



The WattNode® Meter Module measures bi-directional energy, power, voltage, current, etc. It communicates using Modbus® RTU over RS-485. The Meter Module provides revenue-grade system accuracy when used with the CCS Accu-CT® family of revenue grade (C0.6 or better) current transformers.

Features

- One model can measure 120 to 600 Vac single-phase or three-phase, wye or delta services
- ANSI C12.20 class 0.5 and ANSI C12.1 accuracy
- Works with any 0.333 Vac current transformers and milliamp output CTs
- Instrument powered from 6-24 Vdc or 12-24 Vac
- Compact, DIN-rail mount design
- Also available as a PCBA for embedded applications

Links

- **Installation instructions:** <https://ctlsys.com/wp-content/uploads/2017/08/WND-Meter-Module-Modbus-Install-Manual.pdf>
- **Reference manual:** <https://ctlsys.com/wnd-module-modbus-ref-manual/>

1 Models

Table 1: Models

Model	Enclosure	Communication	UL Listed	Certificate of Calibration
WND-M1-MB	DIN	Modbus/RTU	Yes	No
RWND-M1-MB	DIN	Modbus/RTU	Yes	Yes
WND-M0-MB	none	Modbus/RTU	No	No
RWND-M0-MB	none	Modbus/RTU	No	Yes

- The models starting with RWND are provided with a certificate of calibration.
- The models with "-M0" in the model number are provided without an enclosure. They are not UL Listed and are intended for OEM integration into another product or system.

1.1 Options

1.1.1 Communications Options

The communications options are used to configure the Modbus address, baud rate, and other communications parameters.

Defaults: no parity, eight data bits, one stop bit

- **Option AD=xxx** – This is the Modbus slave address. If not specified, the default address is 1.
- **1.2K** - Set the baud rate to 1,200.
- **2.4K** - Set the baud rate to 2,400.
- **4.8K** - Set the baud rate to 4,800.
- **9.6K** - Set the baud rate to 9,600.
- **19K** - Set the baud rate to 19,200.

- **38K** - Set the baud rate to 38,400.
- **57K** - Set the baud rate to 57,600.
- **76K** - Set the baud rate to 76,800.
- **115K** - Set the baud rate to 115,200.
- **BAUD=xxx** - Set the baud rate to xxx, where xxx may be 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, or 115200. The shorter baud rate options like 9.6K are preferred.
- **EP** - Enable even parity (the default is no parity)
- **8N2** - Select two stop bits. The default is one stop bit.
- **T1** - Install a fixed (non-switchable) 120Ω burden resistor and 1.2k Ω bias resistors (to Modbus common and 3.3V). By default, the meter module does not provide termination or biasing.

1.1.2 Meter Element Configuration Options

These are used to configure the **ConnectionType** or **MeterConfig** registers.

Only one of the following two options may be specified for a particular meter.

- **CTR=x** - Set the **ConnectionType** register to x (the default is 1). See the [WND Meter Module Reference Guide](#) for more information.

Connection Type	Name	Meter Element Mapping	Service Types	Notes	Meter Config1	Meter Config2	Meter Config3
0	Custom	Custom	Any	May not be used with the CTR=x option	-	-	-
1	Wye	CT1-V _{AN} CT2-V _{BN} CT3-V _{CN}	3-phase 4-wire wye	May also be used for 3-wire and 4-wire delta services	10	20	30
2	Delta	CT1-V _{AC} CT2-V _{BC}	3-phase 3-wire delta	CT3 is not used. For center, floating, and corner grounded delta services.	90	50	0
3	Branch circuits	CT1-V _{AN} CT2-V _{AN} CT3-V _{AN}	1-phase, 2-wire with neutral	Use for monitoring 1-3 neutral connected branch circuits	10	10	10
4	House and Inverter	CT1-V _{AN} CT2-V _{BN} CT3-V _{AB}	See notes	1-phase, 3-wire with neutral for CT1 and CT2; 1-phase, 2-wire without neutral for CT3	10	20	40
5	Line to Line	CT1-V _{AB}	1-phase, 2-wire (no neutral)	CT2 and CT3 are not used	40	0	0

- **MCR=xx/yy/zz** - Set **MeterConfig1** to xx, **MeterConfig2** to yy, and **MeterConfig3** to zz. See the [WND Meter Module Reference Guide](#) for more information

The mapping from current transformer inputs to line voltage inputs is controlled with the MeterConfig registers. There are one meter element and one configuration register for each current transformer. For each meter element (CT), you can select the line voltage to be associated with that CT from the following list:

- 0 = Disable meter element
- 10 = V_{AN} (also called V_A), CT on phase A
- 20 = V_{BN} (also called V_B), CT on phase B
- 30 = V_{CN} (also called V_C), CT on phase C
- 40 = V_{AB}, CT on phase A
- 50 = V_{BC}, CT on phase B
- 60 = V_{CA}, CT on phase C
- 70 = V_{BA} (equal to -V_{AB}), CT on phase B
- 80 = V_{CB} (equal to -V_{BC}), CT on phase C
- 90 = V_{AC} (equal to -V_{CA}), CT on phase A

The default settings for the MeterConfig registers follow. These match the behavior of the older WNB and WNC meters:

- **MeterConfig1** = 10
- **MeterConfig2** = 20
- **MeterConfig3** = 30

1.1.3 Current Transformer Options

- **L** – Factory lock the CT amps rating, CT directions, CT gain adjust, CT phase adjust, and the creep limit configuration registers. The **CT=xxx** option must be used with this because it will not be possible to set the CT amps in the field. This option is recommended only if required due to security concerns.

Either of the following **CT=** options are recommended for easier installation.

- **CT=xxx** - Pre-assign xxx as the global **CtAmps** value for the current transformers.
- **CT=xxx/yyy/zzz** - Pre-assign xxx to **CtAmps1**, yyy to **CtAmps2**, and zzz to **CtAmps3**. This is used if non-matching CTs are connected to different inputs.

The following options are only for use with non-standard current transformers (CTs), such as milliamp output CTs or CTs with a full-scale output voltage other than 333.33 mVac. Most CCS CTs, including standard Accu-CTs, do not require any of the following options.

- **MA** - Specify that the meter is designed for 40mA output CTs. Equivalent to "Opt R=10,V=0.4".
- **R=xxx** or **R=xxx/yyy/zzz** - Specify the addition of burden resistance for all three CT inputs or individually for each CT input. This means a burden resistor is installed in the meter to allow use of a milliamp output CT. If this option is not specified, then there are no burden resistors installed in the meter and the meter must be used with 0.333 Vac CTs (internally burdened millivolt output CTs). The **xxx**, **yyy**, and **zzz** values are the ohms of the burden resistors. Contact the factory for supported values.
- **V=xxx** or **V=xxx/yyy/zzz** - Specify the full-scale CT output voltage for all three CT inputs or individually for each CT input. If this option is not specified, then 0.33333 Vac is the default value. The **xxx**, **yyy**, and **zzz** values are in units of volts. This supports values from 0.1 to 0.5 Vac. Values below 0.25 Vac may affect the accuracy for low-current signals.
- **PA=xxx/yyy/zzz** or **PA=xxx** – CT phase adjustment in millidegrees. The second form uses xxx as the adjustment for all three CTs. This option determines the values that are written to the **PhaseAdjust1**, **PhaseAdjust2**, and **PhaseAdjust3** configuration registers. Use negative values to compensate for a phase lead in the CT.

1.1.4 Cost Reduction Options

These options are normally only available if the Meter Module is ordered in high volume for OEM applications.

- **NDL** - No LEDs and no light pipes.
- **1PD** - (Single-phase delta) Only populate components for one CT channel (CT1). On the voltage inputs, do not populate or use low-cost/low-accuracy components for the N and L3 (phase C) inputs. Use normal connectors. Unless specified otherwise, this also sets **MeterConfig1,2,3** = 40, 0, 0.
- **1PY** - (Single-phase wye) Only populate components for one CT channel (CT1). On the voltage inputs, do not populate or use low-cost/low-accuracy components for the L2 and L3 inputs. Use normal connectors. Unless specified otherwise, this also sets **MeterConfig1,2,3** = 10, 0, 0.
- **1P** - (Single-phase) Only populate components for one CT channel (CT1). On the voltage inputs, do not populate or use low-cost/low-accuracy components for the L3 inputs. Use normal connectors. Unless specified otherwise, this also sets **MeterConfig1,2,3** = 10, 0, 0.

2 Specifications

2.1 Accuracy

The following accuracy specifications do not include errors caused by the current transformer accuracy or phase angle errors. "Rated current" is the current that generates a CT output voltage of 0.33333 Vac or equivalent milliamp output.

Unless otherwise noted, all accuracy specifications assume the following conditions:

- **Line voltage:** 100 to 690 Vac
- **Power factor (PF):** 1.0
- **Frequency:** 48 - 62 Hz
- **Ambient Temperature:** 23°C ± 5°C
- **CT Current:** 1% - 100% of rated current

Parameter	Test Conditions	Typ	Max	Unit
EnergySum, Energy1, 2, 3 ⁽¹⁾ (active energy)	elapsed time ⁽²⁾ >= 10 s	±0.2	±0.5	%
EnergySum, Energy1, 2, 3; PF 0.5 to 0.9	elapsed time ⁽²⁾ >= 10 s	±0.4	±0.8	%
PowerSum, Power1, 2, 3 (active power)	averaging >= 1 s	±0.3	±0.5	%
PowerSum, Power1, 2, 3; PF 0.5 to 0.9	averaging >= 1 s	±0.5	±1.0	%
VoltAN, BN, CN, VoltAB, BC, CA (RMS voltage)	averaging >= 1 s	±0.3	±0.5	%
Current1, 2, 3 (RMS current)	averaging >= 1 s	±0.25	±0.5	%
Freq (frequency)	averaging >= 1 s	±0.05	±0.2	%
PowerFactor1, 2, 3	averaging >= 1 s, PF > 0.5	±0.5	±1.0	%
EnergyReacSum, EnergyReac1, 2, 3 (reactive energy)	elapsed time ⁽²⁾ >= 10 s, PF < 0.9	±0.6	±1.5	%
PowerReacSum, PowerReac1, 2, 3 (reactive power)	averaging >= 1 s 0.5 < PF < 0.9	±0.6	±1.5	%
EnergyAppSum, EnergyApp1, 2, 3 (apparent energy)	elapsed time ⁽²⁾ >= 10 s	±0.3	±0.5	%
PowerAppSum, PowerApp1, 2, 3 (apparent power)	averaging >= 1 s	±0.3	±0.5	%

⁽¹⁾ Note: when parameters are written like Energy1, 2, 3, this means Energy1, Energy2, and Energy3.

⁽²⁾ Note: This indicates that energy accuracy should be evaluated over a period of 10 seconds or longer.

All models

- Meet the ANSI C12.1-2008 and ANSI C12.20-2010 class 0.5 accuracy requirements, excluding errors caused by attached current transformers.
- Meet the ANSI C12.1-2008 standard for revenue metering with CTs when used with class 0.6 or better current transformers.

2.2 Measurement

- **Update Rate:** Approximately 0.1 second, adjusted to an integer number of AC line cycles. All measurements are performed at this rate. All measurement registers except the energy registers can update as fast as every 0.1 seconds depending on the configuration of the **Averaging** register. The energy registers are updated from the internal values every 1.0 second.
- **Start-Up Time:** Measurements and energy accumulation start ~100 milliseconds after the supply voltage is applied. Modbus communication is enabled ~300 milliseconds after the supply is applied.
- **Default CT Phase Angle Correction:** 0.0 degrees.
- **Creep Limit:** 0.04% (1/2500th) of full-scale.

2.3 Modbus Communication

- **Protocol:** Modbus RTU (binary)
- **Baud Rates:** 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, and 115200
- **Duplex:** Half (two-wire plus common)
- **Parity:**
 - **Standard:** N81 (no parity, eight data bits, one stop bit)
 - **Optional:** E81 (even parity, eight data bits, one stop bit)
 - **Optional:** N82 (no parity, eight data bits, two stop bits)
- **Modbus Buffer:** 256 bytes
- **Communication Response Time:** 5 - 25 milliseconds (may be longer immediately after a Modbus write command, while values are saved to non-volatile memory).

2.4 Electrical

2.4.1 Power Supply

- **Nominal Power Supply Voltage:** 6 to 24 Vdc or 12 to 24Vac
- **Power Supply Minimum Operating Voltage:** 6 Vdc or 10 Vac
- **Power Supply Absolute Maximum Voltage:** 40 Vdc or 30 Vac
- **Power Supply Watts:** typical 0.6 W, maximum 1.0 W

- **Power Supply Current (milliamps):**

DC Supply Volts	Typical (mA)	Maximum (mA)
6	90	130
12	50	70
18	35	50
24	30	45
30	27	40

2.4.2 General Electrical

- **Line Frequency:** 45 to 65 Hz
- **Nominal Line-to-Neutral Vac:** 90 to 347 Vac
- **Nominal Line-to-Line Vac:** 120 to 600 Vac
- **Measurement Over-Voltage Limit:** 720 Vac. If the line voltage for one or more phases exceeds this limit, voltage, power, and energy accuracy will be reduced until the voltage drops below 720 Vac. The WattNode can handle line surges up to 6 kV, but extended over-voltage operation may damage the meter and void the warranty.
- **Over-Current Limit:** 200% of rated current. Exceeding 200% of rated current will not harm the meter, but the current and power will not be measured accurately.
- **Maximum Surge:** EN 61000-4-5: 2kV, ANSI C12.1 combination wave: 6kV, 1.2/50 μ s – 8/20 μ s
- **Line Voltage Power Consumption:** The line voltage sensing circuitry draws 0.006 watts per phase at 120 Vac, increasing to 0.150 watts per phase at 600 Vac.
 - **Real Power (50-60 Hz):** \leq 0.2 watts
 - **Power Factor:** \sim 1.0
 - **Rated VA:** 0.25 VA at 720 Vac, 50 Hz. The Rated VA is the maximum at 115% of nominal Vac at 50 Hz.
- **Measurement Category:** The line voltage measurement terminals on the meter are rated for CAT III, 600 Vac Measurement Category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, busbars, 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.

2.4.3 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 k Ω
- **Current Mode:**
 - **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

2.4.4 EIA RS-485 Interface

- **RS-485 Output Isolation:** 4500 Vac RMS
- **Driver Output:**
 - **Voltage (Open Circuit):** \pm 6 Vdc maximum
 - **Voltage (54 Ω load):** \pm 1.5 Vdc minimum
 - **Current (54 Ω load):** \pm 60 mA typical
 - **Rise Time (54 Ω || 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 256 WattNode meters per subnet)
 - **Failsafe Modes:** bus open, shorted, and idle

2.5 Regulatory

- **Safety:** meets European Parliament Directive 2014/35/EU: Low Voltage Directive
 - UL Listed (U.S. and Canada), file number E312220
 - UL / IEC 61010-1, 3rd Edition
 - CAN/CSA-C22.2 No. 61010-1-12, 3rd Edition
- **FCC:** Class B, FCC Part 15, radiated and conducted emissions
- **EMC:** meets European Parliament Directive 2014/30/EU: Electromagnetic Compatibility
 - **EMC Requirements:** EN 61326-1: 2013, industrial locations
 - **Radiated Emissions:** CISPR / EN 55011, Class B
 - **Conducted Emissions:** CISPR / EN 55011, Class B
 - **Electrostatic Discharge:** EN/IEC 61000-4-2: (B) Self-Recovering
 - **Radiated RF Immunity:** EN/IEC 61000-4-3: (A) No Degradation
 - **Electrical Fast Transient / Burst:** EN/IEC 61000-4-4: (A) No Degradation
 - **Surge Immunity:** EN/IEC 61000-4-5: (A) No Degradation
 - **Conducted RF Immunity:** EN/IEC 61000-4-6: (A) No Degradation
 - **Power Frequency H-field Immunity:** EN/IEC 61000-4-8: (A) No Degradation
 - **Voltage Dips, Interrupts:** EN/IEC 61000-4-11: (B) Self-Recovering
- **RoHS 2 Compliant:** European Parliament Directive 2011/65/EU: Hazardous Substances

2.6 Environmental

- **Operating Temperature:** -40°C to +80°C (-40°F to 176°F)
- **Operating Humidity:** non-condensing, 5 to 90% relative humidity (RH) up to 40°C, decreasing linearly to 50% RH at 55°C.
- **Operating Altitude:** Up to 3000 m (9842 ft)
- **Pollution:** POLLUTION DEGREE 2 - Normally only non-conductive pollution; occasionally, a temporary conductivity caused by condensation must be expected
- **Degree of Protection:** IP40 (>1 mm solids, no protection from liquids)
- **Indoor Use:** Suitable for indoor use
- **Outdoor Use:** Suitable for outdoor use if mounted inside an electrical enclosure (Hammond Mfg., Type EJ Series) rated NEMA 3R or 4 (IP 66)

2.7 Mechanical

2.7.1 Standard Enclosure

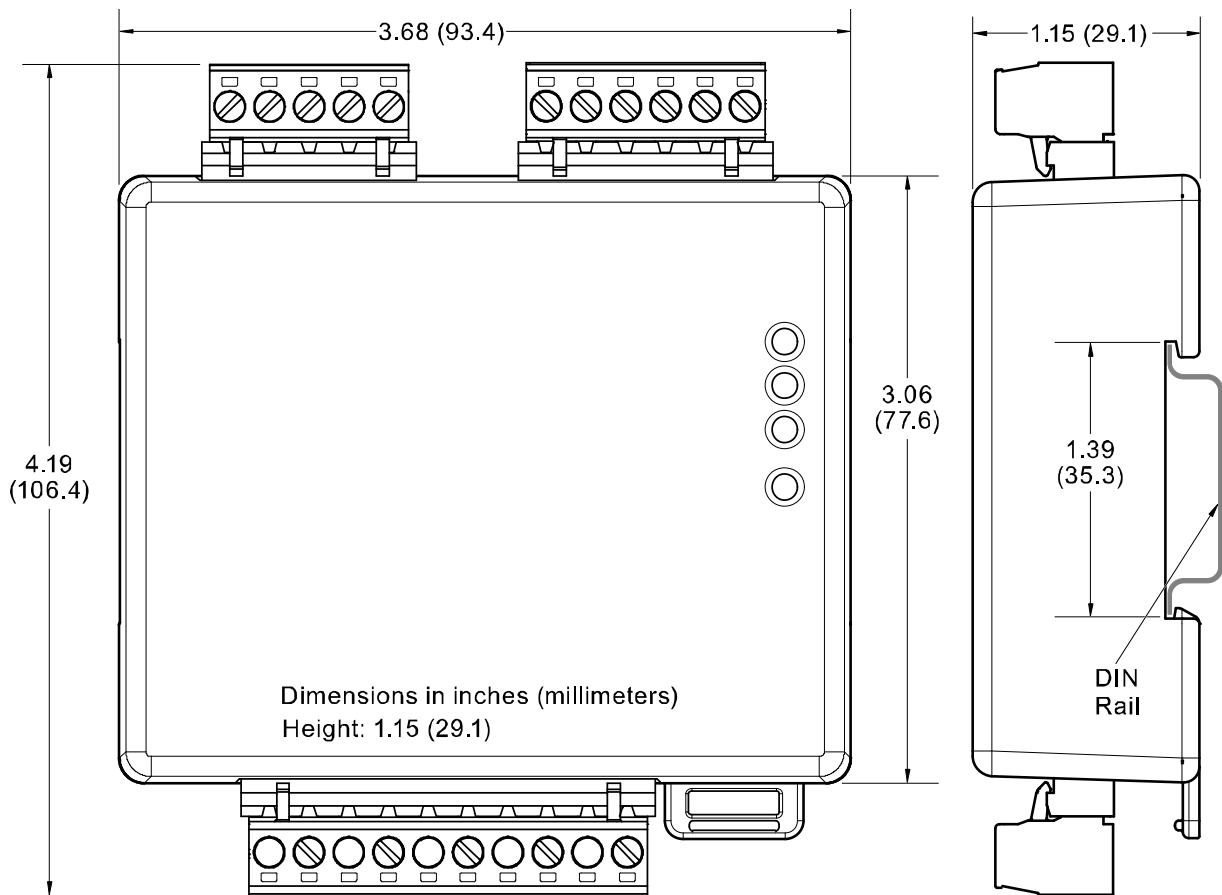
- **Enclosure:** High impact, ABS/PC plastic
 - **Flame Resistance Rating:** UL 94V-0, IEC FV-0
 - **Overall Size:** 4.19 in. x 3.68 in. x 1.15 in. (106.4 mm x 93.4 mm x 29.1 mm)
- **Weight:** 134 gm (4.7 oz)

2.7.2 DIN Rail

- EN 50022, 35 mm, top hat section rail, also called type O, type Ω, or TS35
- Compatible with 7.5 mm depth and 15 mm depth rails

2.7.3 Connectors

- **Connectors:** Euroblock pluggable terminal blocks
 - **Green:** up to 12 AWG or 2.5 mm², 600 V
 - **Black:** up to 12 AWG or 2.5 mm², 300 V



2.7.4 No Enclosure (PCBA Only)

Note: without the enclosure, the meter module is not UL Listed or Recognized.

