CDPM Manual (Configurable Digital Panel Meter)

By Versalent **4-digit LED Scaleable/Offsetable Panel Meter**

Revised 2/22/24

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Description:

The CDPM is a precision, low-cost, very versatile panel meter with a 4-digit .36" LED display. It offers user-generated *display offset and scale factors* which separate the measurement scale from the display scale. (Measurement calibration factors are factory generated and remain fixed.) The result is a meter than can accurately measure 0-50mv/0-10V etc, and display it as 0.00 to 10.00, or 250.0 to 9560 for instance. The scale factors can even be negative which reverses the display to show 9560 down to 250.0 .

CDPM accepts configuration commands, and optional run-time commands using either the Versalent Command Protocol (models CDPMV) , or Modbus RTU & ASCII Protocols (models CDPMB). This manual describes the operation of both models when it refers to CDPM without a suffix. The term 'Modbus' by itself in this manual refers to both RTU and ASCII protocols.

CDPM is offered with either an RS232 or RS485 interface. RS485 units are addressable, so multiple units connected to the same communications line can talk to a single host. The Versalent Command Protocol (described below) is a very simple protocol/command set that uses ASCII characters – so simple that commands can even be manually entered. Modbus is an industry-standard protocol typically used by PLC's and other industrial hosts.

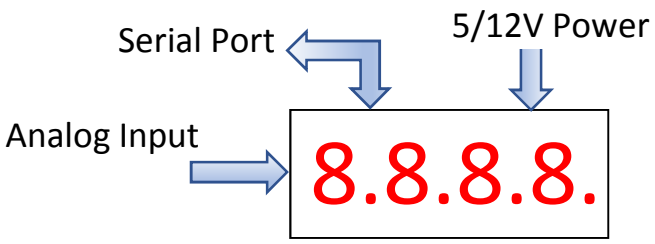
Available Devices/Description

Model Number	Serial Interface	Description
CDPMV2-xx-yy	RS232	Versalent Protocol, non-addressable, single-drop (host can talk to only one device per serial port)
CDPMV4-xx-yy	RS485	Versalent Protocol, addressable, multi-drop (host can talk to 1-248 units via one RS485 port)
CDPMB2-xx-yy	RS232	Modbus protocol, non-addressable, single-drop (host can talk to only one device per serial port)
CDPMB4-xx-yy	RS485	Modbus protocol, addressable, multi-drop (host can talk to 1-248 units via one RS485 port)

-xx-yy in model number specifies operating voltage, and input voltage measurement range

The RS232/RS485 communications port provides for user-configuration of the 8-decimal-digit scaling/offset factors.. Separate scalings means that ANY input voltage input range can be displayed as ANY digital display range. Display values can now be calibrated to units other than volts -- so it could show the number of gallons in a tank even if zero volts does not correspond to zero gallons. (Factory default configuration displays volts like other meters.)

CDPM



Once configured using the Versalent Configurator application, and with the configuration cable removed, the CDPM operates autonomously. However if it remains connected to its serial host, the CDPM offers more advanced features not available in other meters:

1. **Data Return:**
   A serial host can retrieve the meter readings for logging or perhaps to adjust an industrial process, or issue an alarm.
2. **Dynamic Re-configuration:**
   A serial host can send a few simple commands to change the scaling and offset to change the display from pounds to kilograms for instance.
3. **Display Functions:**
   The host can dim the display to one of 8 levels, flash the display, or even show any (cryptic) text message like 'Err9' that can be assembled from a list of characters that 7-segment displays can emulate.

The real power of the CDPM is the digital scaling and offsets which provide ***any display for any input***. The calculation of these factors requires a bit of math that the Versalent Configurator (Windows app) does for you. By entering just a few simple values, the scale/offset factors are calculated, and the press of a button sends them to the meter through a COM port. These values are retained until a new meter configuration is received. You can test-drive the CDPM with the online configuration and meter simulator tool.

In Summary:

User defined scaling/offset allows the CDPM to show ANY values between -9999 to +9999 for ANY input range from 50mv to 100V, and the Configurator application makes operation simple and easy. The meter shows a digitally scaled value in your units … psi in a pipe, gallons in a tank, microns of movement, etc. And because of the programmable offsets, the meter zero-input-display can be non-zero so the same input signal of 0V - 5V can be displayed as 55.5 to 5750 (units) , or -305 to 8860 (units).. using factors created by the Configurator. These are truly versatile meters.

CDPM Advantages:

The CDPM operates like a standard digital panel meter however it offers features not found in other meters:

1. Conventional DPM's offer measurements scaled to 200mv, 2V, 10V etc. and the display shows volts only with no zero-offset capability. The CDPM also offers this, but *because the display is separately scaled and offset*, it can be calibrated in your units. The full scale input range can be ordered in 21 different ranges (see below) and the measurement resolution is 12-bits.
2. CDPM can output its measured value via RS232/485 to your computer systems for logging or process control. Over/under range values (beyond +/-9999) cause the associated meter to flash OL ¯ ¯ or OL _ _ (overrange or underrange) . The input is internally protected from excessive voltages.
3. CDPM operates on +5VDC or +6 to + 12VDC depending on model.

Input Voltage Ranges Available:

CDPM offers a wide range of pre-calibrated input voltage ranges so there is never a need to adjust potentiometers. For best measurement resolution, order an input range that most closely encompasses the expected range of input signals, and use the Configurator to scale up or down digitally to get the display readings desired. These input voltage ranges are defined by assembly configuration and are not user-alterable.

CDPM Input Voltage Ranges Available

Model Code	Unipolar Input Range (Span)		Model Code	Bipolar Input Range * (Span)
0	0.0V to 50mV		1	-50mV to +50mV
2	0.0V to 100mV		3	-100mV to +100mV
4	0.0V to 200mV		5	-200mV to +200mV
6	0.0V to 1.0V		7	-1.0V to +1.0V
8	0.0V to 2.0V		9	-2.0V to +2.0V
10	0.0V to 5.0V		11	-5.0V to +5.0V
12	0.0V to 10.0V		13	-10.0V to +10.0V
14	0.0V to 20.0V		15	-20.0V to +20.0V
16	0.0V to 50.0V		17	-50.0V to +50.0V
18	0.0 to 100.0V		19	-100.0 to +100.0V
20	4.0mA to 20mA		-	-

TABLE 1

- For bipolar ranges the meter displays a portion of its bipolar voltage reference when the input is left floating

CDPM Configuration (using the Configurator):

The Configurator application organizes and simplifies the use of these very flexible meters. Scaling and offsets are auto-computed after a few simple entries. It can also generate dynamic configurations that the host can store/send during operation to change scaling or other meter functions instantly. To configure a CDPM, it must be connected to a PC via:

1) RS232 units can be connected to a DB9 COM port, or to a USB-COM adapter which provides a DB9. Versalent offers a CABLE-CC adapter cable for the JST 3-pin connector to aid in making this connection.
2) RS485 units can be converted to RS232 for configuration with an adapter like the DTECH 9001 for connection to a DB9 COM port. Or an RS485-USB adapter like the Cerrxian USB-RS485 . These are small and inexpensive converters.

Negative Display Values:

The CDPM shows up to 3 negative digits (continuously) using the left-most digit as a negative sign. It shows 4 negative digits by alternately flashing the minus sign by itself, then the 4 negative digits so it can display from -9999 to 9999 on a 4-digit display.

Overload Displays:

Because of the wide-ranging scaleability, and display-offset capabilities, it is possible to generate a display value beyond the -9999 to 9999 range even without exceeding the analog input range.

- If the applied input voltage exceeds the model's range by more than about 1.5% , an overload is generated and the display shows OL‾ ‾ (overscores flash).
- For Bipolar ranges, if the applied input voltage is lower than the model's range by about 1.5% an under-range is generated and the display shows OL _ _ (underscores flash).
- If the input voltage is within the model's range, but the scaling and offset factor cause the display to exceed +9999, the display shows OL‾ ‾ (overscores flash).
- If the input voltage is within the model's range, but the scaling and offset cause the display to be less than -9999, the display shows OL _ _ (underscores flash).
- 4-20mA meters show OL_ _ if the input current is less than 3.8 mA (broken wire).

Signal Connections:

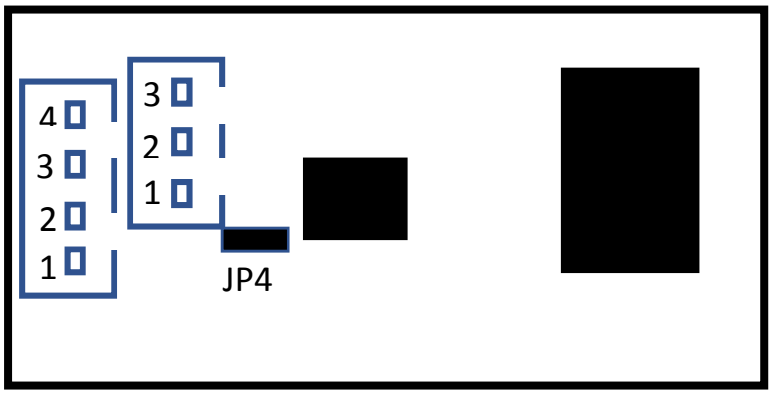
1) 4-Pin Power Connector. The mate is provided with 6" pigtails:
   Pin 1 is a Green Wire, Signal Ground. Connect to the signal source ground.
   Pin 2 is a White Wire, Signal Input. Connect to the signal source.
   Pin 3 is a Red Wire, Power Input. Connect to power source (5VDC or 6-12VDC)
   Pin 4 is a Black Wire, Power Ground. Connect to the power source ground.

   Signal source impedance should be kept as low as possible. Since the CDPM input impedance is > 1M ohm on all voltage-input ranges, a source impedance of:

   - 100 ohms causes a measurement error of about 0.01%
   - 1000 ohms causes a measurement error of about 0.10%
   - 10k ohms causes a measurement error of about 1.0%

2) 3-Pin RS232/RS485 Signal Connector. Connect to a Versalent model CDPM-CC adapter cable to convert the small connector to a DB9 Female RS232 DCE connector that plugs directly into a PC COM port. Or connect to an RS485 adapter/network.

   Pin 1 is a Black Wire, serial/power ground
   Pin 2 is a Blue Wire, RS232 RX signal or RS485 B signal
   Pin 3 is a Yellow Wire, RS232 TX signal or RS485 A signal



Rear View of CDPM

Connectors have ridges to allow gripping for removal – never pull on the wires. Connectors are JST XH2.54 types. Install JP4 to enable RS485 AC termination.

CDPM Specifications:

- 1 Analog input with 21 analog input ranges from 50mv to 100V
- 5V +/- 5% or 6-12V power :
  - 15mA typical (Minimum Brightness)
  - 60mA typical (Maximum Brightness)
- 0.36" high 4-digit LED display (red standard, other colors available)
- 0.25% accuracy all ranges >= 200mv @ 25°C, +/- .01%/°C
- 0.35% accuracy ranges < 200mv @ 25°C, +/- .01%/°C
- Zero-offset factory calibrated to +/- 1 LS digit all ranges
- Input Resistance:
  - UNIPOLAR voltage ranges > 1.0M to signal ground.
  - 4ma-20mA input resistance 100 ohms to signal ground.
  - BIPOLAR voltage ranges > 1M ohm to internal 2.5V reference.
- Dimensions: 1.9" X 1.1" X 0.9"

- Mounts in panel thickness of .030” to .15”
- RS232/RS485 command port 1200 to 115k baud, parity = none, even, odd, mark, space, 1 stop software configured.
- RS485 units have an onboard terminator (enabled by installing JP4 jumper)
- CDPMV provides the Versalent Protocol, CDPMB provides Modbus
- Programmable scaling and offset factors from -9999 to +9999 .
- Display Brightness programmable in 8 levels
- Connections via pluggable connectors
- Non-volatile parameter configuration endurance: 100k cycles typical

Reference Information

Protocol/ Command Set

The CDPMV provides either an RS232 or RS485 interface using the Versalent Protocol. [CDPMB units are also available providing Modbus protocols.] The Configurator application operates with both CDPMV and CDPMB devices and uses the protocol appropriate to the device type. These protocols are described below.

CDPM devices respond only upon command from a serial host, and addressed devices only respond when those commands contain an address matching their uniquely-assigned address. They cannot talk to each other, and they do not initiate any conversations with the host.

CDPM devices can momentarily annunciate/flash the right-most display decimal point on receipt of a command matching the unit address. The flash time is short so multiple consecutive commands generate a burst of flashes. When addressing is disabled, every command received (valid or invalid) flashes the LED. This annunciator feature can be enabled/disabled and is useful as an aid in diagnosing broken or reversed wiring, or invalid addressing -- from the front of the unit.

The front-panel annunciator LED has a secondary feature during Modbus operation: it stays on continuously if the CDPMB is placed in Listen-Only mode (with a specific Function 8 command). CDPMB stops responding to all commands except the one Function 8 command to release it from this mode. In Listen-Only mode, the CDPM can appear to have failed and since it cannot be queried for its mode, the annunciator LED remains ON continuously -- even if the Annunciator LED is disabled .

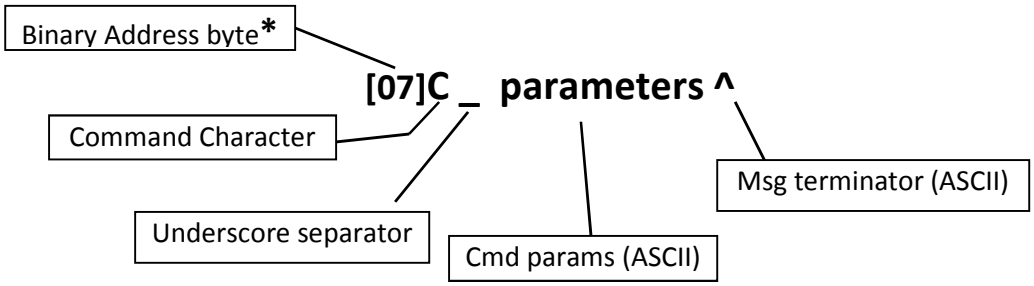
Serial Setup Parameters:

CDPM offers baud rates from 1200 to 115.2k with parity of NONE, EVEN, ODD, MARK, SPACE. This allow it to operate with a variety of serial hosts. The number of databits is always 8, and the number of STOP bits is always 1.

MARK parity sets the parity bit to the 'marking' state which is the same as the STOP bit state. So Mark parity can also be considered 8 databits with no parity and 2 stop bits. Modbus specifies that when operated with no parity, devices should instead use MARK parity to emulate no parity & 2 stop bits. To achieve the 2 stop bits/no parity referred to by the Modbus specification, you must specify MARK parity instead.

Versalent Command Protocol

Versalent Protocol Commands contain all ASCII characters -- except for an optional address byte which is binary (non-ASCII) - see below. Addressing can be enabled for both RS232 & RS485 devices. The single ASCII command character is followed by optional parameters, and terminated with a '^' character. All accepted commands receive a response which also ends with a '^' character. There are no check-characters to compute which does make the protocol less robust than Modbus, but greatly simplifies manual operation. The response can be an acknowledge with/without data, or an error message. The command format is:



*Address is an 8-bit byte shown above in hexadecimal format, enclosed in [ ] brackets

When enabled, the 8-bit address byte precedes the Command Character. This address uses the Modbus addressing format and can have a value of 0x01 – 0xF7 (1-247 decimal). When a unit is assigned an address in this range, it only responds when a command address matches it – and the response will also have that same address prepended. Address 0x0 is a broadcast address which all address-enabled units will accept <u>for the 'V' command only</u> (see below). Unit addresses set to 0xF8 – 0xFF cause addressing to be disabled – commands and responses contain no address.

Although RS232 units can operate with an address, each unit still requires its own serial port since multiple RS232 devices talking to one host port is not possible. RS485 units can operate in a 'multi-drop' configuration (multiple slaves talking to one master on shared serial lines). In this case addressing must be enabled and each daisy-chained unit must have a unique address. RS485 units can also operate with no address but the number of connected slaves is then limited to a single unit.

The Configurator is used to define meter scaling, set unit address, serial parameters , and exercise all CDPM features. It can find, then communicate with units that have an unknown address and unknown serial parameters. Versalent commands can also be sent manually using a terminal-emulator program for configuration or testing. To make this easier, when a CDPMV receives an unbroken sequence of 12 question marks (at any character spacing), it temporarily sets unit addressing to 0xFF – no addressing used, and extends the command timeout period from 20ms to 3 seconds to allow for slow command arrival. When the unit is power-cycled it returns to 20ms command timeout, and the unit address it had previously.

The underscore character '_' is the field-separator, and one must appear before each command parameter. Responses also separate parameters with a '_'. After a command is processed a response is returned to the host. All responses start with a single character indicating 'A'cknowledge or 'E'rror. An 'E'rror response always includes an error code (see error codes following command table) . Error message format:

E_e^ Error response for a bad/missing parameter, command timeout etc

e is a 1 or 2 ASCII digit code identifying the error

A separator character precedes the error code

A_p1_p2_p3^ An acknowledge response can include optional underscore-separated parameters and ends with a '^' terminator character.

When a command returns no data/parameters the 'A'cknowledge is A^ (no separator).

Commands should be issued one at a time with the host waiting for a response before issuing another command. Hosts should implement a response-timeout since noise could corrupt a response format.

Versalent Command Descriptions:

Command	Description
a_x^	**Set CDPMV address**. X represents one binary byte (0x1-0xFF) defining the unit address. Setting the value above 0xF7 forces no command or response addressing to be used . 00 is a broadcast address and therefore is not allowed as a device address. And 0x5E (ASCII '^') is also not allowed since it is the

message terminator. So values of 0x1-0xF7 cause the CDPMV to expect commands to contain that address, and it will return that address in its responses. Factory default = 0xFF. **Stored in non-volatile memory.**
The response is an "A^" acknowledge.

B_x_p^ **Set CDPMV baud rate/parity**. X represents one ASCII character from the following baud table and p represents one ASCII character from the parity table. Before changing these values, the CDPMV returns an "A^" acknowledge (or error) *at the initial baud rate/parity.* On success it then changes the values and is ready to accept commands at the new baud/parity. **Stored in non-volatile memory.**

Baud Rate	'x' value		Baud Rate	'x' value
1200	'0'		19.2k	'4'
2400	'1'		38.4k	'5'
4800	'2'		57.6k	'6'
9600	'3'		115.2k	'7'

Parity	'p' value
NONE	'0'
EVEN	'1'
ODD	'2'
MARK	'3'
SPACE	'4'

b_x^ ***Set/Get Meter Brightness*** The meter can be set to one of 8 brightness levels. X is a single ASCII character - '0' to '7' (preceded by a '_' parameter separator) which sets the level with '7' being the brightest. Factory default is '3'. The response is an ""A^" acknowledge. Value is **stored in non-volatile memory.**

If the command is issued without a parameter ("b^") the current brightness is returned as part of the acknowledge: "A_x^"

C_ x_y_z_n^ ***Set Meter Scaling and Offsets*** The x,y,z parameters (scaling, prescale offset, postscale offset) are the parameters that control the CDPM's independent

display scaling. Each is an up-to-8 decimal digit factor generated by the Versalent Configurator, and each parameter is preceded with a '_' parameter separator. For dynamic scaling, a user host can send a different set of previously generated (3/4) parameters. The last parameter is optional and can have only one value – the character 'n' : when present it causes **storage in nonvolatile memory** so the meter retains this scaling through power cycling. Without this parameter the meter operates in a 'temporary' (non-persistent) configuration and will revert to its last nonvolatile configuration on reset. Response is an "A^" acknowledge.

C^ ***Return Meter Scaling and Offsets*** This command returns the current configuration factors (scaling, prescale offset, postscale offset each prededed by a parameter separator) see x,y,z parameters immediately above. It retrieves them from operating storage (not nonvolatile) so if the meter is operating with a 'temporary' configuration, those are the parameters returned. Typical response:

A_0.994669_450.0_120.0^

y^ ***Return the model number*** string from the unit. The response is an 'A'cknowledge character, a parameter separator '_' ,then the full model number including input-range designation. Example:

A_CDPMV2-5-14^

Model No.

z^ ***Return serial number*** string from the unit. The response is an 'A'cknowledge character followed by a parameters separator '_' , the 7-character serial number, and the command terminator. Example:

A_1234567^

Serial No.

m^ ***Return Meter Display***. This command returns the (string) value that the meter most recently measured. During a text message display, this command continues to return scaled measurements – not the text message. If an overload HIGH "OL~ ~' or LOW "OL_ _" condition occurs, that text will be

returned since there is no valid measurement available. Otherwise the numeric display value is returned . The response is an 'A'cknowledge character , a parameter separator, and the display string. Example:

Response: **A_-60. 24^**

Note: if the display is alternately flashing the negative sign, and 4-digit value as described previously in **Negative Display Values**, the returned value will include the negative sign and remain steady .. it does not 'flash' like the LED display. Note that for overload HIGH the response is "OL~ ~" since there is no ASCII character for an overscore.

L_x^ ***Set LED Command Annunciator ON/OFF***. CDPMV can momentarily flash the display's right-most decimal point to indicate 'Command Received'. The feature is turned ON when x = '1' and OFF when x = '0' . Factory default is ON. The response is an "A^" acknowledge . **Stored in non-volatile memory.**

M_x^ **Create Message** This command allows you to create a cryptic text message which is NOT displayed until a subsequent 'S' (display style) command is issued. The four 7-segment displays can each show the following list of characters only:

A C E F H I L O P U b c d l l n o r u – 0 1 2 3 4 5 6 7 8 9 _ ? and ASCII Space for an empty character position . The x parameter represents a sequence of exactly 4 of these characters (no string terminator). Some valid text messages are: "Err5" , " P?09" . In addition, periods can be displayed AFTER any of the 4 characters by altering the preceding character setting its bit 8 to 1. So "P?En" is a valid 4 character message, and by altering the 'P' character from its normal 0x50 to 0xD0 (setting bit8=1) the display would be "P.?En " … Each of the 4 characters may display a trailing period. The response is an "A^" acknowledge. Stored in volatile memory.

N_w_x_y_z^ ***Store user entry values*** just as the user entered them in the Configurator. This allows the Configurator to retrieve/show the values the user entered to generate the meter's current scaling w-x-y-z are each numeric strings (each preceded with a '_' parameter separator) from the Input Value Low, Input Value High , Display Value Low , Display Value High fields respectively. Later, when the Configurator finds this CDPM connected, it retrieves and displays them. This command should be used if a host re-writes scaling parameters to non-volatile memory ('C' command above). Although this command is not necessary, it provides information on how the scaling was generated. The response is an "A^" acknowledge. **Stored in non-volatile memory.**

N^ ***Retrieve user entry values*** The response is A_w_x_y_z^ where w,x,y and z are the numeric strings that were entered into the Configurator and stored previously. (See N command above). Typical response:

A_0.0_10_-250_250^

S_f_t^ **Show Message ..** displays either solid or flashing, and either for a timed period or indefinitely until specifically turned off causing a return to the meter display.

F = 'S' (message ON solidly, no flashing)
f = 'F' (message flashes)
f = 'O' (turn current message OFF)

t = 1 to 4 ASCII numeric digits ('0' – '3600') specifying the number of seconds the message should persist with '0' meaning the message remains ON indefinitely. (When f='O' , t can be any valid value). The response is an "A^" acknowledge .

V^ ***Retrieve CDPM firmware version number***. This command is used by the Versalent Configurator to find a CDPM connected to the RS232 port. The response is an acknowledge followed by one string parameter -- typically 14 characters : **A_CDPMV v1.05^**

This command is unique – it is the only one that is accepted at the Versalent broadcast address = 0x0 as well as the unit's assigned address. When a unit's address is unknown, this command can be issued at address = 0x0 and if addressing is enabled (address < 0xF8) the unit will respond. The response contains the assigned address and can then be used to execute additional commands.

Command Timing:

- Versalent Protocol – Once a command has been started, that is the first character of a command has been received, each successive character must arrive within 20ms or the command times out and the device issues an error response.
- Modbus Protocol - Per the Modbus specification, if command characters/bytes are separated by more than 1.5 character-times, the received fragment is flushed. No response is issued, and the device must wait 3.5 character-times before beginning receipt of a new command. Command timeout varies with baudrate.

Many commands cause the CDPM to update its non-volatile memory which is a relatively slow process (5ms per byte). Command response may be delayed by 50-70ms for the 'C' command that writes 3 float-point values (12 bytes). The host should wait for a response from each command before issuing any new commands. Typically a host will wait for either a '^' message terminator in the response, or a maximum timeout period. When assigning its timeout, the host must consider the transfer-time of the command getting to the CDPM. At 1200 baud the 'C' command sends a maximum of 34 characters and the transfer time alone is just over 300ms. At 115.2k baud the transfer time drops to 3.5ms.

Since the non-volatile memory has a limited endurance (100k writes) the host should not send non-volatile *configuration* commands within any frequently repeating software loops. The non-volatile commands are identified in the Command Set above.

Versalent Protocol Command Error Code Reference:

Error Code	Description of Error
'1'	Unrecognized command
'2'	Bad Byte Count
'3'	Invalid Parameter
'4'	Wrong Number of Parameters
'5'	Bad Command Length
'6'	Bad Parameter #1
'7'	Bad Parameter #2
'8'	Bad Parameter #3
'9'	Bad Parameter #4
'10'	Non-Numeric Parameter
'11'	Command Buffer Overflow
'12'	Command Timeout
'13'	Bad Command
'14'	Invalid command key

CDPM Factory Defaults:

Unless ordered differently, the factory defaults for a CDPM are as follows:

- Input ranges configured per ordered model #. CDPMxx-P-R. P is either 5 or 12 indicating meter Power voltage, and R corresponds to a number from 0 to 20 designating the CDPM's input voltage Range. (first x = 'V' for Versalent Protocol, or 'B' for Modbus RTU Protocol. 2nd x = '2' for RS232 interface, or '4' for RS485 interface)
- Channel Scale/Offset = dependent on meter range. Scale/PreOffset/PostOffset set to display the input voltage.
- Annunciator LED = ON
- Meter Brightness Level = 3 (of 7)
- Baud Rate 19.2k
    - CDPMV - Versalent devices: Parity = None, Unit Address = 0xFF (disabled)
    - CDPMB - Modbus devices: RTU mode, Parity = Even, Unit Address = 1

Modbus Command Protocol

RS232/RS485 and Modbus:

CDPMB devices provide the Modbus RTU Protocol, and can be ordered with an RS232 or RS485 interface. Modbus requires messages to begin with a unit address – even RS232 single-drop devices. An RS232 host can talk to only one RS232 device per serial port, however the Modbus protocol still requires messages to be addressed.

RS485 Termination:

CDPM RS485 units have an onboard RS485 AC terminator which is enabled by installing JP4 (2mm jumper). This terminator is comprised of a 120 ohm resistor in series with a 1200pf capacitor. For a cable up-to-4000 ft long it is as effective at preventing signal reflections as a DC terminator (120 ohm/no capacitor) but dissipates little power. DC terminations with a 5V driver dissipate about ¼W.

The AC terminator's dissipation power depends on the operating frequency but at a maximum continuous-transmission baud of 115k this terminator would dissipate only 15mW . RS485 lines longer than about 20 feet are typically terminated – and should be terminated at the ends only. JP4 should be removed if an alternate terminator exists.

Modbus Command/Register Map | -- decimal -- |

Fctn Code	Modbus FCTN	Function	Num Regs	Adr Start	Register Value
06	Write 1 Reg	Set Baud/Parity	1	0	Baud/Parity fields
|	|	Set Unit Address**	1	1	0x1 – 0xF8
|	|	Set Annunciator LED	1	2	0=OFF, 1=ON
|	|	Set Brightness	1	3	0-7
|	|	Show Text Display	1	4	Style/seconds
|	|	Set Modbus Mode	1	5	0=RTU, 1=ASCII
16	Write Mult Reg	Scale/Preoff/Postoff	7	36	3 Floats + volatile
|	|	Create Text Display	2	15	4-characters
|	|	User-Entry Values	12	17	4X 6-characters
04	Read Regs	Read Annunciator LED	1	2	0=OFF, 1=ON
|	|	Read Brightness	1	3	0-7
|	|	Read Meter Display	3	4	6 Characters
|	|	Rd scale/preoff/postoff	6	36	3 Floats 2reg/ea
|	|	Read User-Entry Values	12	17	4 X 6-characters
|	|	Read Model #	6	30	12-characters
|	|	Read Serial #	4	42	7-characters
|	|	Read Firmware Vers**	6	46	12-characters

Fctn Code	Sub Function Code	Function	Command Data	Response Data
08	0	Return Query (Echo)	Any	Same
|	1	Restart Communications	0x0000 0xFF00	End Listen-Only ---------- End Listen-Only + Clear Comm Diagnostic Counts*
|	2	Return Diagnostic Register	0x0000	0x0000
|	4	Force to Listen-Only	0x0000	No Response
|	10	Clear Counters & Diag Reg	0x0000	0x0000
|	11	Return Bus Message Count	0x0000	Bus Msg Count*
|	12	Return CRC Error Count	0x0000	CRC Error Count*
|	13	Bus Exception Error Count	0x0000	0x0000
|	14	Return My Messsage Count	0x0000	My Msg Count
|	15	Return No Response Count	0x0000	No Response Count
|	16	Return Server NAK Count	0x0000	0x0000
|	17	Return Server Busy Count	0x0000	Server Busy Count

|	18	Return Char Overrun Count	0x0000	0x0000

** Special CDPMB commands which also responds to a CDPMB 'special' broadcast address 0xFF – which returns a response. (Standard Modbus broadcast address 0 does not allow for responses)

Modbus OPERATION:

CDPMB devices execute the following Modbus commands only (the 'B' indicates Modbus). These can be RS232 (CDPMB2) or RS485 (CDPMB4) devices and they offer all CDPM features such as dynamic display scaling, brightness control, text messages, display read-back etc. Note that per the Modbus Specification, even an RS232 device requires an assigned address of 0x1 – 0xF7. RS232 hardware is not multi-drop so only one RS232 device per host serial port is allowed.

Communicating with a Modbus device requires that the host know both the device address, and its serial baudrate & parity. The Versalent Configurator application has a 'Find CDPM' feature that can identify these settings for a connected CDPMB when none are known. It uses a broadcast address to scan all PC ports, all bauds/parities until it finds a responding unit. Once communications is established, these settings can be changed to desired values. Even if a unit has been assigned an invalid address (0, or 0xF8-0xFF), and unknown serial settings, the Configurator can still find and communicate with it ... to alter these settings.

Because there is no visible address switch, CDPMB uses the Modbus reserved address 0xFF as a broadcast address-with-return. This is non-standard, but required when unit settings are unknown. The only 2 commands that respond at this address are:

1) **Read Firmware Vers** - The Configurator uses this special command to find, then connect to a CDPMB with an unknown address. When this command is received at address = 0xFF, a connected unit responds with its actual address which the Configurator detects.
2) **Assign Unit Address** - The Configurator can use this special command to assign a valid 1-0xF7 address to a unit that does not respond to its expected address, or its assigned address is invalid (0xF8 – 0xFF).

These commands, when sent to address 0xFF, are intended for the use of the Configurator only, and should be sent to this address only when the unit is operating alone (no other slaves sharing its network).

Each Modbus command below includes a maximum response time which is measured from the end of the 3.5 character quiet time that trails each command, to the beginning of the normal response or error message. (Does not include the serial transit time of the response).

Modbus Command Descriptions

Modbus Command Command Description

Set Baud Rate/Parity: (Write Single Register Command)

Function Code 06, Start Address = 0, Baud Value:

Baud Value is a 16-bit value with 2 fields:

Field1 = lower 8-bits defines baud rate per table below (value = 0-7)
Field2 = upper 8-bits defines parity per table below (value 0-4)

The response is issued at the original baud rate/parity …. 100ms after the valid response has completed its transit to the host, the CDPMB changes to the newly assigned baud rate/parity. This value is stored in non-volatile memory. Factory default baud = 4 (19.2k baud), default parity = 1 (EVEN). **Stored in nonvolatile memory.**

Baud Rate	Value		Baud Rate	Value
1200	0		19.2k	4
2400	1		38.4k	5
4800	2		57.6k	6
9600	3		115.2k	7

Parity	Value
NONE	0
EVEN	1
ODD	2
MARK	3
SPACE	4

Command Structure:

Device Address	Functional Code	Address of 1st reg (Hi Byte)	Address of 1st reg (Lo Byte)	Reg Value (Hi byte)	Reg Value (Lo byte)	CRC (Lo)	CRC (Hi)
01	06	00	00	01	04	89	99
				(EVEN)	(19.2k)		

Set Address: (Write Single Register Command)

Function Code 06, Start Address = 1, Address Value = 1 to 0xF7

If the current address is known, this command can be sent to that specific address – and therefore can be issued while the unit is connected in a network of Modbus devices. CDPMB will also respond to this command at the CDPMB broadcast address = 0xFF. This can be used to 'recover' a device whose address is unknown, however it must typically be issued ONLY when the device is the only powered device in the network. This guarantees that another CDPMB, or other slave will not respond.

For this special command, the response is returned with the same address it arrived, unless the command was addressed to = 0xFF (special broadcast) which will cause it to return its newly assigned address. **Stored in nonvolatile memory.**

Command Structure:

Device Address 01	Functional Code 06	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 01	Reg Value (Hi byte) 00	Reg Value (Lo byte) 01	CRC (Lo) 19	CRC (Hi) CA

Set Annunciator: (Write Single Register Command)

Function Code 06, Start Address = 2, Value = 0 or 1

The annunciator LED is the right-most decimal point in the meter LED display. If this value is set=1, the LED flashes briefly upon acceptance of any valid command. If turned off (set value=0) it does not flash. Regardless of the state of this control, if the meter is commanded to Listen-Only mode this LED remains on continuously to provide a visual indication that responses should not be expected.

This command refers to the front-panel annunciator only. The rear-view yellow LED that flashes upon receipt of a command is not affected by this setting, and per Modbus specifications will flash when the unit receives a command/ issues a response. **Stored in nonvolatile memory.**

Command Structure:

Device Address 01	Functional Code 06	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 02	Reg Value (Hi byte) 00	Reg Value (Lo byte) 01	CRC (Lo) E9	CRC (Hi) CA

Read Annunciator: (Read Input Register)

Function Code 04, Start Address = 2, Registers to Read = 1

Retrieve the current annunciator status. 0 indicates that the annunciator is OFF, 1 = ON.

Command Structure:

Device Address 01	Functional Code 04	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 02	Number of regs (Hi byte) 00	Number of regs (Lo byte) 01	CRC (Lo) 90	CRC (Hi) 0A

Set Display Brightness: (Write Single Register Command)

Function Code 06, Start Address =3, Brightness value = 0 thru 7

The meter display can be dimmed to one of 8 brightness levels. The levels control the on/off duty cycle of the LED segments resulting in an apparent nonlinearity in the perceived brightness. **Stored in non-volatile memory.**

Command Structure:

Device Address 01	Functional Code 06	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 03	Reg Value (Hi byte) 00	Reg Value (Lo byte) 03	CRC (Lo) 39	CRC (Hi) CB

Read Display Brightness: (Read Input Register)

Function Code 04, Start Address = 3, Registers to Read = 1

Retrieve the current brightness level (0-7).

Command Structure:

Device Address 01	Functional Code 04	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 03	Number of regs (Hi byte) 00	Number of regs (Lo byte) 01	CRC (Lo) C1	CRC (Hi) CA

Set Modbus Mode: (Write Single Register Command)

Function Code 06, Start Address =5, Mode value = 0 or 1 (RTU or ASCII)

CDPM can use Modbus RTU or ASCII. This command can be issued to change from one to the other. Factory default = 0 (RTU) . The response to this command is issued in the same mode as the command was received. After this response, the new mode is in effect. **Stored in nonvolatile memory.**

Command Structure:

Device Address 01	Functional Code 06	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 05	Reg Value (Hi byte) 00	Reg Value (Lo byte) 00 --or-- 01	CRC (Lo) 39	CRC (Hi) CB

Set Meter Scale & Offsets: (Write Multiple Registers Command)

Function Code 16, Start Address =36, 7 registers:

First 2 registers = 4-byte floating point number representing scale factor
Next 2 registers = 4-byte floating point number representing prescale offset factor
Next 2 registers = 4-byte floating point number representing postscale offset factor
Last 1 register = 0 to store these values in volatile memory
= 1 to store these values in non-volatile memory

These 3 values control the display scaling for the CDPM and must be generated with the Configurator. Alternate scaling(s) can also be generated/stored and sent at any time during operation to change the meter's display (change units from lbs to kg, ^{o}C to ^{o}F etc.). Using the File->Save function stores both the string representation of these floats for Versalent Protocol (i.e. "- .0525") as well as the 4-byte 'encoded' value for Modbus Protocol which the user can load into a float value to recover the decimal string representation.

CDPMB transfers floats as their equivalent 4-byte little-endian representation which is compatible with .NET -- each float occupies 2 registers.

The last register controls the storage of these scaling factors. They **can be stored in non-volatile memory** so they are restored after a power cycle, **or in volatile memory** which does not persist. Non-volatile memory has a limited life (100k cycles). If the scale/offsets are changed frequently during operation, saving in volatile memory instead can extend operating life.

Command Structure:

Device Addr 01	Funct Code 10	Addr of 1st reg (Hi Byte) 00	Addr of 1st reg (Lo Byte) 24	Num regs (Hi byte) 00	Num regs (Lo byte) 07	Byte Count 0E	2- Data Registers	CRC (Lo)	CRC (Hi)
				Float Value #1 (4 bytes):			F787 3365		
				Float Value #1 (4 bytes):			0432 5776		
				Float Value #1 (4 bytes):			A536 9946		
				Volatility (1 register):			0001	XX	XX

Read Meter Scale & Offsets: (Read Input Registers)

Function Code 04, Start Address = 36, Registers to Read = 6

First 2 registers = floating point value as 4-bytes representing scale factor
Next 2 registers = floating point value as 4-bytes representing prescale offset factor
Next 2 registers = floating point value as 4-bytes representing postscale offset factor

These values are retrieved just as they were written in the previous command – except there is no trailing volatile value. The 3 floating point values are each returned as a sequence of 4 binary bytes which the host can convert to a floating point number if desired. These registers cannot be retrieved individually.

Command Structure:

Device Address 01	Functional Code 04	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 24	Number of regs (Hi byte) 00	Number of regs (Lo byte) 06	CRC (Lo) 30	CRC (Hi) 03

Read Model Number: (Read Input Registers)

Function Code 04, Start Address =30, Registers to Read = 6

Model No is a string of 12 characters i.e. CDPMB4-12-18 (12 characters max)

The response consists of the function code, the starting address and 6 registers holding the 12 character string.

Command Structure:

Device Address 01	Functional Code 04	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 1E	Number of regs (Hi byte) 00	Number of regs (Lo byte) 06	CRC (Lo) 10	CRC (Hi) 0E

Read Serial Number: (Read Input Registers)

Function Code 04, Start Address = 42, Registers to Read = 4

Serial number is a string of 7 characters i.e. ‘ 0023006’

The response consists of the function code, the starting address and 4 registers holding the 7 character string. The 8th (most significant) character is an ASCII SPACE and should be ignored.

String characters are returned most-significant-first, 2 characters per register. The register high-byte is the most significant character of the pair.

Command Structure:

Device Address	Functional Code	Address of 1st reg (Hi Byte)	Address of 1st reg (Lo Byte)	Number of regs (Hi byte)	Number of regs (Lo byte)	CRC (Lo)	CRC (Hi)
01	04	00	2A	00	04	D0	01

Read Meter Display As String: (Read Input Registers)

Function Code 04, Start Address = 4, Registers to Read = 3

Returns a string of 8 characters i.e. OL_ _ or -12.45 etc. There may be trailing spaces.

The string returned could be numeric if the display shows a measurement value, or could be text if the meter is in an Over/Under load condition. The Overload High condition returns the 4 characters "OL ~ ~". The LED display shows "OL ¯ ¯" (overscores). Overload Low returns "OL _ _". User-defined text messages are not returned even if one is currently being displayed. CDPMB continues to take measurements while displaying a text message, and continues to return that numeric (or Overload) string.

If a numeric display is flashing because it is alternately showing a 4-digit negative value and the negative sign, this command returns the meter display without the flash function. If the display is negative and 4 digits in size, the negative sign will be prepended to the string returned such as "-98.35" . The string may be left padded with spaces to fill the 6 characters field.

Command Structure:

Device Address	Functional Code	Address of 1st reg (Hi Byte)	Address of 1st reg (Lo Byte)	Number of regs (Hi byte)	Number of regs (Lo byte)	CRC (Lo)	CRC (Hi)
01	04	00	02	00	01	90	0A

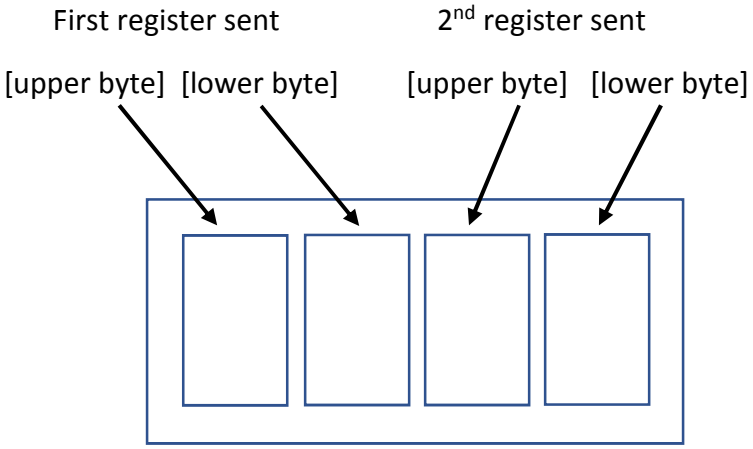
Create Text Display: (Write Multiple Registers Command)

Function Code 16, Start Address =15, 2 registers (4-char sequence)

Host must send exactly 4 characters from the CDPM's 'special character' list which can be emulated on a 7-segment display. To light the decimal point to the right of a character, the character's bit 8 is set =1 making it an 8-bit non-ASCII byte. Allowable character list :

A C E F H I L O P U b c d I l n o r u – 0 1 2 3 4 5 6 7 8 9 _ ? and ASCII Space for an empty character position . Some valid messages are: “Err5” , “ P?09” , “Er[0xB1]0”

The last string example above appears on the LED display as “Er1.0” because [0xB1] is the ‘1’ character [0x31] with its Bit 8 set = 1. The character in the upper byte of the first register appears on the LED display in left-most position. **Stored in volatile memory.**



CDPM LED TEXT DISPLAY

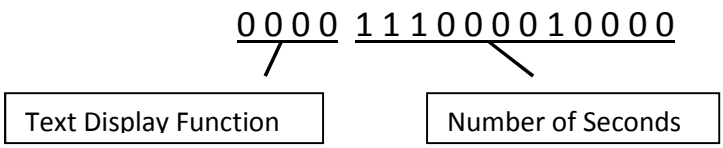
Command Structure:

Device Addr 01	Funct Code 10	Addr of 1st reg (Hi Byte) 00	Addr of 1st reg (Lo Byte) 0F	Num regs (Hi byte) 00	Num regs (Lo byte) 02	Byte Count 04	2- Data Registers “1234”	CRC (Lo) XX	CRC (Hi) XX

Show Text Display: (Write Single Register Command)

Function Code 6, Start Address =4, Value:

This function causes the CDPMB to display the previously set text message, either flashing or steady (or cancels the current text display). Value is one 16-bit register containing two fields as shown below. The most significant 4 bits (field 1) represents the display function, and the rightmost 12-bits (field 2) represent the persistence time in seconds from 0 to 3600 (0x0 - 0xE10) as shown below



Text Display Function	Description
0000	Text message ON steady (no flash) for the specified time
0001	Text message flashes on/off once per second for the specified time
0010	Text message display cancel. Revert to meter display immediately

When the number of seconds is set to 0, the text display remains ON (flashing or solidly) for an indefinite time period -- until the text message display is cancelled, or a power cycle occurs.

Command Structure:

Device Address	Functional Code	Address of 1st reg (Hi Byte)	Address of 1st reg (Lo Byte)	Reg Value (Hi byte)	Reg Value (Lo byte)	CRC (Lo)	CRC (Hi)
01	06	00	04	00	07	89	C9

Show Steady for 7 sec

Store User-Entry Values: (Write Multiple Registers Command)

Function Code 16, Start Address =17, 12 registers (4 6-character strings)

The 4 (numeric) strings which are entered on the Configurator screen and are used in calculating the scale factor, prescale offset, and postscale offset are stored in non-volatile memory. This allows them to be recalled by the Configurator when it detects a connected CDPMB. These values document how the meter factors were originally generated. The Configurator uses this command to store these user entries when factors are sent to the CDPMB .. and this command is available to a serial host . **Stored in nonvolatile memory.**

First 3 registers represent the Configurator's Lowest Applied Input entry (string)
The next 3 registers represent the Configurator's Highest Applied Input entry (string)
The next 3 registers represent the Configurator's Low Meter Display entry (string)
The last 3 registers represent the Configurator's High Meter Display entry (string)

Command Structure:

Device Addr 01	Funct Code 10	Addr of 1st reg (Hi Byte) 00	Addr of 1st reg (Lo Byte) 11	Num regs (Hi byte) 00	Num regs (Lo byte) 0C	Byte Count 18	3- Data Registers "1.3456"	CRC (Lo)	CRC (Hi)
							"0.5400"		
							" 0.010"		
							"10.234"	XX	XX

Read User-Entry Values: (Read Input Registers)

Function Code 04, Start Address = 17, Registers to Read = 12

This command retrieves the previously stored user-entry values (4 6-character strings).

Command Structure:

Device Address 01	Functional Code 04	Address of 1st reg (Hi Byte) 00	Address of 1st reg (Lo Byte) 11	Number of regs (Hi byte) 00	Number of regs (Lo byte) 0C	CRC (Lo) A0	CRC (Hi) 0A

The response consists of the function code, the starting address, and the 12 registers previously written. The 1st register in each group of 3 holds the two left-most string characters.

First 3 registers represent the Configurator's Lowest Applied Input entry (string)
The next 3 registers represent the Configurator's Highest Applied Input entry (string)
The next 3 registers represent the Configurator's Low Meter Display entry (string)
The last 3 registers represent the Configurator's High Meter Display entry (string)

Read Firmware Version: (Read Input Registers)

Function Code 04, Start Address = 46, Registers to Read = 6

The firmware version is a string of 12 characters which may contain trailing spaces. A typical version string is "CDPMB v1.05" **.**

This is one of two commands that can be accepted at the CDPMB broadcast address of 0xFF. This allows the Configurator to find and connect to a CDPMB with an unknown address. A Modbus response is normally returned with the same address contained in the command, however if that address is 0xFF, the CDPMB responds with the currently assigned address instead.

Command Structure:

Device Address	Functional Code	Address of 1st reg (Hi Byte)	Address of 1st reg (Lo Byte)	Number of regs (Hi byte)	Number of regs (Lo byte)	CRC (Lo)	CRC (Hi)
01	04	00	2E	00	06	10	01

Get Diagnostic Register: (Read One Registers)

Function Code 08, Sub-Function 0,1,2,4,10-18,

This diagnostic command returns:

Sub Function	Return value or function
0	Returns the command exactly as received
1	Restart communications/exit Listen Only, clear communcations count registers if data received = FF00
2	Return Diagnostic Register (always returns 0)
4	Forces Listen Only mode .. no response, Annunciator LED stays ON
10-18	Return one diagnostic counter per Modbus specifications

Command Structure:

Device Address 01	Functional Code 08	Sub Function (Hi Byte) 00	Sub Function (Lo Byte) above	Data reg (Hi byte) 00	Data reg (Lo byte) 00	CRC (Lo) 10	CRC (Hi) 01

CDPM Technical Info:

Comparison to Standard Dual-Slope Integrating Meters:

Conventional meters are often dual-slope A/D types which are inherently compensated for variations in their reference voltage(*) . CDPM uses successive approximation conversion which does not have this inherent reference insensitivity, however it achieves measurement stability by using a high stability voltage reference.

Noise Cancellation:

Another reason the dual-slope A/D conversion method was widely adopted for meters is its inherent noise immunity. Noise frequencies higher than 2X the sampling rate are reduced by the integration process. The CDPM uses a similar 'digital integration' technique which emulates analog integration to reject noise.

Measurement Resolution:

CDPM measurements are 12-bit (0 – 4095 A/D counts) however the upper 95 counts are reserved for offset and calibration uses, so measurements use the range of 0 – 4000. Therefore measurement resolution is +/- 1/4001 = +/-0.025% . Total measurement accuracy is +/- 0.25% from 10C to +40C .

Display Resolution:

The 4-digit display can show 0-9999 counts, so has a maximum resolution of +/- 1/10000 = +/- .01% (more than 2X higher than the measurement resolution). When digital scaling is set to show a maximum display of 4000, the measurement and display resolutions are the same, and each increment of measurement results in 1 count on the display.

If the display is scaled-up to show 8000 as its maximum, then as the measurement changes by one increment, the display will change by two units. For displays scaled to greater than 4000 units, display resolution = maximum display units/4000.

Calibration:

CDPM achieves it accuracy using two sets of digital calibrations factors:

1) Factory Calibration Factors .. these compensate for component tolerances, offsets etc – anything that contributes to the meter's zero or full scale inaccuracies. After factory calibration these values never change and are not alterable by the user.
2) Channel Calibration Factors .. these are the factors generated by the Configurator application and provide the meter with its ability to scale the display to any units. User can change scaling at any time as needed.

Both sets of digital calibrations are up to 8-decimal digits which assures that calculation accuracies are much better than 1 least-significant meter digit.

(*) The internal reference voltage is used to compare against an applied input voltage and arrive at a measured value. The technique of integrating a reference voltage, then de-integrating the input voltage renders the measurement insensitive to the actual value of the reference voltage.

FAQ/Trouble-Shooting:

Problem 1:	Display remains at 0 with non-zero voltage applied
Cause #1	Scale factor is set to 0.
Problem 2:	Display flashes negative when non-negative is expected.
Cause #1	Applying a voltage outside of the Input Range specified during Configurator setup. Adjust input voltage or modify Configurator settings.
Problem 3:	Display unexpected shows OL _ _ or OL ¯ ¯ ‐ ‐ .
Cause #1	Meter in overload (display value > 9999 or < -9999) due to input voltage beyond the range of the factory-configured input range or input voltage beyond the Input Low/High values specified during Configurator setup,
Problem 4:	(Bipolar Ranges) Floating input does not read 0.0 volts
Cause #1	Bipolar ranges use an internal voltage reference as an 'input offset'. It is normal than an unconnected input will display the offset (which varies with range), and not 0.0 volts. Connect the input to a signal voltage within the input range.
Problem 5:	Meters not showing values accurately.
Cause #1	**Signal Ground** should be connected to the CDPM connector.

Manual Revision History

Date	Description
11/22/23	Initial release
11/28/23	Add a command, change some text, fix a few text errors
12/29/23	Change 4mA-20mA input impedance to 100 ohms. Add Problem #4 to troubleshooting list.
1/2/24	Add connector diagram
2/22/24	Complete Modbus ASCII command descriptions, add table of contents