

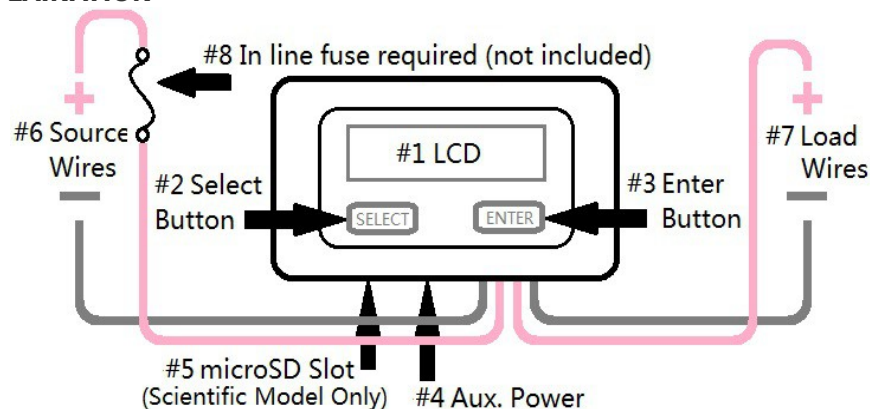
Coulometrix™ ,LLC



Metiri™ Scientific COUMET60100SB Metiri™ Hobbyist COUMET60100HB Smart Energy Meter

Users Manual for Firmware ver: 0.8.8

QUICK PRODUCT EXPLANATION



1. **LCD:** Back-lit primary display.
2. **Select Button:** Touch sensitive button with LED touch indicator. Press to scroll through data options or Smart Graph.
3. **Enter Button:** Touch sensitive button with LED touch indicator. Press to return to the main screen. If on the main screen, will scroll through set-up options.
4. **Aux. Power:** Female socket for device auxiliary power, 5.0Vdc +/-10%. Compatible with USB mini-B Plug.
5. **MicroSD Slot (Scientific Model Only):** Card slot for recording of measured values. Can accept standard microSD flash memory formatted with FAT32. Metiri™-S will automatically detect card, create a CVS file, and start writing measured data.
6. **Source Wires:** Connect to power source or battery up to +60Vdc. Current flowing from Source to Load is considered positive current. Forward continuous current should never exceed 70 amperes.
7. **Load Wires:** Connect to power load or battery up to +60Vdc. Current flowing from Load to Source is considered negative current. Negative continuous current should never exceed 70 amperes.
8. **In Line Fuse (Sold Separately):** The Metiri™ products do not provide protection against too much current flowing through it. A fuse installed in series with the positive Source Wire is required. Current flowing through the Metiri™ product should never exceed the current specified in the Safe Operating Area graph.

TECHNICAL SPECIFICATION

Model Number	COUMET60100HB	COUMET60100SB
Maximum Operating Values		
Voltage Operation Range	+5.5Vdc to +60.0Vdc	+6.5Vdc to +60.0Vdc
...with Aux Power Supply	0.0Vdc to +60.0Vdc	0.0Vdc to +60.0Vdc
Maximum DC Current	+/-70Adc sustained	+/-70Adc sustained
Maximum Peak Current	+/-170A for less than 3 seconds	+/-170A for less than 3 seconds
Input Current from Source or Load	28mA +/-10%	8mA to 149mA*
...with Aux Power Supply	<1mA	<1mA
Measurement Capabilities		
Voltage Detection Resolution	10mV	10mV
Current Detection Resolution	100mA	100mA
Current Measurement Accuracy	+/-1% from 2A ~ 170A**	+/-1% from 2A ~ 170A**
Sample Resolution	8Hz (every 125mSec)	8Hz (every 125mSec)
Clock Resolution	+/-2%	+/-0.5%
Max Energy Recordable Value	+/-2,147,483,648 Joules (watt seconds)	+/-2,147,483,648 Joules (watt seconds)
Max Clock Recordable Value	65,536 days	65,536 days
Recording Capability		
MicroSD Card Size Capability	n/a	FAT32, up to 128GB
SELECT or ENTER Screen Timeout	10 seconds	10 seconds

* Device current depends on source voltage. Higher the voltage, the lower the current.

** Current accuracy depends on proper calibration.

PRODUCT OPERATION

Connections: The Metiri™ Smart Energy Meter product line is an inline voltage, current, and energy measurement device with all of the features and tools a solar enthusiast, RC hobbyist, or Scientific community would love.

The Metiri™ Smart Energy meter is in series with a pair of pure copper 10 AWG wires, one **RED** and one **BLACK** in color. The **RED** wire is the positive or power wire and the **BLACK** wire is the return or ground wire. Metiri™ measures voltage between these wires and uses a low side resistive shunt for monitoring current. The two exposed wires closer to the USB connector should be connected to a power source or battery, and the two exposed wires farthest from the USB connector should be connected to a power load or battery.

CAUTION: Do not place a negative voltage or reverse the voltage polarity of the wires or damage to the Metiri™, and your system, might occur.

WARNING: Always install and in line fuse rated for no more than 200A in series with the Metiri™ Smart Power Meter

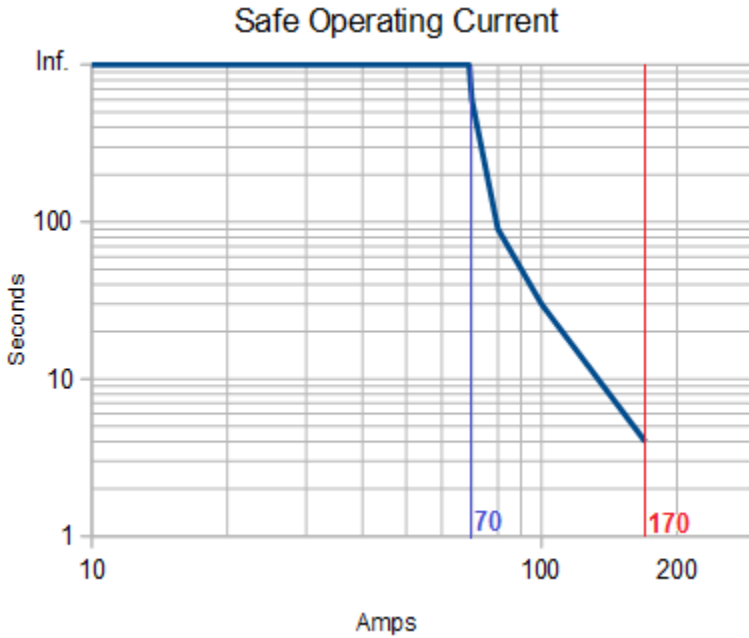
Device Power: The Metiri™ Smart Energy Meter will get the power it needs to run from the wires it is measuring and requires a minimum voltage across those wires to function. If a voltage is desired to be measured that is lower than the minimum voltage, auxiliary power will be needed. The Metiri™ products provide an auxiliary power input using a readily available mini USB connector. Simply plug in a mini USB cable into Metiri™, and the other end into any USB power source, and Metiri™ will shut down its internal regulator, running off of the USB power only.

Device Measurement: When operating Metiri™ from the Auxiliary USB, the Source or Load cables should not be left unconnected (otherwise known as high impedance) or leakage will cause incorrect measurements to occur.

In order to take accurate current measurements, it is important to understand that the minimum current resolution is a percentage of the maximum current the unit is designed to read. The higher the current capability desired, the lower the sense resistance needed to keep from overheating and thus less signal to noise.

Safe Operating Current: The Metiri™ products are fully bi-directional and will record current flowing in either direction. This makes the Metiri™ products perfect for monitoring energy flowing in and out of a system battery bank. The Metiri™ products attempt to interfere as little as possible with current moving through it. Therefore the user is

responsible for ensuring the current through the Metiri™ Smart Energy Meter does not exceed the Safe Operating Current shown in the graph below.



Current vs. Max Time

- Less than 65A = Infinite
- 70A = 10 minutes
- 80A = 90 seconds
- 100A = 30 seconds
- 170A = 4 seconds

* Time is the maximum pulse in seconds before current must fall below 65A for more than 10x the pulse in order to cool.

If the Metiri Smart Energy Meter detects current exceeding the safe DC current level of 70A, the LCD will begin to flash rapidly, warning the user. Allowing the current to exceed this value for sustained periods of time can result excessive heat to the device and the wires connected.

DANGER: Operating at currents above 50Adc can cause the Metiri wires, or the unit itself, to get extremely hot. You should never hold the Metiri Smart Energy meter by the wires with your bare hands or allow the wires to come in contact with anything flammable.

HOME SCREEN

The default display is the screen shown when the Metiri™ starts up or if the ENTER button is touched in any other SELECT screen. This is also the screen the Metiri™ will return to after 10 seconds of inactivity in any screen except when scrolling through the Smart Energy Graph screen.

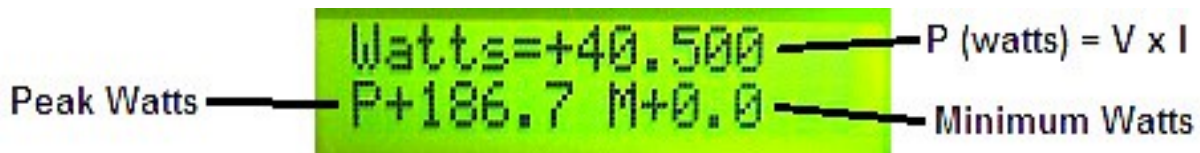


All measured values presented are in real time and updated at the same rate as the sample rate. The top right of the display is programmable and is set in the **Set Home** screen. The bottom right of the display will show the time since start in the format HH:MM:SS. If more than 24 hours pass, the time will roll over to 00:00:00 and will automatically switch back and fourth from time to number of days passed.

For each day passed, Metiri™ will start a new data array for the Smart Energy Graph and will also start a new CVS file for recording of measured data, if applicable.

SELECT SCREENS

Watts Screen: Touching SELECT when on the **Home** screen will display power in watts on top. Bottom left will display peak watts (P) and bottom right will display minimum watts (M) recorded. The LCD will return to the Home Screen after ten seconds or if the ENTER button is touched.



Min & Max Values: Touching SELECT when on the **Watts** screen will display peak (Vp & Ip) and minimum (Vm & Im) current and voltage values recorded. The LCD will return to the Home Screen after ten seconds or if the ENTER button is touched.



Smart Graph: Touching SELECT when on the **Min & Max Values** screen will start the Metiri™ Smart Graph program. The LCD will return to the Home Screen after ten seconds unless the SELECT button is touched again. Touching the SELECT button again will scroll the Smart Graph data to the left of the LCD, and will stay there until the ENTER button is touch, returning the Smart Graph to the first hour.

The purpose of the Metiri™ Smart Graph program is to organize energy recorded over time in a way that is quick and easy to understand. The program will organize energy measured into 24 bars by the hour recorded, with the current hour flashing. The hour with the most energy will be represented as the highest bar (16 pixel rows high) with its value printed on the left side of the screen, and all other hour's energy will be drawn relative to that highest bar. (16 x <Current Energy Hour> / <Peak Energy Hour> = # of pixel rows).



If the energy measured goes negative at any time, the Metiri™ SmartGraph will change so that the top 8 pixel rows of the graph represent positive energy recorded, and the bottom 8 bars represent negative energy recorded. The hour with the most absolute energy will be shows as a full bar (8 pixel rows) and all other hour's energy will be drawn relative to that highest bar. (8 x <Current Energy Hour> / <Peak Energy Hour> = # of pixel rows).



ENTER SCREENS

Set Home Screen: Touching the ENTER button when on the **Home** screen will present the user with the units currently programmed for the Home screen. Touching SELECT will change the units to be displayed and will save this setting to the User Memory. Touching ENTER after making a selection will return to the **Home** screen. After 10 seconds of inactivity, the LCD will return to the **Home** screen. The choices are as follows.

1. Show Joules: One Joule (J) is equal to one watt for one second.
2. Show Watt Hours: A Watt Hour (Wh) is one watt for 3,600 seconds.
3. Show Amp Hours: An Amp Hour (Ah) is one Ampere for 3,600 seconds.
4. Show Coulombs: A Coulomb (Q) is one Ampere for one second.
5. Show Watts: A Watt (W) is one Volt multiplied by one Ampere.
6. Rotate Values: This will rotate through all the values every four seconds.

Reset All Values: Touching the ENTER button when on the **Set Home** screen will ask if the user wishes to clear all values. Touch SELECT to reset all recorded values or touch ENTER to continue to the next screen. After 10 seconds of inactivity, the LCD will return to the **Home** screen.

All time, voltage, current, and energy values including the Metiri™ Smart Graph data will be cleared. Data saved to the microSD card, calibration data, and device settings are not affected by this reset.

Eject SD Card (Scientific model only): Touching the ENTER button when on the **Reset All Values** screen will ask if the user wishes to safely eject the microSD card. Touch SELECT to eject the SD card or touch ENTER to continue to the next screen. After 10 seconds of inactivity, the LCD will return to the **Home** screen.

The Metiri™-S will save all remaining data, close out the open CVS file, and unmount the card. The card cannot be accessed again until it is removed and a new card inserted. The microSD card is not physically ejected, and will have to be manually removed by grasping the edge of the card and pulling straight out.

SD Write Time (Scientific Model Only): Touching the ENTER button when on the **Eject SD Card** screen will ask the user the time desired in between data being saved to the microSD card. Touch SELECT will change the time between saves, or touch ENTER to continue to the next screen. After 10 seconds of inactivity, the LCD will return to the **Home** screen.

If a properly formatted microSD card with enough space is inserted, the Metiri™-S will automatically save recorded data in a CVS file at time intervals set by this screen. The value chosen is written to non-volatile memory and choices range from 125 milliseconds to 4 minutes between saves.

NOTE: Setting the SD Write Time to 125mSec can result in very large data files as each data entry is 64 bytes.

Positive Current/Voltage-B Calibration: Touching the ENTER button when on the **Reset All Values** (or **SD Write Time** for Metiri-S) screen will prompt the user to begin the **Positive Current/Voltage-B Calibration** program. Connect a DC voltage or current through Metiri™ as instructed on the LCD and touch SELECT to confirm for each step, or touch ENTER to cancel. The initial screen will return to the **Home** screen after 10 seconds of inactivity. Once calibration has begun, the screen will stay until calibration is complete or until the ENTER button is pressed to cancel calibration.

STEP 1: Connect the Auxillary USB power for calibration. Connect a calibrated power source to the SOURCE wire side and a load to the LOAD wire side capable of 9.0 Amperes and 12 volts.

STEP 2: Touch the ENTER button until you see the Positive Current/Voltage-B Calibration screen shown below. If the negative current calibration is desired, touch ENTER once more and instructions for Negative Current/Voltage-A Calibration will show.



STEP 3: Connect +12 volts to the SOURCE wires, make sure there is no current flowing through Metiri, and touch SELECT to save the Voltage-B and zero current OFFSET Value. **NOTE:** no voltage is needed beyond this point, only current.

STEP 4: Increase the current so that exactly 4.0 Amperes is flowing through the Metiri Smart Energy Meter. Touch SELECT to save this value.



STEP 5: Increase the current so that exactly 9.0 Amperes is flowing through the Metiri Smart Energy Meter. Touch SELECT to save this value. Touching SELECT at this point will save all calibration values. If a mistake is made, simply touch ENTER to delete the saved values and try again.



STEP 6: Calibration is complete. The calibration results will be printed on the second line of the LCD and will be saved to non-volatile memory. The values printed represent the current detected in 100mA values starting with the zero current OFFSET, then the 9A reading, and finally the 4A reading. These values are for reference only and do not need to be remembered.



In order to ensure proper current and voltage measurement, both the positive current and negative calibration should be done together. It is very important that calibration be done with a low noise power supply and load. Remember that the ENTER button can be touched to cancel the calibration routine anytime before STEP 6 is reached.

Negative Current/Voltage-A Calibration: Touching the ENTER button when on the **Positive Current/Voltage-B Calibration** screen will prompt the user to begin the **Negative Current/Voltage-A Calibration** program. Connect a

DC voltage or current through Metiri™ as instructed on the LCD and touch SELECT to confirm for each step, or touch ENTER to cancel. The initial screen will return to the home screen after 10 seconds of inactivity. Once calibration has begun, the screen will stay until calibration is complete or until the ENTER button is pressed to cancel calibration.



The steps to complete the Negative Current Calibration program are identical to the Positive Current Calibration program except that the power supply needs to be connected to the LOAD wires, and the load needs to be connected to the SOURCE wires so that current is flowing backwards. Remember that the ENTER button can be touched to cancel the calibration routine anytime before STEP 6 is reached.

Clear User Calibration: Touching the ENTER button when on the **Negative Current/Voltage-A Calibration** screen will prompt the user with an option to clear all user calibration data, and restore factory calibration. Touch SELECT and all user data will be cleared from memory, calibration data will be loaded from factory memory, and will return to the home screen. Touch ENTER and you will be returned to the **Home** screen without any action taken.

DATA LOGGING ON SD CARD (Scientific Model Only)

Inserting a microSD card: When a microSD card is inserted, or when Metiri™-S starts with a card already inserted, the Metiri™-S will automatically detect and start the mounting procedure. The mounting procedure checks to see if the inserted microSD card can be used by checking the following:

1. Is the Card Formatted? The microSD card must be formatted using the FAT32 filesystem before it can be used. The Metiri™-S will not attempt to format an unformatted microSD card.
2. Is there enough space available? The microSD card must have enough free space to equal a full days worth of data to be used. The number of bytes needed is equal to 5,529.6KB divided by the SD Write Time in seconds. For example, if the SD Write Time is set to 1 minute in between saves, the amount of space needed is $5,529.6\text{KB} / 60 \text{ seconds} = 92.16\text{KB}$. If the SD Write Time is set to 125mSec, then the amount of space needed is $5,529.6\text{KB} / 0.125 \text{ seconds} = 44,236.8\text{KB}$ or 43.2MB.
3. Is there an available CSV name? The Metiri™-S saves measured data in CSV (Comma Separated Values) format named using 8.3 filenames. The Metiri™-S names files according to the current day proceeded by the letter 'M' followed by two letters starting at 'AA'. If that filename is already taken, then the prefix letters will be incremented to 'AB' and so on until a free filename is found. If all 676 combinations of prefix letters are used using the same date code, then the microSD card cannot be used. (EXAMPLE: On day 13, the Metiri™-S will look for filename M00013AA.CSV and if it does not exist, will create a new CVS file with that name. If the file already exists, then a new file named M00013AB.CSV will be created) Data will only be saved in the root space, so if all available files names are taken, simply moving the old files to a folder will solve this issue.

If all three checks pass, then the Metiri™-S will attempt to mount the SD Card and start recording measured data to the new file created.

SD Error Codes: If an error is encountered trying to use a microSD card, the Metiri™-S will display an error message on the LCD and stop trying to use the card. The user should remove the card and take care of the issue or insert a new card. The following is a list of error messages and their meaning.

1. SD CARD ERROR: This message occurs if Metiri™ is unable to read the card or if the physical connection is not reliable. The user should change to a different microSD card.
2. SD NOT FORMATTED: If this message comes up the microSD card either not formatted using FAT32, or something is preventing the Metiri™-S from interfacing with the card. It is suggested to use a card that has been formatted to FAT32, be between 2GB and 128GB in size, and not be too old.
3. SD MOUNT ERROR: The Metiri™ has recognized the card as formatted correctly but has failed to mount the file system. This usually happens if the file system is corrupt or accessing the card returns too many read errors. The user should try reformatting the microSD card or use another.
4. NOT ENOUGH SPACE: The microSD works correctly and has been mounted, however not enough space is available to start a new measurement record. The user should delete or move files off of the microSD card to make more space available.
5. SD FILE ERROR: The SD card is mounted and has plenty of space, but the Metiri™ cannot find an available file name that can be used to record data into. The user should move old Metiri™ CVS files to another folder before the card can be used.

6. **OPEN FAILURE:** Metiri™ encountered an error attempting to start a new file, or open an existing file. This is usually caused by the card locked to read only or something in the file system is preventing Metiri™ from writing to the SD card. The error will need to be corrected before the microSD card can be used.
7. **WRITE FAILURE:** Metiri™ received back a different value for the number bytes that should have been written to the card. Metiri™ will stop using the SD card to prevent corrupting existing data. The card should be removed and repaired using a CHKDSK or similar utility.

Removing an SD Card Data: Metiri™ needs to unmount the microSD card and close out the file being used for recording of data before the card should be physically removed. This is accomplished by touching the ENTER button twice so the user is prompted with, "Eject SD Card?". Touching SELECT will cause the current file to be closed, and card to be unmounted. When the user is prompted with, "SD CARD EJECT, Ready to remove" the microSD card can be removed.

To remove the microSD card, grasp the edge of the card firmly and pull straight out. The Metiri™ does not use a card ejection mechanism to ensure the card does not accidentally fall out during use.

Removing the microSD card before unmounting it can cause data corruption. If this happens, Metiri™ will force the file system to be unmounted and prompt the user, "SD CARD REMOVED, NOT UNMOUNTED".

Notice Summery: The following rules should always be obeyed when using the Metiri Smart Energy Meter.

1. Working with electricity can be dangerous. Always use the Metiri Smart Energy Meter with an inline fuse and consult a professional before using this device.
2. Never exceed 70A for any sustained length of time. If 70A is exceeded, the Safe Operating Current time should be used as a reference to the safe time at higher current.
3. The Safe Operating Current can vary according to temperature, humidity, and altitude. Safety testing was performed in a 25°C ambient environment, at less than 15% humidity and an altitude of 6,200 feet. Temperatures or humidity levels higher than the stated values will decrease the Safe Operating Current levels and time.
4. Never touch the wires when operating the unit. They may be hot and can cause burns to exposed skin or material.
5. Do not allow the unit to be exposed to the elements. Direct sunlight or exposure to rain and moisture can damage the unit.
6. The Metiri-H and Metiri-S models are not waterproof. If the Metiri units gets wet, do not use. If you notice the unit is wet while in use, do not touch it! Electrical shock hazard may exist.
7. The Metiri can read alternating current (forward or reverse current flow) as long as voltage always stays negative. A negative voltage from the positive (RED) to negative (BLACK) wires can damage the unit.
8. Metiri-H and Metiri-S units were designed to record very large DC currents, so accuracy at very low currents is not guaranteed.

Equations, Acronyms, and Facts to Remember: It is important to understand the difference between units of energy or charge when trying to track energy flow. A Joule is a derived unit of energy in the International System of Units and is equal to one watt (1 volt * 1 Amp = 1 Watt) for one second (1 watt x 1 second = 1 Joule).

EXAMPLE: Consider a 12V battery connected to an inverter needing 100 watts of constant power for an off-grid AC solution for one hour. The amount of energy needed is simply (Power x Seconds = Joules or Ws) 100Wh or 360,000Ws or 360,000 Joules. The inverter will always require 100 watts regardless of the battery voltage, therefore as the battery voltage starts to drop the amount of current needed to equal 100 watts goes up. ($P = V \times I$ so $I = P / V$) Using Ah to measure energy, makes this very difficult as voltage will constantly be changing.

- Volts = Current in Amperes x Resistance in ohms ($V=I \times R$)
- Power = Volts x Current ($P=V \times I$)
- Coulombs = Volts x Capacitance in Farads = Current x Time in seconds ($Q=V \times C=I \times T$)
- Energy in Joules = Power x Time in seconds ($J=P \times T$)
- 1 Joule (J) = 1 Watt Second
- 3,600,000 Joules (J) = 3,600,000 Watt Seconds (Ws) = 1,000 Watt Hours (Wh) = 1 Kilowatt Hour (1KWh)
- Electrons are negatively charged. So when you plug a load into a battery, current is actually flowing from negative (Ground) to Positive.
- Metiri in Latin means to measure or estimate.