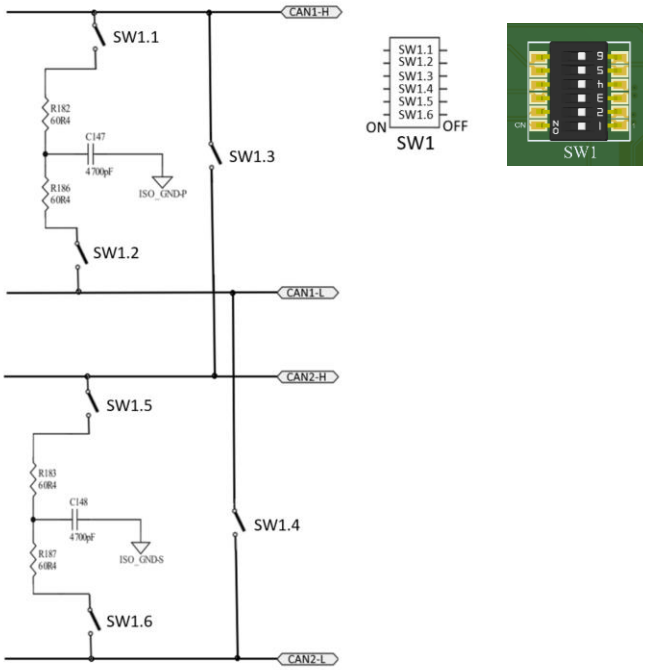
- Duplicate transmission with 2 independent CAN IDs.
- Transfer data normal and inverted.
- Cyclic transmission in fixed time frames.
- Fixed order of messages (normal followed by inverted).

Message monitoring while receiving

- Monitoring the correct sequence.
- Observance of time between normal and inverted messages.
- Observance of time between messages.

7.6 CAN Termination

Figure 9 CAN Terminations



Each CAN bus interface can be terminated as would be required if the CBMCU is located at the end of a cable run.
For CAN1, turn on switches 1 and 2.
For CAN2 turn on switches 5 and 6.
Additionally in some configurations the two CAN interfaces can be joined using SW3 and 4, but normally these are left turned OFF.

7.7 Cable Harness

As illustrated in the following

Figure 10 Cable Harness

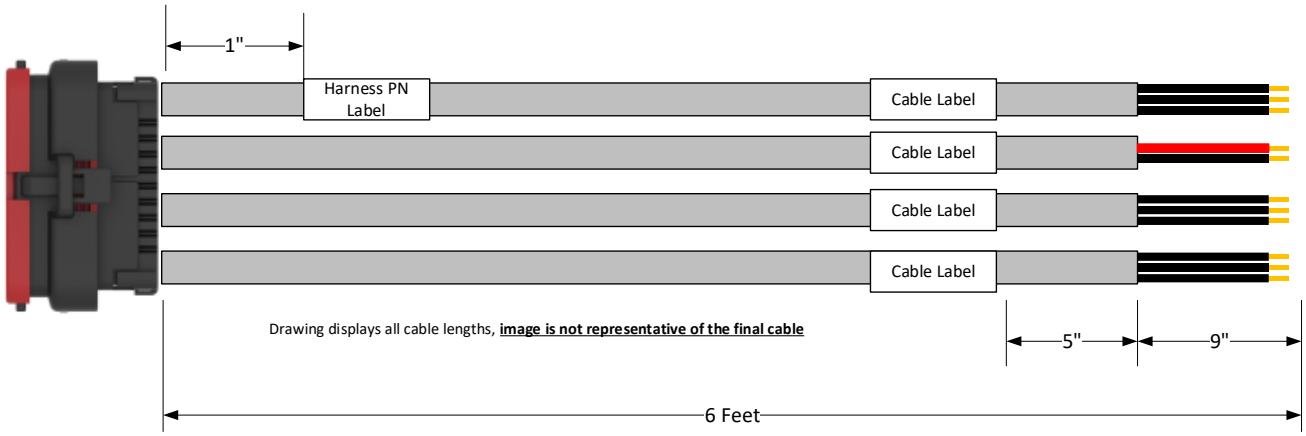


Figure 11 Main Connector

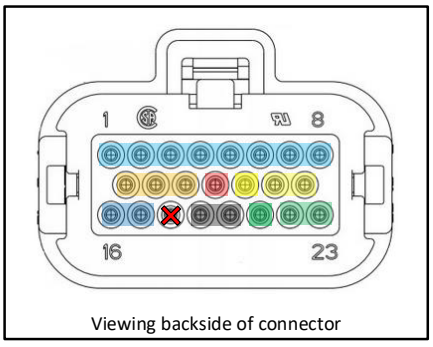


Table 1 Main Connector wire assignment

PIN #	Description	Rating	AWG	Color	CABLE	Wire Label
1	SSR Output #1	4A	18	BROWN	1	SSR 1
2	SSR Output #2	10A	18	WHITE	1	SSR 2
3	SSR Output #3	10A	18	ORANGE	1	SSR 3
4	SSR Output #4	4A	18	YELLOW	1	SSR 4
5	SSR Output #5	4A	18	GREEN	1	SSR 5
6	SSR Output #6	4A	18	BLUE	1	SSR 6
7	SSR Output #7	4A	18	VIOLET	1	SSR 7
8	SSR Output #8	4A	18	GRAY	1	SSR 8
9	SSR Channel Supply Inputs	8A	18	RED	1	SSR POS1
10		8A	18	RED\WHITE	1	SSR POS2
11		8A	18	RED\BLACK	1	SSR POS3
16	SSR Ground		18	BLACK	1	SSR GND
17			Shield	--	1	
13	CAN Bus #1 Shield-GND		Shield	--	3	
14	CAN Bus #1 - L		20	GREEN	3	CAN 1 - L
15	CAN Bus #1 - H		20	YELLOW	3	CAN 1 - H
18	Not used		PLUG	--	--	
12	CBMCU Input + (9-36V)		20	RED	2	POWER 9-36V
19	CBMCU Input GND		20	Black	2	POWER GND
20			Shield	--	2	
21	CAN Bus #2 Shield-GND		Shield	--	4	
22	CAN Bus #2 - L		20	GREEN	4	CAN 2 - L
23	CAN Bus #2 - H		20	YELLOW	4	CAN 2 - H

When making the SSR connections, note the maximum continuous current for any pin is 8A and the maximum total current is therefore 24A with all three SSR Channel Supply pins connected.

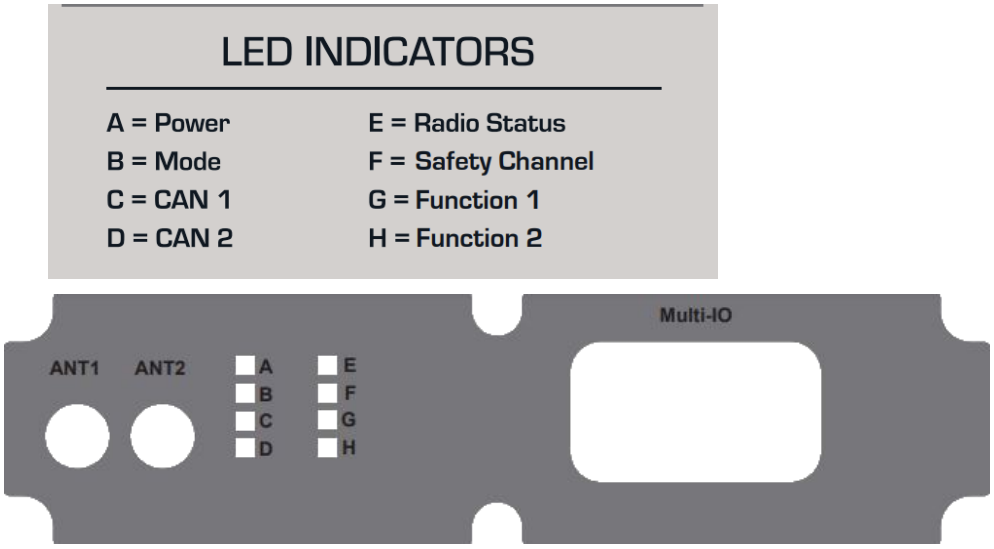
Peak output current on channels 2 and 3 is 10A but should not be maintained for more than 1 minute.

The SSR channels require a Ground reference to be connected, failure to do so will result in an error condition.

7.8 Status LEDs

As illustrated in the following figure, the CBMCU has a total of 10 LEDs

Figure 12 Main Status LEDs



Status LED Functions

LED A – Power — Should be Orange indicating the presence of both 5V and 3V3, if the LED is RED, 3V3 is absent, if the LED is Green 5V is absent.

LED B – Mode — Flashing Red/Green, MCU starting and performing diagnostics

Green, MCU in Run Mode, Normal operation

Red, Error State, CAT1 or CAT2 error, error may clear

Flashing Red, Error State, CAT3 error, unit requires service.

LED C – CAN 1

LED D – CAN 2

The LEDs behavior in this section follow the terminology from CiA303-3 specification, listed below:

LED state	Description
On	The LED is constantly on.
Off	The LED is constantly off.
Flickering	The LED turns on and off with a frequency of 10 Hz: on for 50 msec and off for 50 msec
Blinking	The LED turns on and off with a frequency of 2.5 Hz: on for 200 msec and off for 200 msec
Single flash	Cyclic pattern: one short flash followed by a long off phase Cycle = on (200msec) – off (1000 msec)
Double flash	Cyclic pattern: two short flashes followed by a long off phase (1000 msec) Cycle = on (200msec) – off (200 msec) – on (200 msec) – off (1000 msec)
Triple flash	Cyclic pattern: three short flashes followed by a long off phase (1000 msec) Cycle = on (200msec) – off (200 msec) – on (200 msec) – off (200 ms) – on (200 msec) - off (1000 msec)
Quadruple flash	Cyclic pattern: four short flashes followed by a long off phase (1000 msec) Cycle = on (200msec) – off (200 msec) – on (200 msec) – off (200 ms) – on (200 msec) – off (200 msec) – on (200msec) - off (1000 msec)

J1939 Status LEDs

The Red component shall indicate the CAN node error state, according to the following table:

Red Component	CAN Error State
a. Off	Normal Operation. The unit is in Error Active state.
b. Blinking	CAN configuration error.
c. Single flash	Unit is in Error Passive State. At least one error counter (TEC or REC) has reached the warning limit of 128.
d. Quadruple Flash	PGN Receive Time-out: a PGN has not been received before its Receive Timer elapsed.
e. On	Bus-Off state

The Green component shall indicate the J1939 connection state, according to the following table:

Green Component	J1939 Connection State
a. Blinking	Address claiming in progress
b. Single flash	Address claiming failed
c. On	Address claimed success

CANOpen Status LEDs

The Red component shall indicate the CAN ERROR State:

Red Component		CAN Error State
a.	Off	No Error
b.	Blinking	CAN configuration error
c.	Single flash	Warning Limit Reached: at least one error counter (TEC or REC) has reached the warning limit. The unit is now in Error Passive state.
d.	Double flash	Error Control Event: A guard event (Life guarding or Node guarding) or Heartbeat consumer event has occurred)
e.	Triple Flash	Sync error: The sync message has not been received within the configured cycle period time-out (ref: OD entry 0x1006)
f.	Quadruple Flash	PDO Time-out: a PDO has not been received before its event timer elapsed
g.	On	Bus-Off state

The Green component shall indicate the CANopen RUN Status, according to the following list:

Green Component		CANopen Run State
a.	Blinking	PRE-OPERATIONAL
b.	Single flash	STOPPED
c.	On	OPERATIONAL

LED E – Radio Status

Blue when CattronLink is connected

Green Flash, Valid RF message received

Amber Flash, Valid RF message received with RSSI below -90dBm

Red Flash, RF message transmitted

LED F – Safety O/P Red if ON, Green if OFF, LED OFF if no Safety Channel is assigned

LED G – Function 1 Assigned by Application

LED H – Function 2 Assigned by Application

7.9 Error Behavior

The platform defines 3 error categories, where each category has its own error handling rules. This section defines the characteristics of each the categories.

Error Categories Overview

ERROR CATEGORY	NAME	DESCRIPTION
CAT1	Fatal System Error	Error affecting the Safety integrity of the device, as it may result in unpredictable and/or dangerous behaviour. CAT1 errors bring the Device in a permanent Safe State.
CAT2	Transient System Error	Errors related to possible transient conditions, that could be caused by EMI, or mechanical shock, for example. CAT2 errors forces a RESET Cycle, with complete boot-up diagnostic tests.
CAT3	Isolatable peripheral Error	Errors related to a specific function or peripheral that can be isolated and disabled to a safe state without compromising the safety of the system. The faulty function or peripheral is kept disabled until the next power cycle.

Note: The LED behaviors associated with each type of error are already described in the Status LEDs section, LED B – Mode.

7.10 Data Logging

The CBMCU feature enhanced logging capabilities against a Real Time Clock. Data is stored on the SD card. Some basic logged functions are pre-defined. Other Logged functions can be defined by the user / Application. The data log can be accessed via CattronLink.

8 System Configuration

Every CBMCU will be configured to suit a specific application, if this configuration is provided by Cattron a full set of data will be provided to enable a smooth and successful implementation to be achieved.

Some applications will be standardized to suit a specific type of vehicle or machine and others will be fully customized.

The types of collateral provided may include

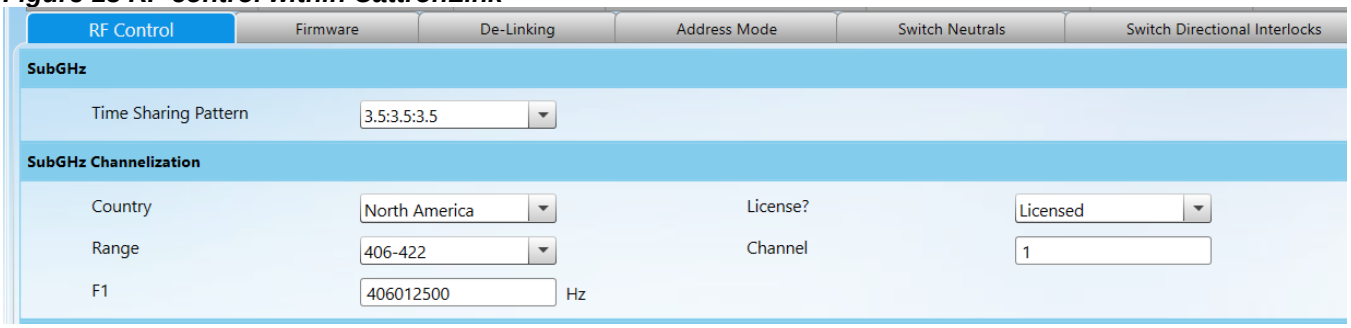
- Installation Drawings
- Controller drawings
- Digital Output maps
- CAN configuration
- CAN mapping
- *.eds files
- Etc.

A critical aspect of System Configuration relates to the setting of Frequency and Address to securely and reliably link the CBMCU with any other CBMCU or Operator Control Unit (OCU).

8.1 Operating Frequency

If the CBMCU is wirelessly paired with a controller, the operating frequency will either be pre-defined or automatically defined, depending on the frequency band in use. 2.4GHz systems for instance use frequency hopping and this requires no configuration, other frequency bands though require the frequency to be manually configured. Where a frequency is to be manually configured this can be done wirelessly using CattronLink™ which is freely available for download on Cattron's website.
Some frequency bands are license exempt and others licensed, users should only select a licensed channel if they have a license to do so, for license exempt bands a free channel should be selected. Using a frequency that has other equipment operating on it will cause low range, poor performance and communication losses. For Sub-GHz frequencies, up to three systems may share a frequency as long as the Time-Sharing Pattern selected in CattronLink is different for each system.
Note that an appropriate radio must be fitted to select a frequency in that band, i.e. you cannot select 433 or 450MHz if a 915MHz radio is fitted.

Figure 13 RF control within CattronLink



8.2 System Address

Each Controller and MCU pair, shares a common, unique overall address. This address is contained in every telegram sent by the controller and is checked by the MCU every time an RF signal is received. The MCU processes a command only when the address in the telegram matches its own defined address. This is a critical safety measure to ensure that the MCU will act only upon its assigned controller, never duplicate an address unless the system design requires it.

	CAUTION
⚠	Conflict of Addresses: Addresses are never repeated and are System Unique. The user must ensure that the system address and addressing mode is used as designed. The system address is marked on the OCU and MCU and must match. In the event of a breach of this undertaking, the user is liable for any resulting damage/loss and shall indemnify the manufacturer against all third-party liability claims.

Address Format

This system uses a 24-bit addressing scheme comprising a 16-bit master-address and an 8-bit sub-address extension.

Addressing Modes

There are two addressing modes that may be implemented depending on the specific application needs, these are TSAC and BSAC;

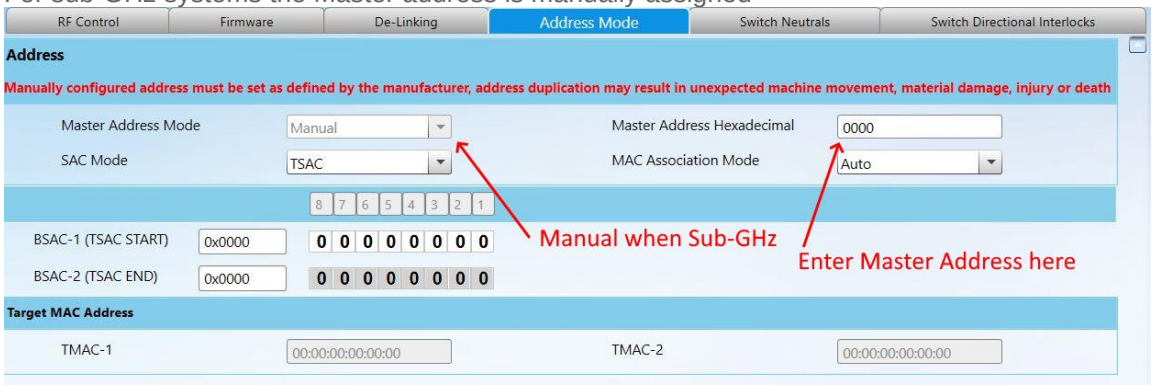
TSAC mode = 16 bit Master Address (MA) and 8 bit Sub Address (SA), creating one single 24 bit address.
e.g. OCU address = 0000 0000 0000 0001 0000 0001
MCU address = 0000 0000 0000 0001 0000 0001 (MCU Online matching MA plus SA byte)
equivalent to a 24 bit address.
This mode enables an OCU to select one of up to 255 MCUs (and request a Talkback™ message from that MCU).
By default the TSAC sub address is 0

BSAC mode = 16 bit MA and an 8 bit SA where each bit of the SA represents one of 8 possible MCUs.
e.g. OCU Address = 0000 0000 0000 0001 0100 0101
MCU 1 Address = 0000 0000 0000 0001 0000 0001 (MCU On line matching MA plus SA bit)
MCU 2 Address = 0000 0000 0000 0001 0000 0100 (MCU On line matching MA plus SA bit)
MCU 3 Address = 0000 0000 0000 0001 1000 0000 (MCU OFF line no matching MA plus SA bit)

This mode enables an OCU to simultaneously select between 1 and 8 MCUs (and request a Talkback™ message from any of those MCUs).
By default the BSAC sub address is 0

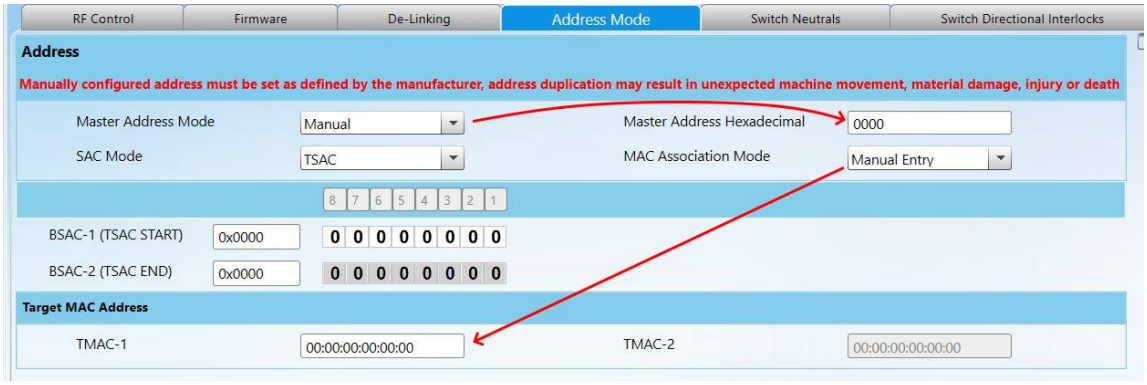
Figure 14 Address Management within CattronLink

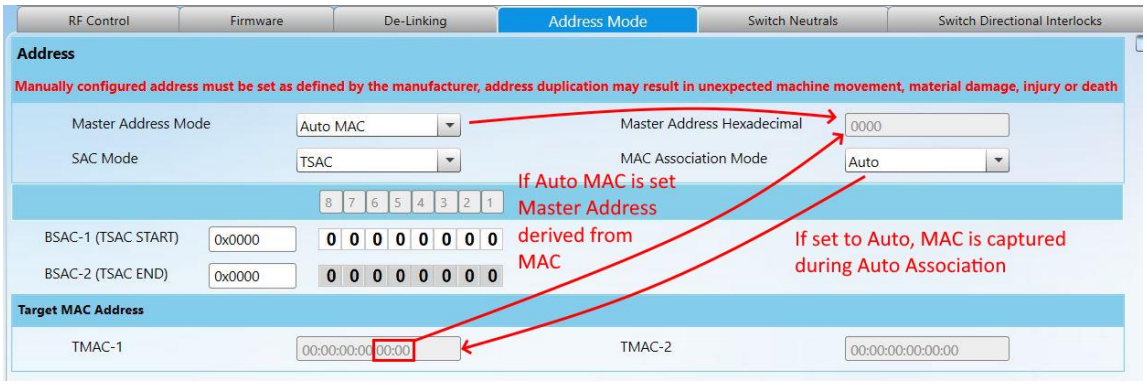
For sub-GHz systems the Master address is manually assigned



For 2.4GHz systems there is an additional layer of addressing, firstly the Controller and MCU must know each other's 48 bit MAC Address, this can be automatic using the Auto-Association method if MAC Association Mode is set to Automatic, or it can be manually set if MAC Association Mode is set to Manual.

Additionally the Master Address must also match. The Master Address can be manually set or automatically derived from the MAC address, see examples below.





9 The Controlled Machine

9.1 Control Power

Your CBMCU must be provided with a Power Supply and Control Supply of between 9 and 36V DC, these are connected via the multi-connector, an additional method of isolation may be desirable.

Note: The MCU motherboard is protected by three fast-blow fuses that are soldered to the printed circuit assembly, these are factory service items as a blown fuse would be indicative of other problems.

9.2 Main Safety Outputs

The CBMCU may be programmed to assign up to two of its SSR outputs as Main Safety Outputs rather than Function control outputs. Internally each output meets a Functional Safety level of category 3 PLd according to ISO13849, externally if a user needs a category 3 input they will require two outputs, otherwise a single output will provide them with a category 2 PLd input.

Main Safety Outputs behave differently than the other function outputs and are directly controlled by firmware rather than Application programming.

Main Safety Outputs can typically be thought of as an E-Stop function to bring the machine to a safe state.

Main Safety Outputs will be de-energized if,

The MCU is without power

The MCU has a fault

If linked to another Control Unit (OCU or MCU) and a Stop command is received

If linked to another Control Unit (OCU or MCU) and there is a communication failure (for any reason)

The need for and use of Main Safety Outputs depends on the risk assessment for the machine being controlled, that Risk Assessment is the responsibility of the integrator or user.

Generally, if a machine has the capability to cause injury or death if a failure occurred, then these Main Safety Outputs should be wired in such a way that they are controlling power (Electrical / Hydraulic etc.) to be able to place the machine in a safe state.

9.3 Circuit Breakers

One or more circuit breakers may be installed to isolate power to the machine to enable safe maintenance operations to be carried out.

10 Operation

10.1 Post Installation

Before setting the system to work for the first time verify that the OCU and MCU are a system pair and share the same Master-Address and Sub-Address.

Do a visual inspection of the MCU to ensure it is clean, tidy and with no obvious defects, damage, loose wires etc. Verify machine operation in Manual mode.

Transfer operation to Remote mode and switch on MCU, check that the Status LEDs are as expected, as a minimum LED-A is Orange and LED-B is Green and if a Main Safety Channel has been defined LED-F will be Green.

Switch on the associated OCU and complete the OCU Start Sequence (Stop then Start or just Start depending on configuration), the OCU Stop switch will be flashing.
The CBMCU LED-E will flash Green every time it receives a valid signal.
If Main Safety Channels are defined LED-F will have changed from Green to RED.

Check each function in turn for correct operation and direction.
Check any motion limit switches on the machine for correct operation.

Check the Stop function to ensure LED-F changes back to Green and the machine power resumes a safe state as expected.

Ensure the OCU is labelled completely and correctly and that the Crane or Machine is clearly identified on the OCU.

10.2 Daily Operation

Before setting the system to work each day ensure the correct OCU is being used by checking that the Crane or Machine ID on the back of the OCU matches the machine to be controlled and that the OCU is in free from any obvious damage.

Switch on the associated OCU (Press Start) and complete any required Start Sequence, observe the OCU status is normal.

Check a non-moving function such as the Alarm/Horn to ensure the correct machine is under control, then if safe to do so briefly check each function in turn for correct operation and direction.

Check the Stop function to ensure the Machine resumes a safe state.

10.3 Service

In the event of any problems, it is always wise to examine the installation for common problems such as loose connections and damaged wiring including antennas and coaxial cables, these same checks should be made annually.

The MCU features advanced Data-Logging that records all the fault and diagnostics data including relay activations.
In the event that system operational problems exist, the log can be downloaded remotely from a PC with a Bluetooth connection, this log can be analyzed by Cattron or an experienced person to examine it for clues relating to possible problems, these may be related to the remote-control system or other items such as RF interference, loss of power etc.

If no obvious faults can be located, contact the Cattron Service Team for further assistance at www.cattron.com/contact

10.4 De-commissioning

If the system is to be de-commissioned ensure that the machine is left in a safe operational state, in the case of a plug in MCU this may be as simple as isolating machine power and unplugging the MCU, but if the MCU is directly wired into an interface panel, this should be completed by a qualified electrician familiar with the machine in question.

11 CattronLink™

	**WARNING**
	More than one remote control system may be used at, around, or nearby your operating facility. Therefore, before selecting an address for a system or spare you must ensure that it is the correct address for the desired equipment to be operated. If the wrong address is programmed into an OCU or MCU, other remote-controlled equipment located at, around, or nearby your facility may unintentionally become operational. Failure to comply with the above warnings may result in serious injury or death to personnel and damage to equipment.

These systems feature the latest innovations in Safety, Programming and Configuration that enable continuous performance and feature upgrades to be a simple process.

There are two parts to this;

1. The Firmware that includes the core safety functions and the Features that have been integrated to give the unit its capabilities.
2. The Configuration Parameters that apply to each feature, these configuration parameters include such items as Operating Frequencies, Address, Addressing Mode, Time-share Algorithms as well as the Digital and CAN mapping etc.

The Firmware may contain features that are not configured or used.
Configuration parameters that are not available in the firmware will not be implemented even if loaded in the Configuration file.

Therefore, as features are release the firmware needs to be upgraded in order to benefit from them (if wanted).

Due to this flexible and easily upgradeable configuration concept, it is not uncommon for one MCU to be kept as a spare for multiple cranes or machines, even if with widely varying functionality.

All OCU and MCU access is carried out wirelessly over a Bluetooth link from a laptop or PC running the Cattron software utility called CattronLink™.

11.1 What is CattronLink™ Software.

CatttonLink™ software is a suite of Apps that enable the latest generation of Cattron remote control products to be accessed over a Bluetooth® link for the purposes of;

- Firmware Upgrades
- Loading or changing of configuration parameters
- Examining device status including switch and relay totalizers
- Examining the datalogging stores.

NB: Not all features of CattronLink™ are available for all systems

The User manual for CattronLink™ can be found on the Cattron.com website

12 Requirements to Achieve PLd within a ‘System’

The CBMCUs meet a PLd rating for all digital outputs, additionally one or two of these may be defined as Main Safety Outputs to control machine power providing a category 2 (single channel) or a category 3 (dual channel) input to the controlled machine.

The two CANbus outputs also meet a PLd rating as these are controlled and monitored in a category 3 architecture ensuring that there can be no corruption of data within the system.
Protection of the data being handled can either be accomplished by implementing deterministic and security elements within the payload or by implementation of CANopen Safety.

It has to be remembered that the CBMCU is only one part of a ‘System’, the system will include any associated OCU and the machine to which they are integrated; to achieve an overall PLd rating (if required) no part of that serial system or configuration can be below a PLd rating.
The machine itself is outside of the scope of this user manual but the corresponding OCU is not; this MCU can be used with many of Cattron’s latest controllers, sales will be please to advise.
If an OCU is paired with the MCU and a control function is required to meet a PLd, the OCU must also implement a category 3, switch input, this can be achieved with any dual step switch as may be found on the Safe-D-Stop, and 325 push button controllers or a Joystick controller for example.

e.g. Both the direction switch and speed switch are required together to activate a safety function in the MCU.

NB: the direction and speed switches have both mechanical and electrical diversity, each of course is subject to the normal OCU function OFF at switch-on testing, so by using a specific OCU configuration and the CBMCU with its Functional Safety level, a category 2 or category 3 3 PLd control function is possible.

13 PFHd Values

Function	Exclusions	MTTFd	MTTFd Rating	Dcavg	Dcavg Rating	Cat	PLr	CCF	Meets Minimum Requirement of PL d	PFHd	PL
DC DIG 1	NO	183	HIGH	98.6	MEDIUM	3	d	YES	YES	4.29E-08	e
DC DIG 2-8	NO	226	HIGH	98.5	MEDIUM	3	d	YES	YES	4.29E-08	e
DC CAN	NO	257	HIGH	98.1	MEDIUM	3	d	YES	YES	4.29E-08	e

NB: MTTFd values capped at 100

14 Technical Specifications

Refer to datasheet on resources tab of product on website

https://www.cattron.com/resources/

15 CE Declaration of Conformity

Hereby Cattron declares that the radio equipment is in compliance with Directive 2014/53/EU. View the EU Declaration of Conformity document. www.cattron.com