

# ***MULTI-CIRCUIT METER (MCM) MODBUS<sup>®</sup> RTU, MODBUS<sup>®</sup> TCP***

## ***Electric Power Meter - Installation Guide***

**Models: MCMxx-y-MB-zzzz, MCMxx-y-MBT-zzzz**



***Continental  
Control  
Systems, LLC***

Socomec Group

[www.ctlsys.com](http://www.ctlsys.com)

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# 1 Precautions

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- Only **licensed electricians** or qualified personnel should install the MCM. The mains voltages of 100 to 600 Vac can be lethal!
- Follow all applicable local and national electrical and safety codes.
- The terminal block screws are **not** insulated. Do not contact metal tools to the screw terminals if the circuit is live!
- Verify that circuit voltages and currents are within the proper range for the MCM model voltage group.
- Use only UL Listed or Recognized current transformers (CTs). Depending on the meter options, you may use either CTs with built-in burden resistors that generate 0.333 Vac (333 millivolts AC) at rated current or milliamp output CTs that generate 40 mA at rated current. **Do not use 1 amp or 5 amp output CTs: they will destroy the meter and may create a shock hazard.**
- If your MCM model does not include a circuit breaker or fuses, then protect the line voltage conductors supplying the MCM with fuses or circuit breakers. See **3.5.1** below.
- Disconnect equipment from HAZARDOUS LIVE voltages before access.
- If the meter is not installed correctly, the safety protections may be impaired.
- Torque all screws as specified on the information label on the inside of the enclosure door.

## 1.1 Symbols

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Read, understand, and follow all instructions including warnings and precautions before installing and using the product

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Potential shock hazard from dangerous high voltage

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Earth ground

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UL Listed mark for the USA and Canada. It is located on the UL 508A label inside the enclosure and applies to the entire MCM.

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The UL Recognized mark for the USA and Canada appears on the MCM cards and some accessories.

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## 1.2 Terminology

**current sensor (or current transformer or CT):** the terms current sensor and current transformer (CT) are used interchangeably in this guide. They refer to devices that measure AC current and output a millivolt signal representation of the current. The MCM may also support milliamp output current transformers when ordered with the correct option.

**meter element (or element):** a meter element combines a voltage signal with a current signal to measure and report AC power and energy, as well as additional parameters of interest. Each meter element accepts one CT input. There are three meter elements in each submeter block. See **2.2 Multi-Circuit Metering** for more details.

**Modbus RTU:** a version of the Modbus protocol primarily used over RS-485 (EIA-485) links.

**Modbus TCP:** a version of the Modbus protocol used over Ethernet TCP/IP networks.

**primary SMB:** the first submeter block in an MCM system, with a Modbus address offset of 0 relative to the address assigned with the DIP switches or using Modbus **Address** register.

**submeter block (SMB):** the MCM is composed of multiple SMBs. Each SMB has three CT inputs and behaves much like an independent three-phase meter. See **2.2 Multi-Circuit Metering** for more details.

## 2 Overview

Congratulations on your purchase of the Multi-Circuit Meter for Modbus® (MCM) watt/watt-hour meter. The MCM can measure 100 to 600 Vac, single-phase and three-phase, wye and delta services. It supports demand-side management (DSM), submetering, energy monitoring, billing, and renewable energy applications.

There are two communication versions of the MCM:

- **MCM...MB...** - Communicates using Modbus RTU over EIA RS-485 two-wire twisted-pair links.
- **MCM...MBT...** - Communicates using Modbus TCP over Ethernet TCP/IP networks.

The MCM meets the revenue metering ANSI C12.1 Class 1 standard when used with class 0.6 current transformers (CTs) and meets ANSI C12.20 Class 0.5 with class 0.2 or class 0.3 CTs.

The MCM includes the multi-circuit meter, a NEMA rated enclosure, a DC power supply, circuit protection (fuses or circuit breaker), and terminal blocks, all prewired as a UL 508A Listed industrial control panel, ready for mounting.

### 2.1 Model Number Scheme

The MCM is available with many different model numbers. The following section explains how to decode the MCM model numbers.

**MCM<NumCTs>-<VoltageGroup>-<Comm>-<Enclosure>-<Protection> Opt <Options>**

**<NumCTs>** - The number of CTs (or current sensors), which may be 12, 24, 36, 48, 60, 72, or 84. For example: **MCM12**. Each submeter in the MCM has three CT inputs, so the number of submeters will be the number of CTs divided by three: 4, 8, 12, 16, 20, 24, or 28.

**<VoltageGroup>** - The measurement circuitry on all MCM models can measure 100 to 600 Vac, but the power supply configuration depends on the electrical service type. The voltage group (**A**, **B**, **C**, **D**, or **E**) selects the appropriate configuration. See the table below to verify that the voltage group matches your electrical service type. If possible, choose from the bold entries in the table below as they are the most common.

**Table 1: MCM Voltage Groups**

Voltage Group	Power Wiring Description	Supported Electrical Service Types
<b>A</b>	<b>Direct from the overcurrent protection to the AC/DC power supply (N, L1)</b>	<b>1-Phase, 2-Wire 120V with neutral</b> <b>1-Phase, 3-Wire 120/240V</b> <b>3-Phase, 4-Wire 120V/208Y</b> <b>1-Phase, 2-Wire 230V with neutral</b> <b>3-Phase, 4-Wire 230V/400Y</b> <b>3-Phase, 4-Wire Delta 120/208/240V with neutral</b> <b>3-Phase, 4-Wire Delta 240/415/480V with neutral</b>
<b>B</b>	Direct from the overcurrent protection to the AC/DC power supply (L1, L2)	<b>1-Phase, 2-Wire 208V (no neutral)</b> <b>1-Phase, 2-Wire 240V (no neutral)</b> <b>3-Phase, 3-Wire 208-240V Delta (no neutral)</b> 1-Phase, 3-Wire 120/240V 3-Phase, 4-Wire 120V/208Y 3-Phase, 4-Wire Delta 120/208/240V with neutral
<b>C</b>	<b>From the overcurrent protection to the step-down transformer (L1, L2) 480V tap to the AC/DC power supply</b>	<b>3-Phase, 4-Wire 277V/480Y with neutral</b> <b>3-Phase, 3-Wire 400V Delta (no neutral)</b> <b>3-Phase, 3-Wire 480V Delta (no neutral)</b> 3-Phase, 4-Wire 230V/400Y 3-Phase, 4-Wire Delta 240/415/480V with neutral

D	From the overcurrent protection to the step-down transformer (N, L1) 277V tap to the AC/DC power supply	<b>1-Phase, 2-Wire 277V with neutral</b> 3-Phase, 4-Wire 277V/480Y with neutral
E	From the fuse to the step-down transformer (L1, L2) 600V tap to the AC/DC power supply	<b>3-Phase, 4-Wire 347V/600Y with neutral</b> <b>3-Phase, 3-Wire 600V Delta (no neutral)</b>

<Comm> - The communication type. The MCM does not support both RS-485 and Ethernet in one model.

- **MB** - Modbus RTU using RS-485
- **MBT** - Modbus TCP using Ethernet and TCP/IP

<Enclosure> - The enclosure field specifies one of the following enclosure options:

- **ME3** - Steel NEMA 4 enclosure, 12 to 48 CTs, 12 in. x 12 in. x 6 in.
- **FE1** - Fiberglass NEMA 4X enclosure, 12 to 48 CTs, 12 in. x 12 in. x 6 in.
- **ME4** - Steel NEMA 4 enclosure, 60 to 84 CTs, 16 in. x 14 in. x 6 in.
- **FE2** - Fiberglass NEMA 4X enclosure, 60 to 84 CTs, 16 in. x 14 in. x 8 in.

<Protection> - The protection field specifies the overcurrent protection as one of the following:

- **C** - Three-phase circuit breaker, rated up to 480 Vac; also acts as a disconnect.
- **F** - Three-phase fuse block, rated for 600 Vac; typically used with voltage group E. The fuse holder is not rated for use as a disconnect.
- **N** - No circuit protection. The MCM provides field wiring terminal blocks in place of the circuit protection. An external disconnect and overcurrent protection are required.

**Opt <Options>** - Some models may include additional options, such as **Opt EP**, to configure the MCM for even parity communications. See the datasheet for all options.

The four most common models follow:

- **MCM24-A-MB-FE1C** - 24 CTs, 120 - 240 Vac, fiberglass enclosure, circuit breaker
- **MCM24-A-MB-ME3C** - 24 CTs, 120 - 240 Vac, steel enclosure, circuit breaker
- **MCM72-A-MB-FE2C** - 72 CTs, 120 - 240 Vac, fiberglass enclosure, circuit breaker
- **MCM72-A-MB-ME4C** - 72 CTs, 120 - 240 Vac, steel enclosure, circuit breaker

## 2.2 Multi-Circuit Metering

The CCS MCM is organized into multiple three-element (or three-phase) submeter blocks (SMB). Each SMB behaves as an independent meter, with a different Modbus address. For example, an MCM12-A-MB-FE1C supports twelve current transformers and contains four SMBs, each with three CT inputs. This design has several implications.

- Each submeter block has the same Modbus register list as a regular WattNode® meter.
- The SMBs' Modbus addresses start with the primary SMB's address (ADDR+0) and increments by one for each SMB (ADDR+1, etc.). The address can be configured with the DIP switch or using the **Address** Modbus register.
- Communication settings can only be changed on the primary submeter (ADDR+0) and will automatically cascade to all other SMBs in the MCM.
- All SMBs use the same baud rate and parity settings.
- The sum and average registers will only sum or average the metering elements within a single SMB. Readings from different SMBs can be combined externally.
- Each SMB independently measures the line voltages and line frequency, so the reported values will differ slightly from one submeter to another.
- The SMB readings will not always update simultaneously.

## 2.3 Additional Literature

- Continental Control Systems, LLC website: [ctlsys.com](https://ctlsys.com) product and support pages
- MCM product page: <https://ctlsys.com/product/mcm/>
- MCM support page: <https://ctlsys.com/support/mcm/>
- Install record: <https://ctlsys.com/s/mcm-install-rec/>
- Datasheet: <https://ctlsys.com/m/MCM-Datasheet.pdf>
- Modbus register list: <https://ctlsys.com/m/WND-Modbus-Registers-FW37.xls>



The figure above shows all possible connections for an MCM84, including both Modbus RTU and Modbus TCP, even though both will not be present on a single MCM. The line voltage connections in the lower-right are factory wired to the circuit protection, and the 5 Vdc connections are factory wired to the power supply. Models of the MCM with fewer circuits follow similar layouts but with fewer modules. Each MCM ships with a connection diagram affixed inside the front door.

The connection diagram shows the position (CT1, CT2, CT3) and polarity (white, black) of each current transformer input.

### 3.1 Installation Record

The MCM is provided with an installation record to plan and document the installation. The first page documents general information: model number, serial number, electrical service, Modbus settings, RS-485 settings, Ethernet settings, etc. The additional pages of meter and CT schedule document each load and current transformer input to the MCM. **It is essential to document the loads and CT configurations because the meter must be correctly programmed to match the actual installation.** To download additional copies, see <https://ctlsys.com/support/mcm-installation-record/>.

The meter and CT schedule contains several columns of information. The electrician or installer should fill in most of these columns, but the integrator will typically fill in the **MeterConfig**. See below for an example schedule.

**Channels:** The MCM is composed of one or more modules (PCBs), each with 12 CT inputs (channels). The channels column shows one block for each set of 12 channels. The numbering, 1-12, 13-24, etc., is just informational and will not be used when accessing data from the MCM.

**Submeter Block:** As described above, the MCM is composed of four or more SMBs, each behaving like a WattNode meter with three CT inputs. Each SMB has its own Modbus address, based on the address (ADDR) set with the DIP switch on the primary SMB. For example, if you set the DIP switch address to 2, then ADDR+0 = 2, so the address of the primary SMB will be 2.

**Modbus Addr:** The Modbus address field is filled in by hand, by adding the DIP switch address to the offset documented in the SMB column. For example, if the DIP switch address is 2 and the submeter block shows ADDR+3, then fill in the Modbus address as 5.

**CT#:** Each SMB has three CT inputs. This column shows the CT numbers printed on MCM boards and on the wiring diagram.

**Panel:** You may use the panel column to identify the panelboard or circuit breaker panel. Be sure to use this column if you are metering more than one panel with a single MCM.

**Ckt#:** Use this column to record the circuit number within the panelboard. These are the numbers printed adjacent to circuit breakers and on the panel schedule.

**CT Amps:** It is important to record the rated amperage of each current transformer. In many cases, the CT amps will match the circuit breaker rating, but this is not always true.

**L1, L2, or L3:** Use this column to record the line voltage phase associated with this current transformer. You may refer to the phases as L1, L2, L3 or as ØA, ØB, ØC.

**MeterConfig:** The integrator will normally configure the **MeterConfig** registers and fill in this column. The **MeterConfig** value depends on whether a CT input is associated with L1, L2, or L3, and whether the CT measures a line-to-neutral or a line-to-line load.

**Load Name/Description:** Fill in this column to document the load for each MCM input.

### 3.1.1 Example Meter and CT Schedule

Channels	Submeter Block	Modbus Addr	CT #	Panel	Ckt #	CT Amps	L1, L2, or L3	Meter Config	Load Name / Description
1-12	ADDR+0	2	CT1	P3	1	20	L1	10	Foyer Lighting
			CT2	P3	3	20	L2	20	Foyer Outlets #1
			CT3	P3	5	20	L3	30	Foyer Outlets #2
	ADDR+1	3	CT1	P3	7	20	L1	10	Kitchen Outlets #1
			CT2	P3	9	20	L2	20	Kitchen Outlets #2
			CT3	P3	11	20	L3	30	Kitchen Outlets #3
	ADDR+2	4	CT1	P3	2	50	L1	10	RTU #1
			CT2	P3	4	50	L2	20	
			CT3	P3	6	50	L3	30	
	ADDR+3	5	CT1	P3	8	50	L1	90	Compressor (208V, no neutral)
			CT2	P3	10	50	L2	50	
			CT3	P3	13	20	L1	10	Kitchen Outlets #4
ADDR+4	6	CT1	P3	15	20	L2	20	Men's Bathroom Lighting	
		CT2	P3	17	20	L2	20	Women's Bathroom Lighting	

Figure 2: Sample Installation Record

In this example, the panel (P3) is a 120/208V three-phase wye panel. All of the loads have a neutral connection except the delta connected compressor.

The first six circuits are single-phase, 20A, lighting and outlet branch circuits. For all six, L1 is matched with CT1, L2 is matched with CT2, and L3 is matched with CT3. This is the simplest configuration and does not require any changes to the **MeterConfig** registers.

The next three CT inputs are monitoring a three-phase, 50A, rooftop unit (RTU) load. Again the line voltages are matched with the CT inputs and do not require any changes to **MeterConfig**.

CT1 and CT2 of Modbus address 5 are monitoring two legs of a delta connected compressor. The MCM only requires two CTs for delta loads, but if only two CTs are used, then the **MeterConfig** registers must be changed. In this case, the CT1 input is associated with the L1-L3 (VoltAC) line voltage (**MeterConfig** = 90), while the CT2 input is associated with the L1-L2 (VoltAB) line voltage (**MeterConfig** = 50). Delta loads can also be measured with three current transformers using the default **MeterConfig** settings.

CT3 of Modbus address 5 is monitoring a single-phase outlet load (Kitchen Outlets #4). CT3 monitors the load on L1 or ØA (phase A), so **MeterConfig** must be changed to 10.

The final two loads in the example are lighting loads, both on L2 (ØB), so both need to have **MeterConfig** set to 20.

### 3.2 Electrical Service or Load Types

The MCM supports any electrical service from 100 to 600 Vac, line-to-neutral or line-to-line, 50 to 60 Hz, single-phase, split-phase, or three-phase, wye or delta, two-wire, three-wire, or four-wire. It

monitors multiple branch circuits or loads on a single service. Note: when describing service types, the number of wires only includes neutral and line conductors, not the ground conductor.

The MCM only has one set of line voltage connections, so all submeter blocks (SMBs) share the same line voltages. However, one MCM can monitor different types of loads powered by the same service. For example, if your MCM line voltage connection is 120/208 wye, the MCM could simultaneously monitor three-phase wye loads, three-phase delta loads (no neutral), two-wire line-to-line loads (e.g., L1 to L2), and single-phase line-to-neutral loads.

Internally, each SMB acts as three separate single-phase meters, one tied to each CT input. By default, the meter associates CT1 with VoltA (or  $V_A - V_N$ ), CT2 with VoltB, and CT3 with VoltC. This default configuration may be changed using the **MeterConfig** registers. When this guide refers to the **MeterConfig** registers, there are three registers, **MeterConfig1**, **MeterConfig2**, and **MeterConfig3**, associated with **CT1**, **CT2**, and **CT3** respectively.

Connect the line voltages to the MCM inputs, as shown in the following sections. If you are monitoring different types of loads, be sure to use the line voltage connection for the type of load with the most wires connected.

### 3.2.1 Three-Phase, Four-Wire Wye

This is a common commercial and industrial service that includes a neutral conductor. Load #1 is three-phase and could be wye or delta connected. Loads #2, #3, and #4 are single-phase, line-to-neutral.

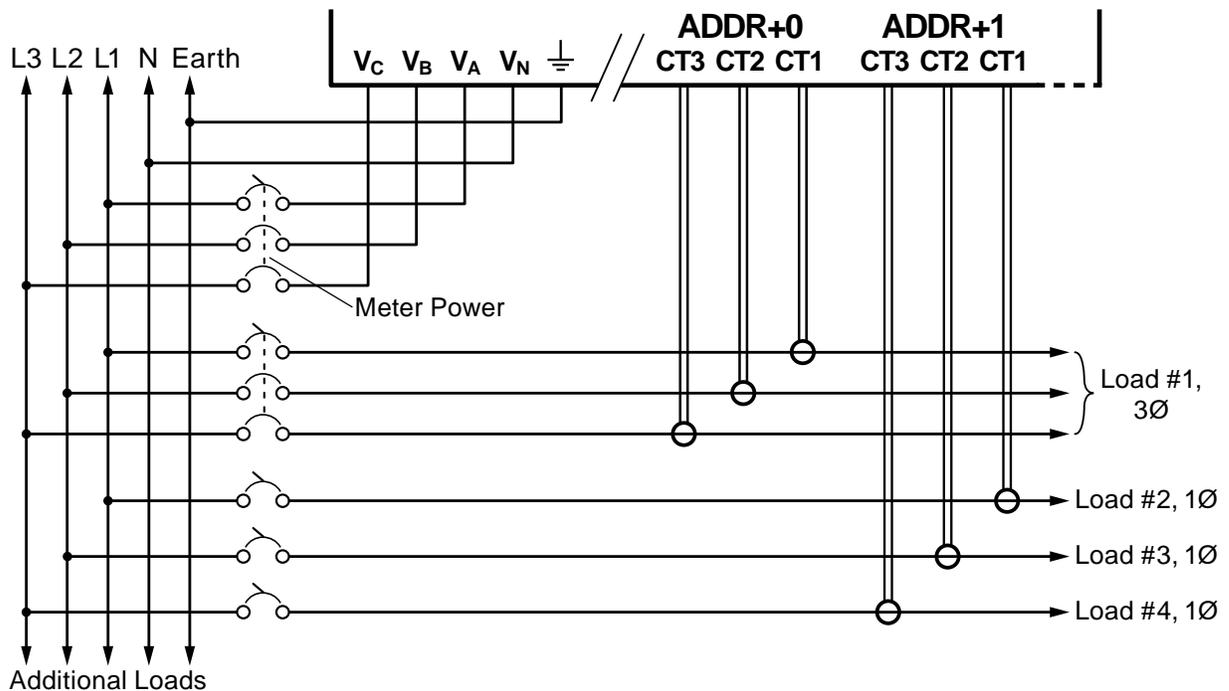


Figure 3: Three-Phase Four-Wire Wye

This service supports the following types of loads:

- **Three-phase, four-wire, wye (with neutral):** This requires three CTs. You do not need to change the **MeterConfig** registers if you wire the CTs as shown for load #1 above, with **CT1** placed around L1, **CT2** around L2, and **CT3** around L3.
- **Three-phase, three-wire, delta (no neutral):** See 3.2.2 Three-Phase, Three-Wire Delta below for details.
- **Single-phase, line-to-neutral:** This is metered with a single CT, as illustrated for loads #2, #3, and #4. The **MeterConfig** registers may need to be changed.

- **MeterConfig** = 10 for the CT around L1
- **MeterConfig** = 20 for the CT around L2
- **MeterConfig** = 30 for the CT around L3
- **Single-phase, two-wire, line-to-line, without neutral:** See 3.2.2 Three-Phase, Three-Wire Delta below for details.
- **Single-phase, three-wire, line-to-line, with neutral:** See 3.2.3 Single-Phase, Three-Wire (Split-Phase) below for details.

For loads with more than one CT, we recommend keeping all CTs on the same SMB.

### 3.2.2 Three-Phase, Three-Wire Delta

This service is common in commercial and industrial settings. It does not include a neutral conductor. Load #1 is three-phase, three-wire, delta, measured with three CTs. Load #2 is three-phase, three-wire, delta, measured with two CTs. Load #3 is single-phase, line-to-line, and measured with one CT.

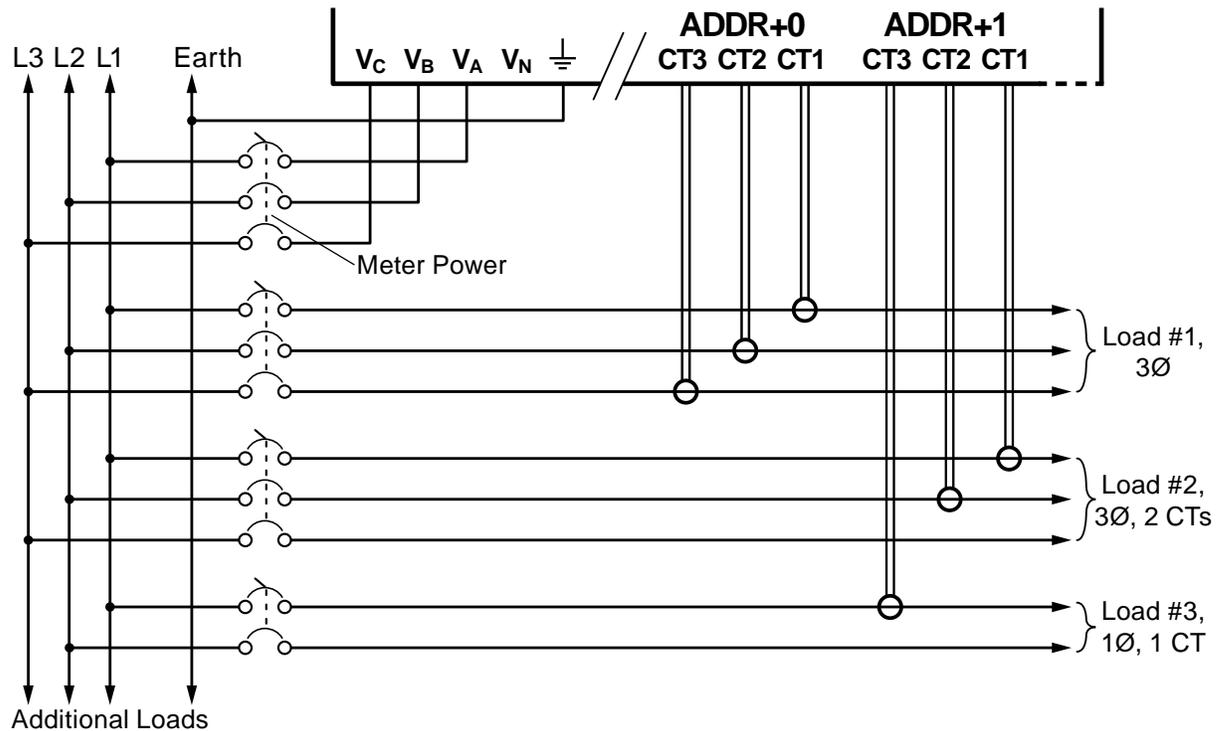


Figure 4: Three-Phase Three-Wire Delta

This service supports the following types of loads:

- **Three-phase, three-wire, delta (no neutral):** You may meter this with either three or two CTs.
  - With three CTs wired as shown for load #1 above, use the default **MeterConfig** values:
    - **MeterConfig1** = 10
    - **MeterConfig2** = 20
    - **MeterConfig3** = 30
  - With two CTs wired as shown for load #2 above, use the following **MeterConfig** values:
    - **MeterConfig1** = 90
    - **MeterConfig2** = 50
- **Single-phase, line-to-line:** You may meter this with one or two CTs.
  - With two CTs, use:
    - **MeterConfig** = 10 for any CT around L1

- **MeterConfig** = 20 for any CT around L2
- **MeterConfig** = 30 for any CT around L3
- With one CT, assign **MeterConfig** as follows:
  - The load connected from L1 (ØA) to L2 (ØB) and the CT around L1: **MeterConfig** = 40
  - The load connected from L1 (ØA) to L2 (ØB) and the CT around L2: **MeterConfig** = 70
  - The load connected from L2 (ØB) to L3 (ØC) and the CT around L2: **MeterConfig** = 50
  - The load connected from L2 (ØB) to L3 (ØC) and the CT around L3: **MeterConfig** = 80
  - The load connected from L3 (ØC) to L1 (ØA) and the CT around L3: **MeterConfig** = 60
  - The load connected from L3 (ØC) to L1 (ØA) and the CT around L1: **MeterConfig** = 90

For loads with more than one CT, we recommend keeping all CTs on the same submeter block.

### 3.2.3 Single-Phase, Three-Wire (Split-Phase)

This is the typical North American residential service at 120/240 Vac with a neutral connection. Load #1 is three-wire, with neutral, measured with two CTs. Load #2 is two-wire, with neutral, measured with one CT. Load #3 is two-wire, line to line, without neutral, measured with one CT.

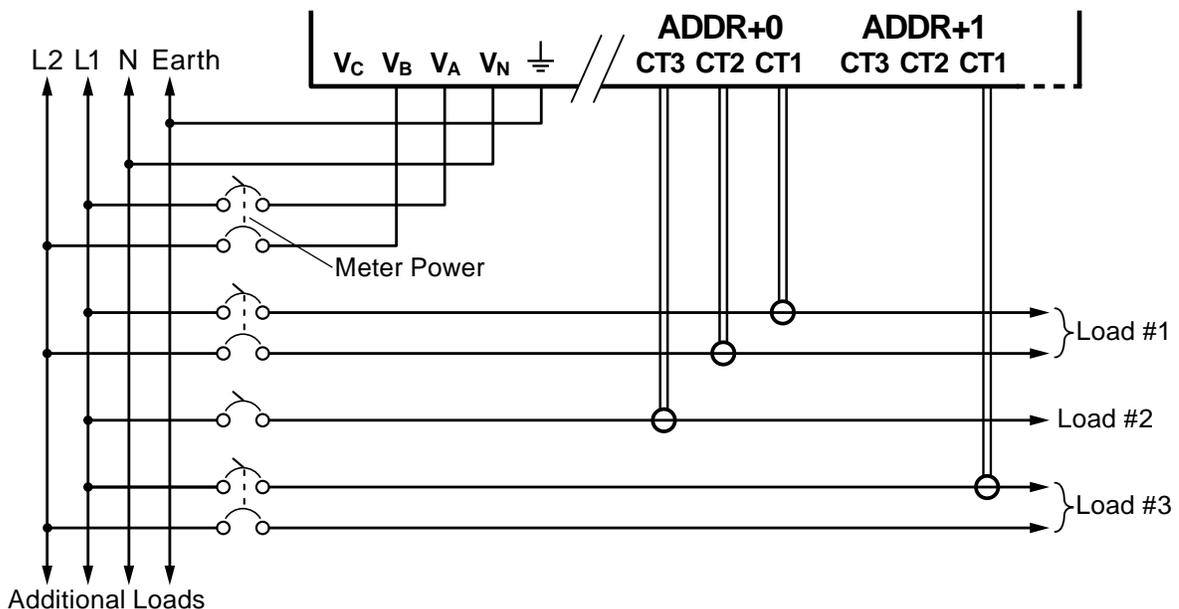


Figure 5: Single-Phase, Three-Wire

This service supports the following types of loads:

- **Single-phase, line-to-neutral:** This is metered with a single CT, as illustrated for load #2. The **MeterConfig** registers may need to be changed.
  - **MeterConfig** = 10 if the CT is around L1
  - **MeterConfig** = 20 if the CT is around L2
- **Single-phase, two-wire, line-to-line, without neutral:** See 3.2.2 Three-Phase, Three-Wire Delta above for details.
- **Single-phase, three-wire, line-to-line, with neutral:** This is metered with two CTs, as illustrated for load #1. The **MeterConfig** registers may need to be changed.
  - **MeterConfig** = 10 for the CT around L1
  - **MeterConfig** = 20 for the CT around L2

For loads with more than one CT, we recommend keeping all CTs on the same submeter block.

### 3.2.4 Grounded Leg Service

In rare cases with delta services or single-phase two-wire, line-to-line services, one of the phases may be grounded. The MCM will correctly measure the voltages, power, and energy for grounded leg services. Depending on how the **MeterConfig** registers are programmed, the measured voltage, power, and energy for the grounded phase may be zero, and the status LEDs will not light for the grounded phase. This type of service may result in unusual power factors.

See the web article [Corner-Grounded Delta Circuits](#) for more information.

### 3.2.5 Four-Wire Delta Service

There are several names for this service type, including high-leg, wild-leg, stinger leg, or wild phase. It is a three-phase delta service with a center-tap on one of the transformer windings to create a neutral for single-phase loads. These occur in North America in two configurations: 120/208/240 Vac and 240/415/480 Vac.

With the MCM, this service type can be measured just like any three-phase, four-wire wye service. By convention, you should connect the  $V_B$  terminal to the high leg. See the web article [Four-Wire Delta Circuits](#) for more information.

## 3.3 Installation Checklist

See the sections referenced below for installation details.

- Turn off power** before making line voltage connections.
- Mount the MCM (see [3.4](#)).
- If needed, connect any external circuit protection and disconnects (see [3.5.1](#)).
- Connect the line voltage wires (see [3.5](#)).
- Mount the CTs around the line conductors. Make sure the CTs face the source (see [3.6](#)).
- Connect the twisted white and black wires from the CTs to the black terminal blocks on the MCM, matching the wire colors to the white and black dots on the MCM label (see [3.6.2](#)).
- Document the information for each circuit (load) using the installation record. Whoever does the commissioning with need this record (see [3.1](#)).
- Connect the RS-485 output (for Modbus RTU) or the RJ45 Ethernet jack (for Modbus TCP) of the MCM to the monitoring equipment (see [3.7](#)).
- Configure the DIP switches (see [3.7.3](#)).
- Check that all the wires are secure in the terminal blocks by tugging on each wire.
- Turn on power to the MCM.
- Configure the appropriate MCM registers (see [4.1](#)).
- Verify correct operation using the LEDs or the Modbus interface (see [4.2](#), [4.4](#)).

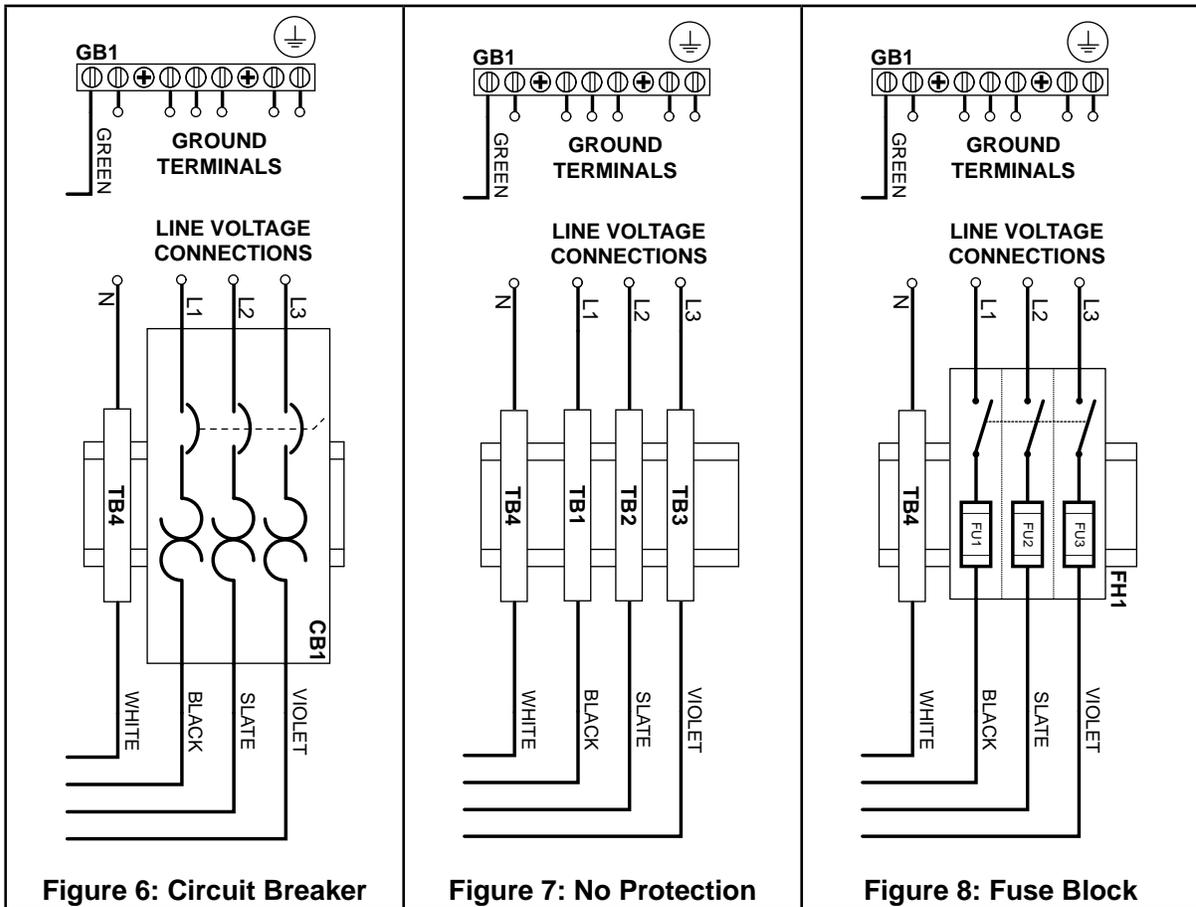
## 3.4 Mounting

The MCM is available in four NEMA rated enclosures, small and large, steel and fiberglass.

- Protect the MCM from temperatures outside its limits. See [5.6 Environmental](#).
- The MCM enclosure is rated for NEMA 4 (steel) or NEMA 4X (fiberglass). If you need to preserve this rating, be sure to use fittings with the same ratings.

The MCM enclosure can weigh up to 30 pounds (14 kg), not including the weight of any connected conduit. Mount it securely using the four holes in the mounting tabs. The steel enclosures include fixed mounting tabs with four 5/16 inch (7.9 mm) holes, while the fiberglass enclosures use detachable mounting tabs with four 11/32 inch (8.7 mm) holes.

## 3.5 Line Voltage Connections



### 3.5.1 Circuit Protection

The MCM is considered “permanently connected equipment” and requires a disconnecting means (circuit breaker or disconnect switch) and overcurrent protection (fuse or circuit breaker). Most models include a three-phase circuit breaker that functions as both a disconnect and overcurrent protection. The MCM draws less than 0.2 amps.

Note that the circuit breaker is only rated for operation from -25°C to +55°C (-13°F to 131°F).

- If you purchase a model with a three-phase fuse block, you will need to provide an external disconnect.
- Models with no protection will need an external disconnect and overcurrent protection.
  - Any external disconnect or circuit breaker must be clearly marked, suitably located, and easily reached.
  - Use circuit breakers or fuses rated for 20 amps or less and rated for the service voltage.
  - Use ganged circuit breakers when monitoring more than one line voltage.
  - The circuit breakers or fuses must protect all hot line voltages: **L1**, **L2**, and **L3**. Neutral does not need overcurrent protection.
  - The circuit protection/disconnect system must meet IEC 60947-1 and IEC 60947-3, as well as all national and local electrical codes.

### 3.5.2 Line Wiring

- **Always turn off the power** before connecting the line voltages.
- For the line voltage wires, CCS recommends 18 to 12 AWG stranded wire, type THHN, MTW, or THWN, 600 V.

- Use copper conductors only. The screw terminals are only rated for copper wire.
- Do not place more than one wire in a screw terminal; use wire nuts or terminal blocks if needed.
- Verify that the highest line-to-neutral or line-to-line voltage is nominally between 100 and 600 Vac. The absolute maximum operating voltage is 690 Vac.
- Torque all screws as specified on the information label on the inside of the enclosure door.

Connect neutral (if present) to the white DIN rail screw terminal (TB1) labeled **N**.

Connect line voltage conductor to **L1**, **L2**, and **L3** labeled terminals on the circuit breaker, fuse block, or DIN rail screw terminals.

Connect each line voltage wire, as shown in **Figure 6** through **Figure 8** above.

### 3.5.3 Grounding

The MCM includes a grounding block (GB1) in the upper-right corner of the backplate. Connect earth ground to any available position. See **Figure 6** through **Figure 8** above.

If you are using a fiberglass enclosure, use grounded conduit bushings and wire the bushings to the grounding block.

## 3.6 Current Transformer Connections

The meter must be used with UL Listed or UL Recognized current sensors or transformers. UL has only approved listed CTs for retrofit applications in panelboards; do not use recognized CTs for this application.

The standard MCM supports CTs with a 0.33333 Vac output (one-third volt). With the correct options, the MCM can support CTs with a 40 milliamp output: contact CCS for details.

### 3.6.1 Current Transformer Installation

See the web article [Selecting Current Transformers](#) for information on selecting appropriate current transformers (CTs).

- **WARNING:** To reduce the risk of electric shock, always open or disconnect the circuit from the power-distribution system or the building service before installing or servicing CTs.
- **WARNING:** When using UL Recognized CTs, they must be installed on insulated conductors only and maintained away from all live parts.
- **Do not** use 1 amp or 5 amp current output CTs!
- Treat CTs as class 1 circuits. They are not suitable for Class 2 wiring methods.
- Use plastic cable ties to secure the current transformers and route the lead wires so that they do not directly contact uninsulated live terminals or conductors.
- Split-core CTs can be opened for installation around a conductor. A nylon cable tie may be secured around the perimeter of the CT to prevent inadvertent opening.
- Do not install current transformers where they would: 1) exceed 75 percent of the wiring space of any cross-sectional area within the equipment, 2) would block ventilation openings, or 3) would be in an area of breaker arc venting.
- See the CT datasheets for the maximum input current ratings.
- To minimize current measurement noise, avoid extending the CT wires beyond 100 feet (30 meters), especially in noisy environments. You may extend the wires with twisted-pair wire 18 to 14 AWG, rated for 300 V or 600 V (not less than the service voltage) and shielded if possible.

Find the source arrow or label “THIS SIDE TOWARD SOURCE” on the CT and face/point toward the source of current. CTs are directional, so if they are mounted backward or with their white and black wires swapped, the measured power will be negative. The power status LEDs indicate negative measured power by flashing red. **Note: negative power and red LEDs may also occur if the**

**MeterConfig registers have not been configured yet.** This can be corrected after installation using the **CtDirections** register.

Install the CTs around the phase conductors to be measured as shown in section **3.2 Electrical Service or Load Types** above. Connect the CT leads to the MCM.

For revenue accuracy, use revenue-grade current transformers; other CTs are less accurate and may not provide revenue accuracy. Contact sales for more information on appropriate CTs.

### 3.6.2 CT Wiring

The current transformers connect to the six-position black screw terminal blocks for each submeter block. Connect the white and black CT wires to the terminals marked **CT1**, **CT2**, and **CT3**. See **Figure 1** for an overview. Excess length may be trimmed from the wires if desired.

The white and black lead wires mark the CT polarity. The polarity for the MCM is marked with **WHT** and **BLK** on the MCM board and with white and black circles on the connection diagram label on the inside of the front cover.

Connect each CT with the white wire aligned with the white dot on the connection diagram, and the black wire aligned with the black dot. Be sure to fill in the meter and CT schedule for each CT; see section **3.1 Installation Record** above. You will need this information for correct power measurement!

Torque the screws to 3.5 lbf·in (0.4 N·m).

## 3.7 Modbus RTU (RS-485) Communication

This section only applies for MCM-MB models (MCMxx-y-**MB**-zzzz) with Modbus RTU communication using the RS-485 physical link. The MCM-MB can be connected to PCs with RS-485 interfaces, gateways, data loggers, and other devices that accept RS-485 Modbus RTU.

### 3.7.1 RS-485 Cables

There are many choices for RS-485 cabling. Ideally, use cable specifically rated for RS-485 applications as it will have the best impedance for long distances to minimize interference and reflections. However, for distances up to 100 meters, especially at baud rates of 38,400 or lower, a special RS-485 cable is normally not required. See [RS-485 Cables for Modbus](#) for more information.

There are some standard conductor configurations for RS-485 cables:

- Two conductors without shield: we do not recommend using this type of cable because the MCM design expects the common terminal to be connected.
- Two conductors with a shield: use the two conductors for the **A-** and **B+** terminals, use the shield for **C** (common). If you connect the shield to earth, only connect it at the Modbus master device.
- Three conductors without a shield: use the three conductors for the **A-**, **B+**, and **C** (common). If two of the conductors are twisted together as a pair, use those for the **A-** and **B+** terminals.
- Three conductors with a shield: use the three conductors for the **A-**, **B+**, and **C** (common). If two of the conductors are twisted together as a pair, use those for the **A-** and **B+** terminals. The shield may be connected to earth at the Modbus master device for improved noise immunity.
- If there are additional conductors, they may be left disconnected.
- Use a twisted-pair cable to prevent interference.
- For longer distances (>30 meters) or electrically noisy environments, use shielded cable.

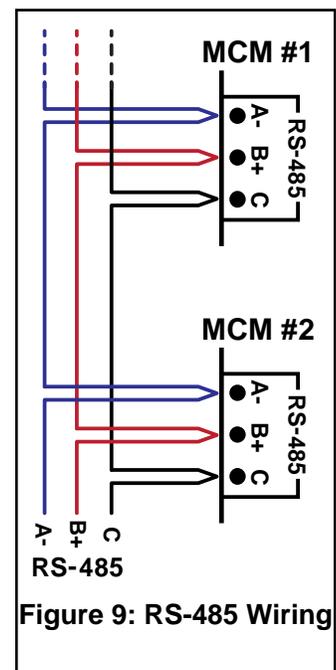


Figure 9: RS-485 Wiring

### 3.7.2 RS-485 Connection

RS-485 wiring can be complex when multiple devices are connected, when running wires for long distances, and when using termination and biasing resistors.

- The MCM RS-485 outputs are electrically isolated from dangerous voltages.
- If the output wiring runs near line voltage wiring, use wires or cables with a 300 V or 600 V rating (not less than the service voltage).
- If the output wiring runs near bare conductors, it must be double insulated or jacketed.
- RS-485 wiring may be daisy-chained between devices. Avoid a star or home run wiring system, where each device is wired back to the Modbus master, as this can cause signal reflections.
- You may install two wires into each screw terminal by twisting the wires together first.
- Torque the screws to 3.5 lbf·in (0.4 N·m).
- **Note:** one loose wire can disable an entire network section.

### 3.7.3 Modbus RTU DIP Switches

The MCM-MB uses two DIP switches to configure the address, the baud rate, termination, and biasing.

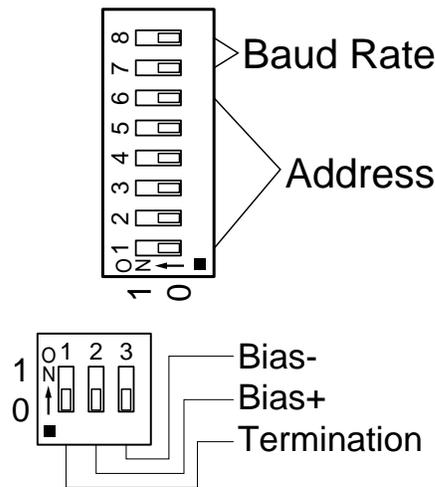


Figure 10: DIP Switches

Use DIP switches 1-6 from the upper switch to select the base Modbus address (1 to 63). Each submeter block has its own offset from the base address. The first submeter’s address is the base address, the next is the base plus one (designated as “ADDR+1”), and so on. **Note: do not set DIP switches 1-6 all off, since this would result in a base address of 0, which is invalid.**

Table 2: Modbus Address DIP Switch

DIP Switch	1	2	3	4	5	6
On (1) Value	1	2	4	8	16	32
Address	Examples					
1	1, On	0, Off				
1+2+4 = 7	1, On	1, On	1, On	0, Off	0, Off	0, Off
4+16 = 20	0, Off	0, Off	1, On	0, Off	1, On	0, Off
1+2+16+32 = 51	1, On	1, On	0, Off	0, Off	1, On	1, On

For example, if the DIP switch address is set to 2, then ADDR+0 = 2, so the address of the primary SMB will be 2, the address of the next SMB will 3, and so on.

Select the baud rate with DIP switch positions 7 and 8 (see below). The change will take effect immediately. Other baud rates may be factory configured or programmed using the **BaudRate** register.

**Table 3: Modbus Baud Rate DIP Switch**

Baud Rate	DIP Switch 7	DIP Switch 8
9,600 (default)	0, Off	0, Off
19,200	0, Off	1, On
38,400	1, On	0, Off
115,200	1, On	1, On

The RS-485 settings default to no parity, 8 data bits, and one stop bit (N81). Other parity and stop bit settings may be configured with factory options or with the Modbus **ParityMode** register.

Select the RS-485 termination and biasing using the lower DIP switches. Set DIP switch 1 to the **ON** position to enable 120  $\Omega$  termination. Set DIP switches 2 and 3 to the **ON** position enables RS-485 biasing with 1.2 k $\Omega$  ohm resistors.

## 3.8 Modbus TCP (Ethernet) Communication

This section only applies to MCM-MBT models (MCMxx-y-MBT-zzzz) with Modbus TCP using the Ethernet physical link. These models may have DIP switches present, but if so, they will be inactive.

The MCM-MBT uses a Lantronix XPort-IAP-05 with Modbus (part number XP1001000M-05R) to provide the Modbus TCP Ethernet interface. The XPort includes the following features:

- Modbus bridge from Modbus TCP (port 502) to Modbus RTU
- DHCP for automatic IP address assignment
- Telnet interface (port 9999) for advanced configuration
- Automatic discovery of devices (port 30718) with DeviceInstaller
- Supports ARP, ICMP (ping), and TFTP

Some XPort models support other features, such as a web interface, but this model does not.

The directions in this guide should be sufficient for most installations, but for more advanced configuration or additional details, see the following Lantronix links.

- Main XPort product page: <https://www.lantronix.com/products/xport/>
- DeviceInstaller utility: <https://lrxdev.atlassian.net/wiki/spaces/LTRXTS/pages/106070471>
- DeviceInstaller user's guide: [http://www.lantronix.com/wp-content/uploads/pdf/DeviceInstaller\\_UG.pdf](http://www.lantronix.com/wp-content/uploads/pdf/DeviceInstaller_UG.pdf)
- XPort user's guide: [https://cdn.lantronix.com/wp-content/uploads/pdf/XPort\\_UG.pdf](https://cdn.lantronix.com/wp-content/uploads/pdf/XPort_UG.pdf)
- XPort datasheet: [https://cdn.lantronix.com/wp-content/uploads/pdf/XPort\\_DS.pdf](https://cdn.lantronix.com/wp-content/uploads/pdf/XPort_DS.pdf)
- Modbus protocol guide: [https://cdn.lantronix.com/wp-content/uploads/pdf/Modbus\\_Protocol\\_UG\\_Rev\\_J.pdf](https://cdn.lantronix.com/wp-content/uploads/pdf/Modbus_Protocol_UG_Rev_J.pdf)

### 3.8.1 Ethernet Cables

The MCM-MBT communicates at 10 Mbit or 100 Mbit and will work with CAT5, CAT5e, CAT6, or better Ethernet cables with RJ45 plugs. Generally, the Ethernet cable will connect to an Ethernet switch, which then connects to the local area network (LAN). It may also be connected directly to another device, although a crossover cable may be required.

- The MCM-MBT Ethernet output is electrically isolated from dangerous voltages.
- If possible, route and secure the Ethernet cable away from line voltages.
- If you run the Ethernet cable near line voltage wiring, use cables with a 300 V or 600 V rating (not less than the service voltage).
- If the output cable runs near bare conductors, it must be double insulated or jacketed.

### 3.8.2 RJ45 Jack LED Indications

There are two LEDs on the RJ45 jack. They are used to indicate the connection speed and activity. In addition to these, the COMM LED shows Modbus traffic (see **4.3 Modbus Communication LED**).

#### Left LED (Link)

- Off = No link
- Amber = 10 Mbit
- Green = 100 Mbit

#### Right LED (Activity)

- Off = No link
- Amber = half-duplex
- Green = full-duplex

### 3.8.3 IP Address Configuration - DHCP

There are two methods of assigning the IP address to the MCM-MBT: DHCP and static IP. This section describes the DHCP options, while **3.8.5 Advanced Configuration** describes assigning a static IP.

We recommend using the MCM-MBT default DHCP configuration combined with a DHCP reservation on your DHCP server. A DHCP reservation tells the DHCP server to always assign the same IP address to a particular device, based on its MAC address. With this approach, the MCM-MBT will always have a known IP address. For this approach, you need the MAC address of the MCM-MBT, which is printed on the top label of the XPort like 00-80-A3-D4-50-CA (note, all XPort MAC addresses start with 00-80-83). The same MAC address (without the hyphens) is encoded in the Code 128 barcode on the label.



**Figure 11: Lantronix XPort MAC Address Label**

Once you know the MAC address, you can program that into your DHCP server. For larger organizations, contact your IT department for this step. For more information, search the internet for “DHCP reservation”. A similar approach is to let your DHCP server assign an IP address to the MCM-MBT, then find the assignment and convert it to a DHCP reservation so that it does not change in the future.

**Note: If you do not use a DHCP reservation or a static IP address, the DHCP server may not continue to reassign the same address over time.**

If you are not using DHCP, see **3.8.5 Advanced Configuration** below for information on assigning a static IP address.

### 3.8.4 Lantronix DeviceInstaller Utility

The Lantronix DeviceInstaller utility for Windows finds all Lantronix devices on a LAN (local area network), allows some basic query features, and includes a telnet client for advanced configuration. It is not necessary to use DeviceInstaller, but may be helpful if your MCM-MBT was automatically assigned an IP address, and you cannot determine the address, or if you need to perform advanced configuration.

Search the internet for **Lantronix DeviceInstaller** to find the latest version. Download and install the program, then run it. Windows may prompt you for firewall settings: be sure to allow it access to your local network. It uses port 30718 (0x77FE) to discover Lantronix devices and port 9999 for telnet access. On start up, it will search for all known Lantronix devices. If it finds more than one XPort device, you may need to use the MAC address to determine which is the correct MCM-MBT.

Once you have found the correct meter, you can double-click it to access more details. It may complain it could not access configuration details; this is common and does not indicate a problem. You may be able to click the **Configuration Records** tab to read the configuration. See **3.8.5 Advanced Configuration** below for more information.

### 3.8.5 Advanced Configuration

The XPort supports telnet access for advanced configuration. There are multiple telnet client options: there is telnet built into the Lantronix DeviceInstaller utility, Windows includes telnet although it may need to be enabled (see **3.8.6 Windows Telnet Client**), and you may use any other telnet client.

The XPort includes a unique default password for telnet access. The factory default password will be the UL Listing serial number from the label installed in the enclosure. For **Figure 12** below, the password would be "B 84728808" with a space between the B and the number.



**Figure 12: UL Listed Label**

If you are using the DeviceInstaller, click on the **Telnet Configuration** tab, then click **Connect** to connect. If you are using a different telnet client, connect using port 9999. The example below assumes the MCM's IP address is 192.168.1.100.

```
C:\> telnet 192.168.1.100 9999
```

If you do not know the IP address of the MCM, you will need to determine it by checking your DHCP server or using the Lantronix DeviceInstaller.

As soon as you are connected, the XPort will prompt you to enter the password. You must type it correctly on the first try (backspace does not work). As soon as you type the last character, it will show "Press Enter for Setup Mode"; press **Enter** to continue. If you make a mistake typing the password, you will need to disconnect and reconnect to try again.

Now, the XPort telnet interface will display the current configuration. See the figure below for an example.

```

Modbus/TCP to RTU Bridge
MAC address 0080A3D450CA
Software version V3.3.0.6 (180102) XPTE
Password :-----
Press Enter for Setup Mode

Model: Device Server Plus+! (Firmware Code:YM)

Modbus/TCP to RTU Bridge Setup
1) Network/IP Settings:
   IP Address ..... - 0.0.0.0/DHCP/BOOTP/AutoIP
   Default Gateway ..... --- not set ---
   Netmask ..... --- not set ---
   Telnet config password set
2) Serial & Mode Settings:
   Protocol ..... Modbus/RTU,Slave(s) attached
   Serial Interface ..... 57600,8,N,1,RS485
3) Modem/Configurable Pin Settings:
   CP1 ..... Not Used
   CP2 ..... Not Used
   CP3 ..... Not Used
4) Advanced Modbus Protocol settings:
   Slave Addr/Unit Id Source .. Modbus/TCP header
   Modbus Serial Broadcasts ... Enabled (Id=0 used as broadcast)
   MB/TCP Exception Codes ..... Yes (return 00AH and 00BH)
   Char, Message Timeout ..... 00000msec, 00200msec
7) Security Settings:
   SNMP ..... Disabled
   Telnet Setup ..... Enabled
   TFTP Download ..... Enabled
   Port 77FEh ..... Enabled
   Web Server ..... Disabled
   Enhanced Password ..... Enabled
   Port 77F0h ..... Disabled

D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..7) to change:

```

**Figure 13: XPort Telnet Configuration**

**WARNING: Only change settings in 1) Network/IP Settings. Changes to other settings may render the MCM-MBT inoperable.** The 2) *Serial & Mode Settings* is for the internal MCM network; if you change any of these settings, such as the baud rate, the XPort will not be able to communicate with the MCM submeter blocks (SMBs).

The *Network/IP Settings* can be used to assign a static IP address, specify a gateway, and a netmask.

To change these settings, press **1**, then perform the following steps. For each step, the current value is displayed in parenthesis; if you do not need to change it, press **Enter** to skip to the next field.

- 1) Enter each octet of the IP address followed by **Enter**. Use all zeros to configure DHCP.
- 2) Choose whether to set the gateway IP address (this is not usually needed). Type **Y** or **N**. If you select **Y**, then type each octet of the IP address, followed by **Enter**.
- 3) Choose whether to set the netmask (this is not normally needed). Type **Y** or **N**. If you select **Y**, then type each octet of the netmask followed by **Enter**.
- 4) Choose whether to change the telnet password. Type **Y** or **N**. If you select **Y**, then type the new password. It will display on the screen. **Be sure the password is correct and to record it.**
- 5) Finally, choose to save or quit without saving by typing **S** or **Q**.

The following figure shows an example of setting a static IP address to 192.168.1.100.

```
IP Address (000) 192.(000) 168.(000) 1.(000) 100
Set Gateway IP Address (N) ? N

Set Netmask (N for default) (N) ? N

Change telnet config password (N) ? N

...<displays new configuration>...

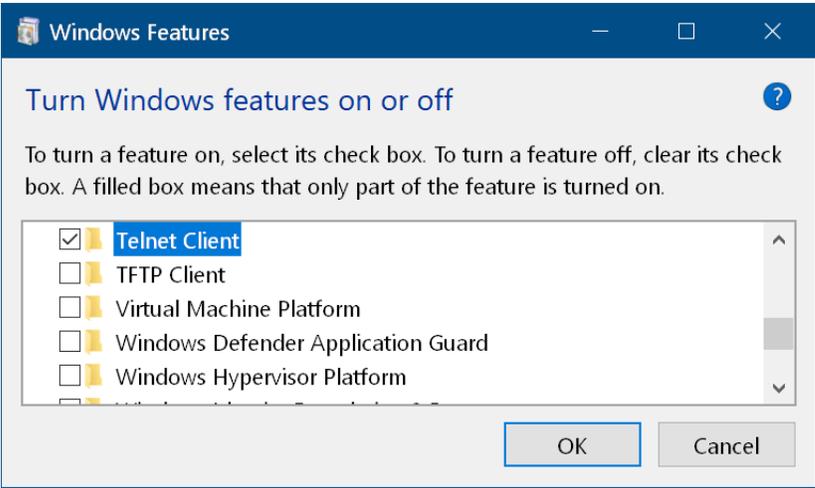
D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..7) to change:
```

**Figure 14: Change XPort Network/IP Settings**

### 3.8.6 Windows Telnet Client

If you are not using Lantronix DeviceInstaller, then you may need to install a telnet client. You may use any telnet program, but if you want to use the standard Windows telnet, and it is not already available, use the following steps to enable it.

- 6) Open “Control Panel”
- 7) Open “Programs”
- 8) Select the “Turn Windows features on or off” option
- 9) Check the “Telnet Client” box (see figure below)
- 10) Click “OK” and wait for the installation to complete



**Figure 15: Windows 10 Telnet Installation Dialog**

You can run telnet from the command line by typing something like the following, but change the IP address to match the address of the MCM. The 9999 is required because the XPort uses a custom TCP port number for the telnet interface.

```
C:\> telnet 192.168.1.100 9999
```

### 3.8.7 Modbus TCP Communications Configuration

The MCM-MBT includes the Modbus registers for RS-485 communication configuration, but they are read-only. There are no Modbus registers to configure the Ethernet interface. Instead, use telnet to configure the Ethernet interface.

The MCM-MBT only supports IPv4 and the standard Modbus TCP port number 502. See **3.8.3 IP Address Configuration - DHCP** and **3.8.5 Advanced Configuration** above for instructions on configuring the IP address.

## 4 Operation

### 4.1 Initial Configuration

Generally, the network integrator will remotely configure the MCM and the variables.

The MCM does not include a display or buttons, so it is not possible to configure or monitor it directly, other than some Modbus settings and the basic LED diagnostics described below.

**If you have not configured the *MeterConfig* registers, then the LED indications may be incorrect or misleading.** Be sure to configure the MCM before using the LEDs for diagnostics.

At a minimum, you must assign the **CtAmps** with the rated current (amps) of the attached current transformers for correct measurements. In many cases, with the MCM, it will be necessary to program the **MeterConfig** registers. If any CTs are installed backward, you can use the **CtDirections** register to correct the polarity. If you are using a potential transformer, then you will also need to configure the **PtRatio** register with the correct ratio. See the website article [Using Potential Transformers](#) for details.

### 4.2 Power Status LEDs

The three status LEDs for each submeter block (SMB) can help indicate correct measurements and operation. The “CT1”, “CT2”, and “CT3” on the diagrams correspond to the three meter elements of each SMB (see [1.2 Terminology](#)).

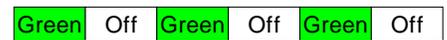
#### 4.2.1 Normal Start-Up

Each SMB displays the following start-up sequence whenever power is first applied.



#### 4.2.2 Positive Power

Any element with the LEDs flashing green indicates positive active power.



#### 4.2.3 No Power

Any element with a solid green LED indicates no power, but the line voltage is present.



#### 4.2.4 No Voltage

Off LEDs indicate no voltage on that element.



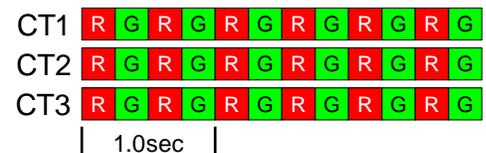
#### 4.2.5 Negative Power

Red flashing indicates negative power for that element. Reversed CTs, swapped CT wires, or CTs not matched with line voltage phases can cause this.



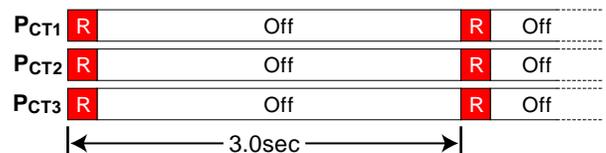
#### 4.2.6 Overvoltage Warning

The following indicates that the line voltage is too high for this model. **Disconnect power immediately!** Check the line voltages and the meter ratings (in the white box on the label).



#### 4.2.7 No Line Voltage

If the measured line voltages for all the elements of an SMB is less than 24 Vac, then the SMB will briefly flash all three status LEDs together every three seconds.



**Note:** it is possible to configure the meter elements using the **ConnectionType** or **MeterConfig** registers so that the meter elements are monitoring voltages that are near zero, even though higher voltage AC is being applied to other terminals. For example, if **MeterConfig1** = 10 (VoltA or  $V_A$ ), **MeterConfig2** = 10 (VoltA), and **MeterConfig3** = 10 (VoltA), and at the same time, VoltA is near zero, then this LED pattern will appear, even if 230 Vac is present on VoltB ( $V_B$ ) and VoltC ( $V_C$ ).

#### 4.2.8 Meter Not Operating

If none of the LEDs light, then check the line voltages applied to the MCM. If the voltages are correct, call customer service for assistance.

CT1	Off
CT2	Off
CT3	Off

#### 4.2.9 Error

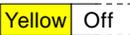
If the MCM experiences an internal error, it will light all LEDs red for three or more seconds. If you see this happen repeatedly, return the meter for service.

CT1	Red
CT2	Red
CT3	Red

|← 3.0sec →|

### 4.3 Modbus Communication LED

Near the lower-left corner, there is a diagnostic **COMM** (communication) LED that provides the following indications for both Modbus RTU (MBM-MB) and Modbus TCP (MCM-MBT) models. The Modbus TCP model will normally only show green flashes.

-  A short green flash indicates a valid packet addressed to this device.
-  Short yellow flashes or rapid flashing indicate valid packets addressed to different devices.
-  A one-second red flash indicates an invalid packet: incorrect baud rate, bad CRC, noise, incorrect parity, etc. This should never happen on Modbus TCP models.
-  Solid red indicates the address is set to zero: an invalid choice. This should never happen on Modbus TCP models.

### 4.4 Monitoring

The MCM communicates measurements over a Modbus RTU or Modbus TCP network. These include energy, power, voltage, current, line frequency, power factor, reactive power, and demand.

To monitor and configure the MCM, you will need an appropriate monitoring solution, either stand-alone or PC software.

### 4.5 Maintenance and Repair

The MCM ordinarily requires no maintenance. The MCM cards (white PCBAs) are not user-serviceable and contain no replaceable parts except the pluggable screw terminals. It is possible to replace the AC/DC power supply, the circuit protection, and the optional step-down transformer. Contact CCS technical support for assistance.

In the event of most failures, the MCM must be returned for service (contact CCS for an RMA).

The MCM should not ordinarily need cleaning. The enclosure may be cleaned with a dry or damp cloth or brush.

## 5 Specifications

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The following is a list of basic specifications. For extended specifications, see the datasheet <https://ctlsys.com/m/MCM-Datasheet.pdf>.

### 5.1 Measurement

**Update Rate:** 0.1 second. Internally, all measurements occur at this rate, except the energy registers, which update every 1.0 seconds.

**Start-Up Time:** ≤ 1 second after the supply voltage is applied.

**Default CT Phase Angle Correction:** 0.0 degrees.

### 5.2 Electrical

**Power Supply Voltages:**

**Table 4: Voltage Group Limits**

Voltage Group	Nominal Voltage	Min / Max Voltage	Connection
A	110 to 240 Vac	85 / 264 Vac	Line-to-neutral
B	208 to 240 Vac	166 / 264 Vac	Line-to-line
C	480 Vac	384 / 552 Vac	Line-to-line
D	277 Vac	222 / 318 Vac	Line-to-neutral
E	600 Vac	480 / 690 Vac	Line-to-line

**Over-Current Limit:** 200% of rated current. Exceeding 200% of rated current will not harm the MCM, but the MCM will not accurately measure current and power.

**Operating Frequencies:** 50/60 Hz

**Measurement Category:** The line voltage terminals on the MCM are rated for CAT III, 600 Vac

Measurement Category III is for measurements performed in the building installation. Examples are distribution boards, circuit breakers, wiring, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with a permanent connection to the fixed installation.

**Current Transformer Inputs:**

**Voltage Mode:**

**Nominal Input Voltage (At CT Rated Current):** 0.33333 Vac RMS

**Absolute Maximum Input Voltage:** 5.0 Vac RMS

**Input Impedance at 50/60 Hz:** 23 kΩ

**Current Mode (Opt MA):**

**Nominal Input Current (At CT Rated Current):** 40 mA RMS

**Absolute Maximum Input Current:** 200 mA RMS

**Input Impedance at 50/60 Hz:** 10 Ω

**Circuit Protection:**

**C - Three-phase circuit breaker:** three-pole; 480 Vac; 5A; 10kA UL 489 interrupting capacity; operating temperature -25°C to +55°C (-13°F to 131°F)

**F - Three-phase fuse block and fuses:** three-pole; 600 Vac; 2A; 100kA or greater interrupting capacity; time-delay; class CC; not rated as a disconnect; operating temperature range of -50°C to +125°C. **Note: the MCM is not rated for this range, so do not exceed the MCM's limits.**

**N - No circuit protection:** the MCM is provided with terminal blocks in place of the circuit protection to allow field wiring

### 5.3 EIA RS-485 Interface

**RS-485 Output Isolation:** 4500 Vac RMS

**Driver Output:**

**Voltage (Open Circuit):**  $\pm 6$  Vdc maximum

**Voltage (54  $\Omega$  load):**  $\pm 1.5$  Vdc minimum

**Current (54  $\Omega$  load):**  $\pm 60$  mA typical

**Rise Time (54  $\Omega$  || 50 pF load):** 900 nS typical

**Receiver:**

**Common-Mode Range:** -7 Vdc to +12 Vdc max

**Sensitivity:**  $\pm 200$  mV

**Bus Load:** 1/8 unit load, up to 64 devices

**Failsafe Modes:** bus open, shorted, and idle

### 5.4 Ethernet Interface

**Network Interface:** RJ45 Ethernet 10BASE-T or 100BASE-TX (auto-sensing)

**Ethernet Version:** 2.0/IEEE 802.3

**Ethernet Isolation:** 1500 V

### 5.5 Certifications

**Safety:**

**UL 61010-1:** 3rd Edition, UL file number E312220

**CAN/CSA-C22.2 No. 61010-1-12**

**UL 508A:** 3rd Edition, 2018, UL file number E495898

**Emissions:**

**FCC Part 15:** Class B, radiated and conducted emissions

**CISPR / EN 55022:** 1994, Class B, radiated and conducted emissions

### 5.6 Environmental

**Operating Temperature:**

**MCM12, MCM24, MCM36, MCM48, MCM60:**  $-30^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$  to  $158^{\circ}\text{F}$ )

**MCM72, MCM84:**  $-30^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$  to  $149^{\circ}\text{F}$ )

**All models with circuit breaker:**  $-25^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$  to  $131^{\circ}\text{F}$ )

**Altitude:** Up to 3000 m (9842 ft)

**Operating Humidity:** non-condensing, 5 to 90% relative humidity (RH) up to  $40^{\circ}\text{C}$ , decreasing linearly to 50% RH at  $55^{\circ}\text{C}$ .

**Pollution:** POLLUTION DEGREE 2 - Normally, only non-conductive pollution; occasionally, a temporary conductivity caused by condensation must be expected.

**Indoor Use:** Suitable for indoor use.

**Outdoor Use:** Suitable for outdoor use if electrical enclosure NEMA 4 rating is preserved.

### 5.7 Mechanical

See datasheet.

### 5.8 FCC Information

This equipment has been tested and complies with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may

not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The FCC limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## 5.9 Warranty

The MCM meter products sold by Continental Control Systems, LLC (CCS) are guaranteed against defects in material and workmanship for five years from the original date of shipment. CCS's responsibility is limited to repair, replacement, or refund, any of which may be selected by CCS at its sole discretion. CCS reserves the right to substitute functionally equivalent new or serviceable used parts.

This warranty covers only defects arising under normal use and does not include malfunctions or failures resulting from misuse, neglect, improper application, improper installation, water damage, acts of nature, lightning, product modifications, alterations, or repairs by anyone other than CCS.

**Except as set forth herein, CCS makes no warranties, expressed or implied, and CCS disclaims and negates all other warranties, including without limitation, implied warranties of merchantability and fitness for a particular purpose.**

For more information, see <https://ctlsys.com/warranty-and-return-policy/>.

## 5.10 Limitation of Liability

**In no event shall CCS be liable for any indirect, special, incidental, punitive or consequential damages of any kind or nature arising out of the sale or use of its products whether such liability is asserted on the basis of contract, tort or otherwise, including without limitation, lost profits, even if CCS has been advised of the possibility of such damages.**

**Customer acknowledges that CCS's aggregate liability to Customer relating to or arising out of the sale or use of CCS's products, whether such liability is asserted on the basis of contract, tort or otherwise, shall not exceed the purchase price paid by Customer for the products in respect of which damages are claimed. Customer specifically acknowledges that CCS's price for the products is based upon the limitations of CCS's liability set forth herein.**

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Continental Control Systems, LLC

+1 (303) 444-7422, <https://ctlsys.com>

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