TECHNICAL NOTE #4

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TROUBLESHOOTING the TriMetric battery monitor
Revised for the TM-2020 TriMetric

What to do when the TriMetric TM-2020 does not work as you expect.

Although occasionally a meter will be defective or fail, most problems are due to improper installation, or misunderstanding of how a meter function is supposed to work. The following is based on actual experience of helping a number of persons who have installed the TriMetric. If this Technical Note does not help you cure a problem, please give us a call so we may help you, and also possibly improve this guide to help others who may have a similar problem.

Troubleshooting summary: General troubleshooting procedure should first be to get the VOLTS to measure properly, and next get AMPS to measure properly. Problems with these must be addressed before other problems are dealt with. Once the VOLTS and AMPS are working properly, the problems with BATTERY % FULL are usually caused by some wrong data programmed into one or more of the TriMetric setpoints. After these are working, then the "BATTERY % FULL" display will work properly if the correct programmed values of "charged setpoint volts", "charged setpoint amps", "battery capacity" , "efficiency factor" and "preferences" are entered.

0. PRELIMINARY: If this is a new installation that hasn't worked before, First recheck the wires from the meter to the shunt, using the wiring diagram in thte TriMetric instuctions. Tighten all the screws on the terminal strip on the TriMetric using a screwdriver small enough to fit properly into the recessed holes of the terminal strip.

1. Some or all meter digits do not light up.

If all digits are blank, perform these steps until problem is solved:

1.1 Push "select" button a few times to be sure it is not on the "dark" mode.

1.2 Check the fuse (shown in the wiring diagram of the TriMetric instuction manual) at the battery.

1.3 Check wires from TriMetric to battery particularly the "G1" and the "+" wire to see they are wired correctly.

1.4 If a hand multimeter is available, set it to measure "volts" and check that the battery voltage is present, (at least 8 volts) measuring right at the TriMetric terminal block screws, from G1 to +. Be sure polarity is correct, with + voltage on the + terminal. If necessary correct the wiring until fixed.

1.5 Check that the jumper is present from + to M+ at the TriMetric terminal block (shown on the TriMetric wiring diagram.) Also check that the screws on the terminal block are holding the wires tightly.

1.6. If you did not momentarily remove the fuse in 1.2 above, momentarily remove and reconnect the "+" wire to the meter to reset the microcontroller. This can be done by momentarily removing and replacing the small fuse in the "+" wire that is shown in the wiring diagram in the TriMetric instruction manual.

1.7 If you still get no response the meter is probably bad. Return for repair

If some digits light up but others do not, or some parts of digits do not light:

1.8 Check if the same digits or parts have problems on "Volts" "amps" and "Battery% Full". If so, defective meter. Return for repair.

2. Meter digits light up. "Volts" not correct.

Perform these steps until problem is fixed.

2.1. **If digits show all 8's,** meter probably bad. Possible damage from lightning energy or meter polarity reversal.

2.2 If volts are off by a factor of 2, check that the "charged setpoint voltage" setting in the TriMetric is correct for your system. This is the programmed setting which is accessed while viewing "volts" with the TriMetric. (Refer to table on page 13 of the TriMetrric TM-2020 instructions for how to access and change program data.) For a 12 or 24 volt battery system this programmed setting should be LESS than 35 volts. If not, the TriMetric will be in the "48Volt" mode, and will show a volts value twice the correct value. (Although it is not supposed to, occasionally this "voltage setpoint" value changes when the meter is disconnected and reconnected to power.) If you have a 36 or 48 volt system it should be set to ABOVE 35 volts, (and of course the 48 volt adapter must be attached to the TriMetric.) If you are using the TM-48VA "48V adapter/lightning protector" with a 12 or 24 volt system, be sure the jumpers are set for your system voltage. See the instruction sheet for the "TM-48VA 48V adapter/lightning protector" for how to do this. Also, if using the 48V adapter review all instruction steps from 1 to 5 in the instructions accompanying the TM-48VA 48V adapter/lightning protector.

2.3. **If voltage slightly off: (less than 1 volt)**

2.3.1 Use "SELECT" switch to switch from "Volts" to "Amps". If the switch doesn't work, meter is bad. Return for repair

2.3.2 Do a simple test to see that the "amps" read approximately correctly. With no charging sources on (turn off generators or solar or other charging sources) then turn on and off a known load. A 15 watt compact florescent light, for example, should cause the "amps" value to go more positive by a little more than one amp (for a 12V system) or about half an amp with a 24V system. If it doesn't change at all , skip to step 4 and correct "Amps" problem first.

2.3.3 If you have an accurate digital multimeter use it to measure the voltage at the TriMetric. Measure this voltage at top of the screw heads on the terminal block on the TriMetric circuit board, between the "G2" terminal and the "+M" terminals. The terminals are identified by lettering on the green circuit board adjacent the terminals. Or consult the TriMetric instruction manual wiring diagram to identify the terminals. Check that the TriMetric agrees with the voltage measured by the digital multimeter.

2.3.3.1 If accurate digital meter doesn't agree with TriMetric--:If "amps" reading is OK, and volts are still incorrect (with an error of less than 1 volt), meter may have became uncalibrated. (This shouldn't happen on its own. Possibly someone accidentally readjusted it.) Either return to factory to be calibrated for most accuracy, or if you are sure your multimeter is accurate, connect it between "SIG" and "+" terminals at TriMetric terminal block, NOT at the battery. Then. use <u>small</u> screwdriver to adjust the screw on the square blue or gray "pot" located on TriMetric circuit board until voltage reads correctly. This should make it accurate to within 0.1 volt or better if you are careful.

2.3.4 If, with above test accurate digital meter does agree with TriMetric: Then the meter is measuring OK and there is probably a wiring problem. Check the following possibilities that may be causing voltage inaccuracy.

2.3.4.1 Possible reason #1: It's easy to forget about the voltage drop possible between two seemingly identical measuring points. For example, if you compare the TriMetric voltage reading where the wires from the TriMetric are connected directly to the battery terminals with a voltage read with another meter a few feet away at the charge controller, the resistance between wires connecting the controller and battery can cause significant errors if charge current is flowing. Example: If controller and battery are 10 feet away connected by two #8 wires carrying 25 amps of charge current there will be 0.3 volt drop--and hence 0.3 volt difference in reading-- between controller and battery. If in addition there is a poor connection between these points the error can be greater. Use an *accurate* digital meter to measure voltage between the Kelvin terminal at the shunt where the "G1 and G2" wires are connected and the exact point that the "+" wire to the TriMetric joins the battery. This reading should agree with the TriMetric.

2.3.4.2Possible reason #2 if voltage is slightly low The wire connections between the TriMetric and the battery could have developed some resistance, especially the "+" wire. Check that the wires at the TriMetric are tight and well connected at both the TriMetric termnal block, and at the shunt and battery + end. Excess resistance, *especially in the "+" wire* could cause the voltage to read low at the TriMetric.

2.3.4.3 Possible reason #3 if voltage is slightly low. If wire going from the "+" terminal at the TriMetric can introduce an error of 0.1 volt for each 3 ohms of resistance. The following wire lengths (from TriMetric to

battery) represent resistance of 3 ohms. Longer distances will result in greater error. 120 feet #24 wire. 190 feet #22 . 470 feet #18. 750 feet #16. This error can be avoided by using a larger wire, or instead can be eliminated with two smaller wires by running both from the battery "+" terminal to the TriMetric. In this case you should remove the jumper that is usually connected from the "+" and "+M" terminals on the TriMetric terminal block, and run one of the two wires to "+" and the other wire to "+M". See page 3 of the TriMetric instruction manual under **"For unusual cases....."**. .

2.4 If volts are low, but not by a factor of 2, see above, **section 2.3.4.2** ("Possible reason #2").

2.5. **If volts shows "00.0"**, check that the jumper is present from + to M+ is connected at the TriMetric terminal block (shown on the TriMetric wiring diagram.) and that it is making proper contact where the wire to shunt is in same terminal hole. If jumper is OK probably a defective meter.

2.6 If volts stuck at some value besides zero, *especially 51.1*: Meter probably bad. Return for repair.

3. Meter won't switch from VOLTS to AMPS when "SELECT" is pushed.

Defective TriMetric. Return for repair.

4. "AMPS" don't measure properly:

If not, perform these steps in order.

4.1. Check that meter reads "0" amps with 0 current: Turn all loads in the system off, and make sure any inverter is switched "off" (not even in the search mode). Be sure that no charging is taking place, either because the solar array is dark, or disconnected, and no other charging sources are operating. If you are using the 500 AMP/50 mV. shunt you should read "0.0" or "0.1". (It is also possible that an inverter, even if "off" can still be drawing a small amount of amps-- usually less than 1.) If you are using the 100 AMP/100 mV. shunt, even if no other current is being drawn it should read minus "0.02" to "0.04" because the meter is reading the small current that the **meter itself** uses. There should be no unsteadiness around this value, except possibly fluctuation of ±1 in the least significant digit.

If there are residual AMPS showing perform these steps:

4.1.1 . Be sure that both G2 and G1 wires *each* connect directly to the Kelvin terminal on the shunt as shown in the TriMetric instructions wiring diagram, and that you do not have G2 and G1 sharing a common wire *for even one inch* with only one wire actually connecting to the Kelvin terminal.

4.1.2 Check that the SIG , G1 and G2 wires are properly and tightly connected from meter to shunt.

4.1.3 Check that there is no short between the G1 and G2 wires in their travels from meter to shunt, or similarly no short from G1 and Sig wires, and that the G1 and G2 wires meet only right at the shunt Kelvin terminal.

4.1.4 If the :"Amps" number doesn't change, or doesn't seem to be responsive to loads or charging sources that are turned on or off-- That is, the "amps" value does not go more positive when a charging source is turned on, or more negative when a load is turned on, proceed to next step.

4.2 "Amps" display shows a (possibly large) value of amps that doesn't change with loads or charging sources-- and may slowly drift around. This is usually caused by an open "G2" or "Sig" wire going from the TriMetric to the shunt connection at the battery. Check the connections carefully at both ends. Also wires could have been cut for some other reason. (Rogue mouse?) You can also use a miltimeter to measure resistance (ohms) from the G2 to Sig terminals (with wires connected to them that go to the shunt). This resistance should be less than a few ohms if the connection to the shunt is intact. A high resistance here would indicate defective wiring to the shunt.

4.3 Always shows 0 amps. Check that the G2 and "Sig" wires to the shunt are not switched. Also check that the shunt is wired correctly. (See wiring diagram in the TriMetric instructions). Otherwise see below section **4.7 "If it still does not work, and if a digital multimeter is available"** follow procedure and check that millivolt measurement across G2 and SIG is not zero. If it is not zero, meter is probably defective. Return for repair.

4.4. TriMetric doesn't measure "amps" from some charging source, or some load: for example, it doesn't measure the current from the solar array, although it does measure loads connected to the inverter OK. This is almost always caused by a miswired shunt in the system. The TriMetric measures *only* electrical current (amps) that flow through the shunt. Make sure the missing current flows through the shunt to get to the battery. The only item that should be connected to the negative terminal of the battery system is one end (large bolt) of the shunt, (as shown in the wiring diagram). *All other loads and charging sources* must be connected to the *other* side (large bolt) of the shunt (as shown in the TriMetric instructions wiring diagram.) For example, if solar panels or solar charge controller are connected **directly** to the negative terminal of the battery instead of the other side of

the shunt (where the inverter is connected) then the current from the panels goes directly into the battery without going through the shunt, so the meter will not measure the charge current from this source. Rewire the shunt if necessary.

4.5. Amps shows a negative value when "charging" and a positive value when "discharging". That would NOT be correct. Charging should show as a positive value of amps, and loads should show as a negative value. The connections to the Kelvin terminals on the shunt are reversed, so that SIG terminals need to be reversed with the G2 wires. This is usually easiest to accomplish by switching the "G2" and "Sig" wires at the TriMetric terminal block. Check TriMetric wiring diagram in the TriMetric instruction manual.

4.6. Meter seems to measure all charging sources, and all loads, but inaccurately:

4.6.1Current is off by a factor of 10: make sure that the meter is correctly programmed for the shunt you have. (See section C2. "Shunt type and charge efficiency factor", in the TriMetric TM-2020 instructions.)

4.6.2 Check that the shunt is either a 500 AMP, 50 millivolt shunt, or a 100 AMP, 100 millivolt shunt, and that shunt is programmed correctly as described in 4.6.1. Shunt amps and millivolts are usually stamped somewhere on the shunt.

4.6.3. make sure that there is no wire, or bus bar, or any other connection that shorts from one side of the shunt to the other. (i.e. from one of the large bolts on the shunt to the other) If any other wires connect from the large bolt on one side of the shunt, to the other large bolt, then the shunt is being bypassed, and the meter will display current that is **too low**. A ground, if used, should usually be connected not *directly* to the minus side of the battery, but rather to the other side of the shunt (minus load).

4.7 If it still does not work, and if a digital multimeter is available with a low voltage "millivolts" scale which can read down to 0.1 (or less) millivolts, turn on a steady load (or charging source) that will cause at least 10 amps to flow out (or in) the battery. Using the "millivolts" scale, use the digital meter to read the voltage between G2 and SIG at the TriMetric terminals. If the TriMetric is set for the "H" shunt, then each millivolt on the multimeter should register as 10 amps on the TriMetric. For example, 1.5 millivolts should show as 15 amps on the TriMetric. If the TriMetric is set for the "L" shunt, then each millivolt should register as 1 amp on the meter. If this agrees with TriMetric, the TriMetric is probably OK, and there must be a shunt or wiring error. If you read much less than 1 millivolt with a load (or source) that is known to be over 10 amps, then there must be a wiring error from meter to shunt, or an error in wiring the shunt in the system. Either the current is not flowing through the shunt, or the wires from the TriMetric to shunt are not connected correctly to the shunt Kelvin terminals.

4.7.1 If the TriMetric disagrees with a known good meter:, If the multimeter reads the correct millivolts between G2 and Sig, but the TriMetric still reads always 0, or TriMetric stuck at some other value that does not agree with the multimeter**,**. the TriMetric is probably bad.

5.Battery % Full" reading seems wrong.

5.1 One common reason that this function does not work properly is that the solar current (or other charging source) does not register on the TriMetric. Be sure that the TriMetric is correctly measuring the "Amps" of all charging sources and all loads. With the TriMetric viewing "Amps" check that all charging sources, such as solar or wind powered sources indicate a positive value of "amps" when charging. Turn on and off each source--when ON, the amps value should become more positive, and when OFF the amps value should go more negative. **See section 4.4 to correct this problem.**

5.2 Is the "amps" value registering backwards?, so that loads show as "positive" and charge sources show as negative values. If this is the case the "G2" wire and "Sig" wires must be connected incorrectly. Reverse these two to correct this problem. **See section 4.5, above.**

5.3 The other common problem is that one or more of the following programmed setpoints are incorrect: "Charged voltage setpoint", "Charged amps setpoint", "Shunt type", Efficiency factor" "Preferences" setting and "Battery Capacity". Refer to the TriMetric instruction manual on page 13 for information on how to access and change data in these program modes..

5.3.1"Charged voltage setpoint" and"Charged amps setpoint": As batteries are being charged by their charging sources (i.e, the inverter charger system and the solar or other charge controllers) their voltage gradually rises until it reaches the "bulk voltage" settings of the charger systems. Once this voltage is reached, the chargers should remain at this voltage while the current ("Amps") gradually declines as the battery becomes more charged. When the voltage is at this "bulk" voltage, and the charging current (amps)

has declined sufficiently this will indicate that the battery is becoming pretty well charged. The 'charged voltage setpoint" and "charged amps setpoints" programmed into the TriMetric allow the TriMetric to determine when this has occurred. When the battery voltage rises above the "charged voltage setpoint" and simultaneously the charging amps are LESS than the "charged amps setpoint" (for at least 20 seconds) the TriMetric will judge the batteries as "fully charged" . When this occurs, the Battery % Full is ordinarily reset to "Ful" or "100%".

First, generally you should check that all your charging systems are using the same, or nearly the same "bulk charge voltage". These adjustments are usually made on your charger (or charger/inverter) and solar charge controller. If not adjusted to about the same "bulk" charge voltage they should be adjusted correctly according to the battery manufacturer. For the most commonly used "liquid electrolyte" lead acid batteries, this voltage is about 14.5 for 12V battery systems, and 29.0 volts for 24V systems. Other battery types may have different voltage requirements. Then the TriMetric "Charged Voltage" setpoint should be set *a little lower* than this: usually about 14.3 or 28.6 volts for 12 or 24V systems respectively.

Next enter a value for the "charged amps setpoint" . Determine the total system battery capacity in Amp Hours of your battery system (see section C4 of TriMetric instructions for how to determine this) and divide by a number about 50 to get a value of "amps" to use for this. You can use a higher or lower number than 50 (25 to 100) depending on "how charged" you wish the batteries to be before the TriMetric resets the meter to "Full". By dividing by a number higher than 50 you will be demanding a higher standard before the batteries are declared "charged", and if you divide by a lower number you will lower the bar for what is considered "charged" .

5.3.2 Next check the "Shunt type and Efficiency factor". The most common setting is "H94". The "H" is used when you are using the most commonly used shunt: the 500A/50mV shunt--however if you are using the less common 100A/100mV shunt it should be set to about L94. The meaning of these is explained in the TriMetric instructions, sections D6 and C2. Higher numbers for the "efficiency factor" will give more optimistic-- i.e. generally higher--values of Battery % Full.

5.3.3 Check the "preferences" This should be set to "P00" or P01 to allow the TriMetric to automatically reset itself in the manner described above in **section 5.3.1**. "P01" will also allow the "Battery %Full" to displayed in 1% increments instead of 5% increments. The benefit of this is that you can watch the %Full readings gradually go up and down, instead of jumping only at 5% increments. The drawback is that it is implying an accuracy of measurement that is somewhat greater than is realistic. If these are set to "P02" or P04 the meter will NOT reset when the "charged criteria" (**section 5.3.1**) is reached, so leave it on "P00" or P01 if you want the "Battery % Full" reading to display properly. Incidentally, this also makes the "amp hours from full" to reset to 0 when discharging commences, just after the batteries have been fully charged sufficiently for the amp hours to become positive.

5.3.4 Check the "Battery Capacity" setting: As "amp hours" are removed from the battery the TriMetric causes the "Battery % full" do decrease in proportion to the number of "amps hours" removed. This setting determines the rate at which the "Battery %Full" goes up and down as it is being charged and discharged. When the "amp hours from full" (as a negative value) is equal to the value programmed here (in amp hours), the TriMetric will show "0%" or "LO". It is usually a good idea to enter a value here which is 50% to 75% of the amp hours specified by the battery manufacturer. This should make the "Battery %Ful" numbers go to 0 before the battery actually is flat out of power, and thus gives you a more conservative (lower) estimate of how full you r batteries are. Also, many renewable energy systems don't get the batteries really fully charged, so the actual usable storage capacity is often less than the (optimistic) number proclaimed by the battery manufacturer. **Also note that when you enter the "battery capacity" value in the program mode, the flashing decimal point means "multiply the number by 1000". Therefore "1.02" with flashing decimal point represents 1020 amp hours**.

5. Charging takes place (Amps shows positive,) but "charging" lamp doesn't come on. Or "Charging" lamp is off, but the "Amps" display shows negative sign.

Either the "charging" lamp is defective, or the "-" sign lamp. Return for repair.

6. Can’t get the RESET button to work. When pushing “RESET” it doesn’t do what the label claims it is supposed to do. To make the RESET happen you need to PUSH AND HOLD the reset down until the display flashes 3 times. This is to insure that you don’t accidentally reset something you didn’t intend to. If nothing happens at all in the display when you push it down, the RESET button could be defective. Sometimes noodling it around, using a little extra pressure will get it to work. After that it should continue to work properly. If the switch is defective the meter can be returned to have it replaced