victron energy
BLUE POWER

MPPT charge controllers - testing and diagnosing

We replace, not repair

- The MPPTs are not repairable
- We “err on the side of caution”, in other words, when in doubt, we issue a warranty replacement
- Not all faults are provable customer faults
- But…. Don’t just believe the customer, always look at the unit prior to lodging an RMA.
- This means a thorough visual inspection and a bench test.
- This presentation explains how

Why does a MPPT break?

Not warranty:

- Overvoltage
- Overcurrent and overcurrent during reverse solar polarity
- Reverse battery polarity
- Mechanical damage
- Bad MC4 connector crimping
- Wiring issues leading to burned contacts
- Water damage

Warranty:

- Faulty electronic component
- Manufacturing faults
- Hardware bugs
- Firmware bugs

These are less common

Common issues

MPPT solar charge controllers

For example the 75/15:

- The maximum PV voltage is 75V
- The maximum charge current is 15A
- For other specifications always see the datasheet

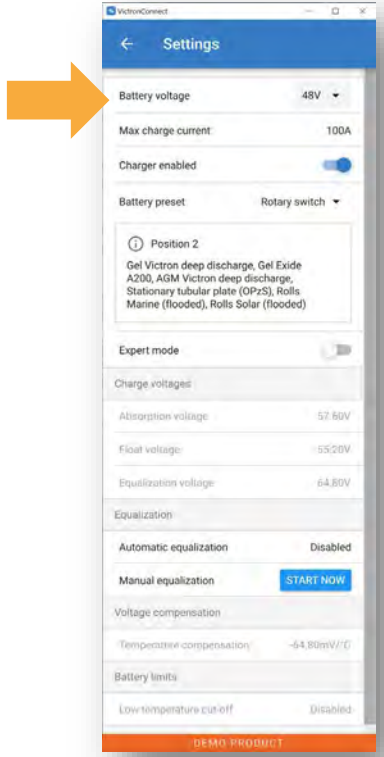
SmartSolar Charge Controller	MPPT 75/10	MPPT 75/15	MPPT 100/15	MPPT 100/20	MPPT100/20-48V
Battery voltage (auto select)	12/24V				12/24/48V
Rated charge current	10A	15A	15A	20A	20A
Nominal PV power, 12V 1a,b)	145W	220W	220W	290W	290W
Nominal PV power, 24V 1a,b)	290W	440W	440W	580W	580W
Nominal PV power, 48V 1a,b)	n.a.	n.a.	n.a.	n.a.	1160W
Max. PV short circuit current 2)	13A	15A	15A	20A	20A
Automatic load disconnect	Yes				
Max. PV open circuit voltage	75V			100V	
Peak efficiency	98%				
Self-consumption	12V: 25 mA 24V: 15 mA				25 / 15 / 10 mA
Charge voltage 'absorption'	14,4V / 28,8V (adjustable)				14,4V / 28,8V / 57,6V (adj.)
Charge voltage 'float'	13,8V / 27,6V (adjustable)				13,8V / 27,6V / 55,2V (adj.)
Charge algorithm	multi-stage adaptive				
Temperature compensation	-16 mV / °C resp. -32 mV / °C				
Max. continuous load current	15A			20A	20A / 20A / 1A
Low voltage load disconnect	11,1V / 22,2V / 44,4V or 11,8V / 23,6V / 47,2V or Battery Life algorithm				
Low voltage load reconnect	13,1V / 26,2V / 52,4V or 14V / 28V / 56V or Battery Life algorithm				
Protection	Output short circuit / Over temperature				
Operating temperature	-30 to +60°C (full rated output up to 40°C)				
Humidity	95%, non-condensing				
Data communication port	VE.Direct (see the data communication white paper on our website)				
ENCLOSURE					
Colour	Blue (RAL 5012)				
Power terminals	6 mm² / AWG10				
Protection category	IP43 (electronic components), IP22 (connection area)				
Weight	0,5 kg		0,6 kg	0,65 kg	
Dimensions (h x w x d)	100 x 113 x 40 mm		100 x 113 x 50 mm	100 x 113 x 60 mm	
STANDARDS					
Safety	EN/IEC 62109-1, UL 1741, CSA C22.2				

1a) If more PV power is connected, the controller will limit input power.
1b) The PV voltage must exceed Vbat + 5V for the controller to start.
Thereafter the minimum PV voltage is Vbat + 1V
2) A PV array with a higher short circuit current may damage the controller.

Battery voltage

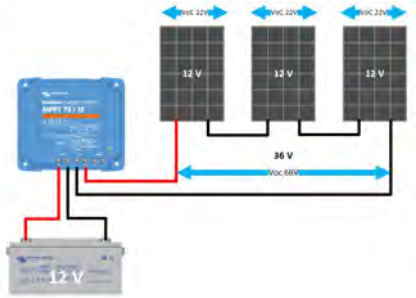
- The MPPT automatically detects the battery voltage on first install, after that the self detection is turned off
- So if a MPPT that came out of a 24V system and is now used in an 24V system it will overcharge a battery
- In the very early days the MPPT s would always automatically detect, but this was problematic in case the battery was disconnected often, by a BMS for example, so we now have turned this off
- Use VictronConnect to check the battery voltage settings

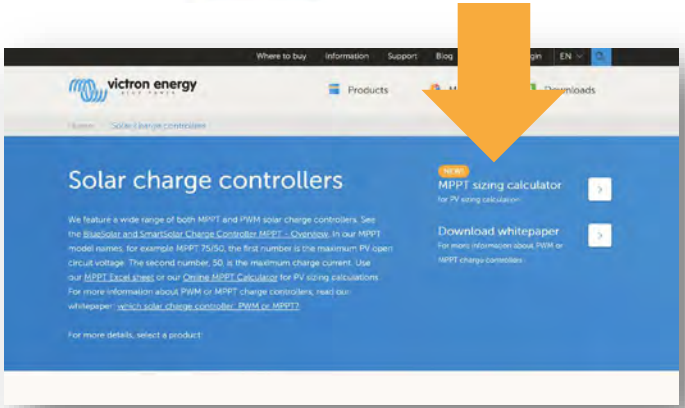
- Reverse battery voltage will damage the MPPT and is not warrantable



PV voltage

- The VoC is the solar panel open circuit voltage
- See the solar panel datasheet and the MPPT datasheet for the maximum VoC
- Exceeding this voltage **will** damage the MPPT
- Take care in areas with cold nights, use a 10% safety margin
- Use the MPPT calculator on our website to find out if array is suitable for MPPT, the calculator an be found on MPPT product overview page
- Over voltage is not warrantable





The PV voltage needs to be high enough

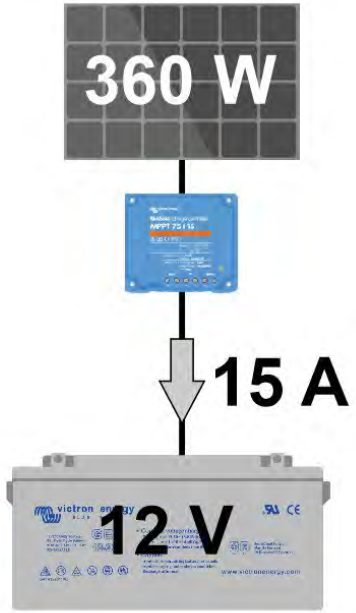
- The PV voltage must be 5 volt higher than the battery voltage for the MPPT to start charging
- Once started, the PV voltage needs to be 1V higher
- In case of low PV voltage the charger might appear broken to the customer

Charge current

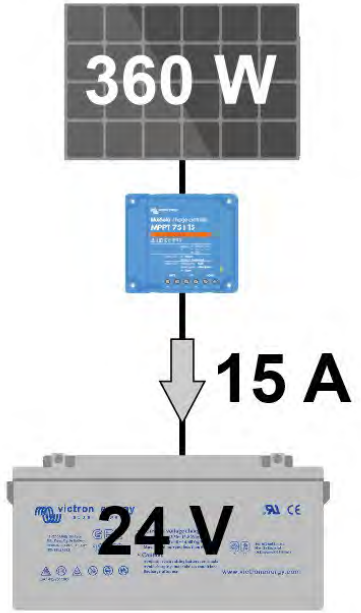
- Example:
- For a 75/15 MPPT the current rating is 15 A

- This is the current going into the battery

- This means that with a 12V battery you will get less power into your battery than with a 24V battery.



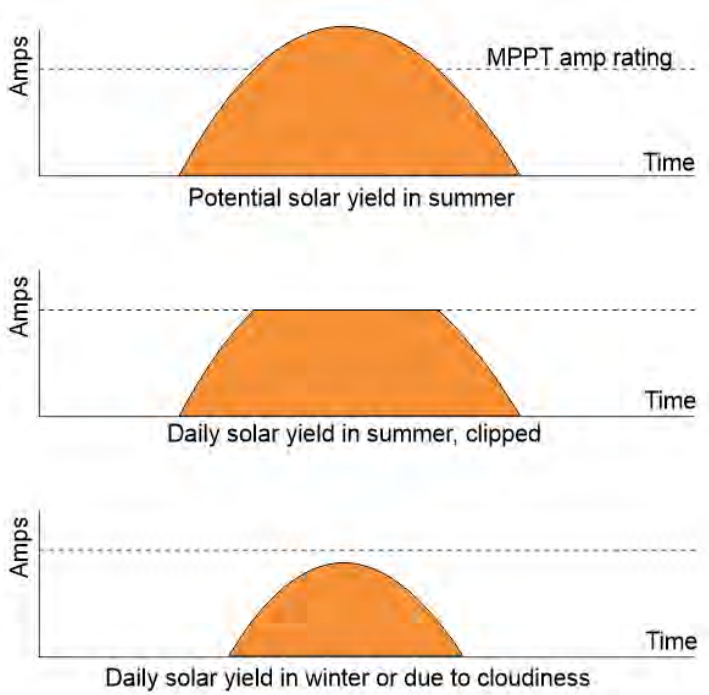
15A x 12V = 180W



15A x 24V = 360W

Current rating

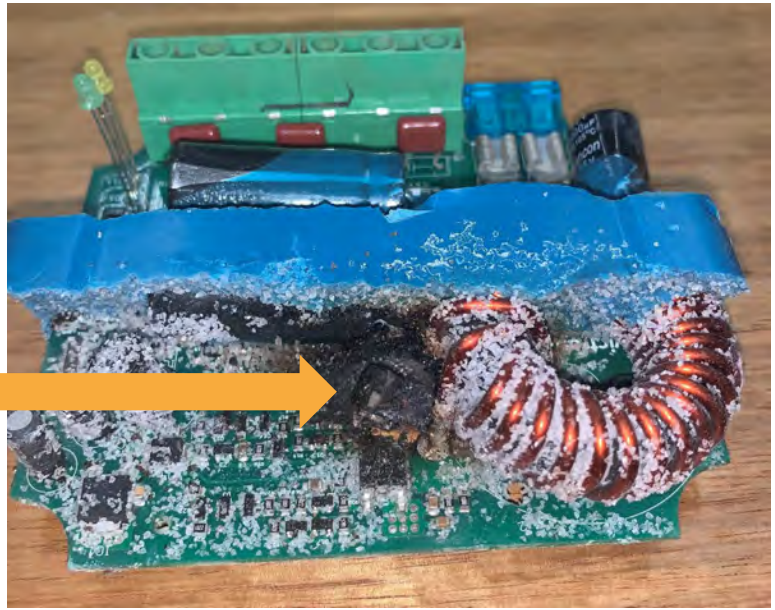
- The MPPT solar chargers are current limited
- Over current will not cause damage.
- This means that you can oversize the solar panels providing you don't connected them in reverse polarity
- During cloudy weather, or winter, you will benefit from larger solar panels.
- But in summer you will get less than maximum, but that will easily be compensated by the longer daylight hours.



Reverse PV polarity current

- Be aware, over current will cause damage in case of a reverse polarity PV connection. So stick to the advise current as per datasheet
- Not warrantable

- Reverse polarity FET



MC4 connector problems

- Not crimped correctly
- Too much current
- Not dividing the current evenly over the 3 MC4 connector pairs
- Solar cable too thin - remember that the current will be higher when the PV voltage is lower
- Not warrantable

Datasheet voltage and current ratings

- Refer to datasheet for maximum voltage, currents and nominal PV power ratings

SmartSolar Charge Controller	250/60	250/70	250/85	250/100
Battery voltage	12 / 24 / 48V Auto Select (software tool needed to select 36V)			
Rated charge current	60A	70A	85A	100A
Nominal PV power, 12V 1a,b)	860W	1000W	1200W	1450W
Nominal PV power, 24V 1a,b)	1720W	2000W	2400W	2900W
Nominal PV power, 36V 1a,b)	2580W	3000W	3600W	4350W
Nominal PV power, 48V 1a,b)	3440W	4000W	4900W	5800W
Max. PV short circuit current 2)	35A (max 30A per MC4 conn.)		70A (max 30A per MC4 conn.)	

1a) If more PV power is connected, the controller will limit input power.
1b) The PV voltage must exceed Vbat + 5V for the controller to start. Thereafter the minimum PV voltage is Vbat + 1V.
2) A PV array with a higher short circuit current may damage the controller.
3) MC4 models: several splitter pairs may be needed to parallel the strings of solar panels
Maximum current per MC4 connector: 30A (the MC4 connectors are parallel connected to one MPPT tracker)

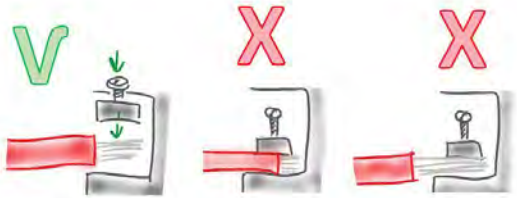
Burned connectors

Caused by:

- Not tightening screw
- Using wrong cable

•Inserting cable isolation in the connector

Not warrantable

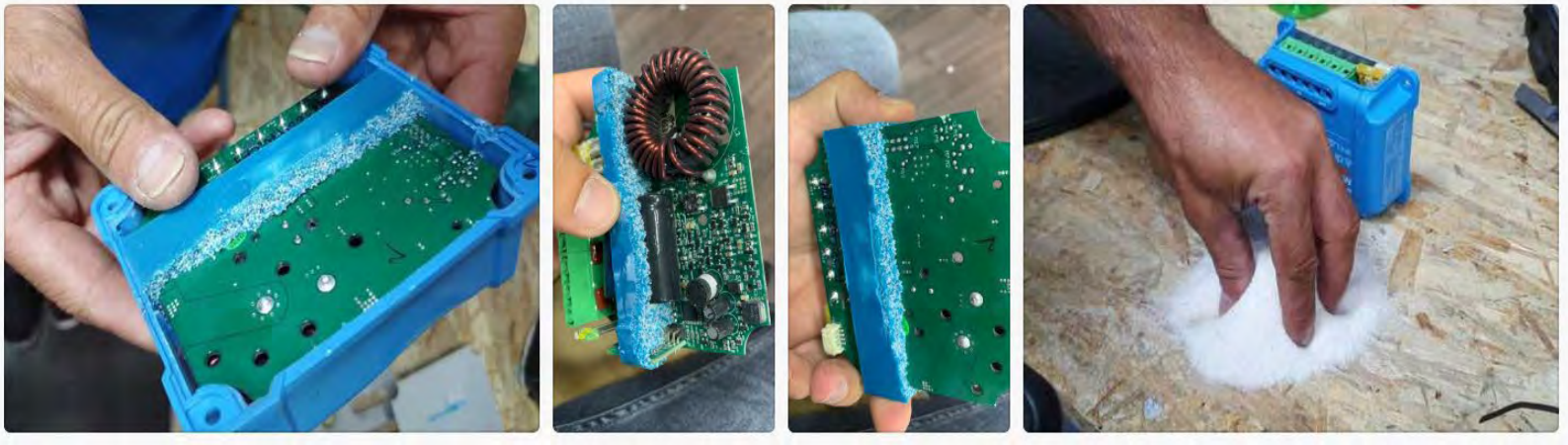


Mechanical damage

- Inspect unit for dents or other types of mechanical damage
- Not warranty

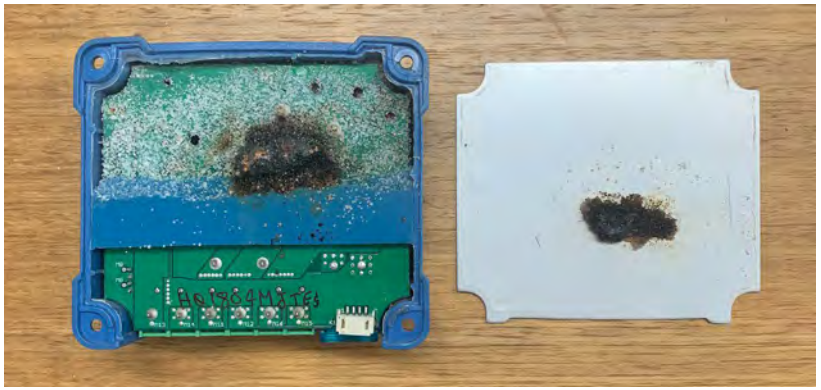
Sand in MPPT 15A

- If a 15A MPPT has been dropped on a concrete floor sand might come out
- Sand is used for cooling a 15A MPPT without sand is the 10A MPPT
- The sand can cause confusion.



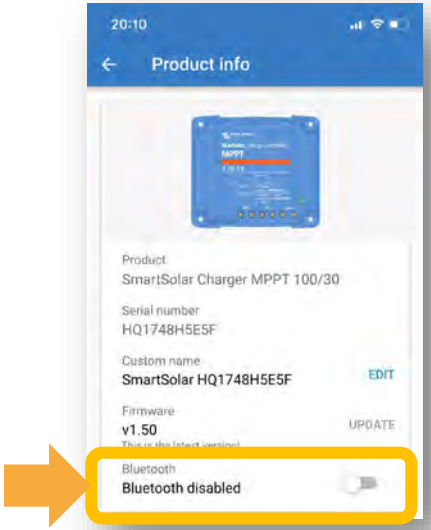
Sand

- Sand can also come out because something inside has blown up and internally the MPPT has expanded



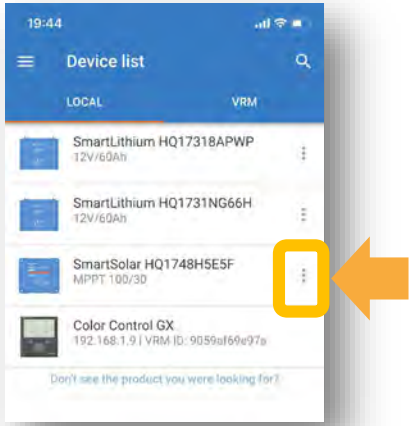
Bluetooth issues

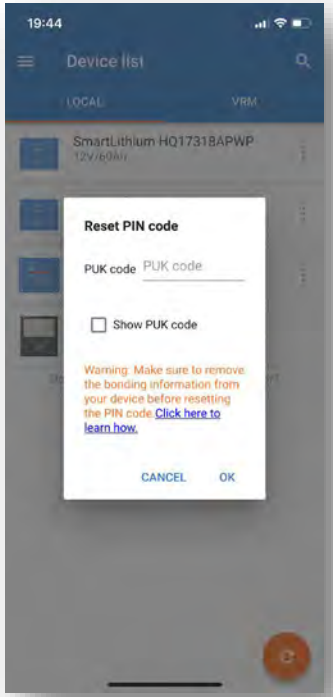
- It is highly unlikely that the Bluetooth module is broken
- More likely an issue wit a phone
- Look in the Victron connect manual
- It also could be that Bluetooth has been turned off - the recovery is to connect with a PC and re-enable Bluetooth
- Also see the Victron connect manual



Reset PIN code

- Go to the device list of the VictronConnect App
- Click on the menu symbol next to the MPPT
- A new window will open
- Enter the MPPT PUK code.
- The PUK code is printed on the product information sticker on the SmartShunt.
- This will reset the PIN code to oooooo

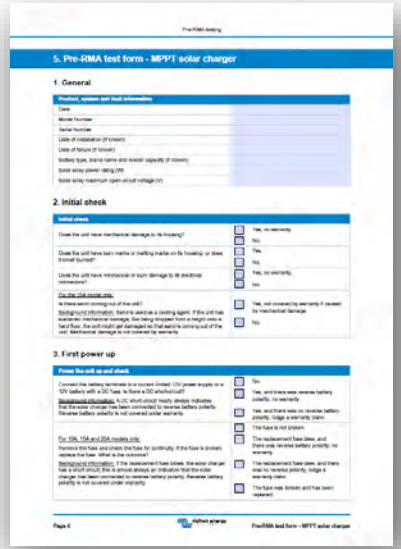




Test procedure

Test procedure and the result form

- Use the Pre-RMA test Documents to see if the Unit is faulty and submit for Warranty

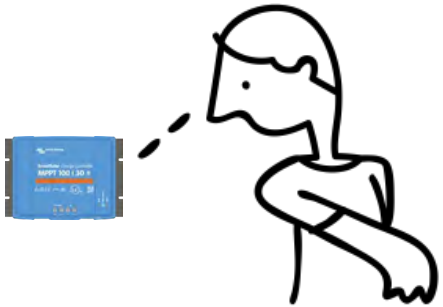


Equipment needed

- Small DC power supply with current limiting capability.
- Large DC power supply (this can also be a battery bank or large Victron battery charger).
- Empty battery or a battery with DC load (this can also be an inverter connected to an AC load like a heater).
- Phone, tablet, mac or pc with VictronConnect installed (Android, Apple, Mac or Windows)
- VE.Direct Bluetooth Smart dongle or VE.Direct to USB interface
- Digital Multimeter True RMS with diode test capability.
- Current clamp for above multimeter.

Visual check

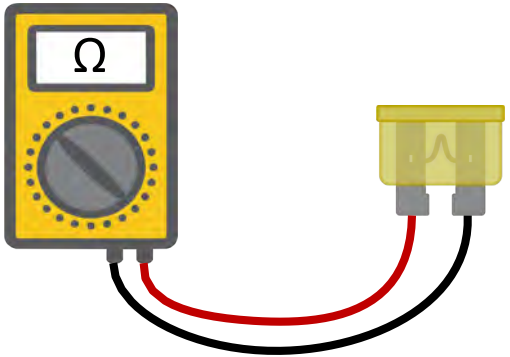
- Does the unit have water damage?
- Is the unit very dirty, is there soot, dust or oil present?
- Does the unit have mechanical damage to its housing?
- Does the unit have mechanical damage to its connectors?
- Does the unit have burned connectors?
- Does the unit have loose MC4 connectors?
- Does the unit have burn marks or molten areas to its housing or does it smell burned?



- Mechanical damage, dirt, dust water and damaged or burned connectors are not covered by warranty. Do not lodge an RMA for a non-warrantable fault

Replaceable fuse check

- If the unit has an external fuse remove the fuse and test its continuity.
- If the fuse is broken replace the fuse by a new one.
- The most likely cause of blown fuse is reverse battery polarity or an internal fault in the MPPT



Battery reverse polarity check

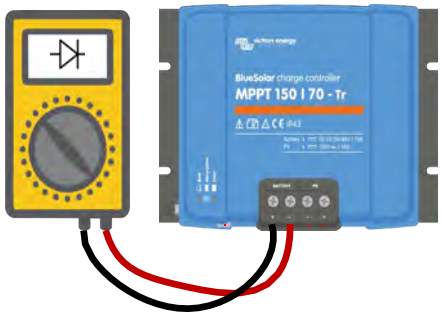
- Set the Multimeter to Diode position.
- Connect the negative (black) multimeter lead to the battery positive terminal.
- Connect the positive (red) multimeter lead to the battery negative terminal.

Fail: Open circuit (OL) – internal fuse has blown

Fail: Below 0.3 V – internal fuse has blown

Pass: Above 0.3 V

Pass: Overload (OL)



- A blown internal fuse is caused by a failure of an internal component or battery reverse polarity.
- Reverse polarity does not fall under warranty. If you suspect that there might have been reverse polarity do not lodge an RMA.

PV input test

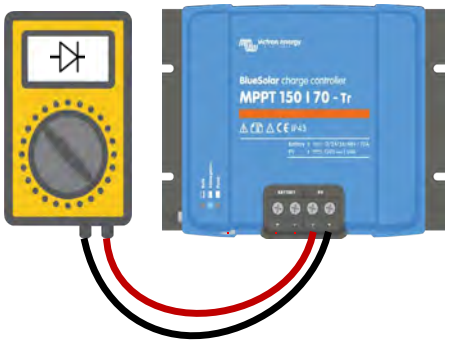
- Set the Multimeter to Diode position
- Connect the negative (black) multimeter lead to the PV positive terminal
- Connect the positive (red) multimeter lead to the PV negative terminal

Fail: Open circuit (OL) - The PV FET has failed in open circuit

Fail: Below 0.3 V - The PV FET has failed in short circuit

Pass: Above 0.3 V

Pass: Overload (OL)



- Report the result of this test in the RMA

Battery to PV - reverse FET test

- Set the Multimeter to Diode position
- Connect the negative (black) multimeter lead to the PV positive terminal
- Connect the positive (red) multimeter lead to the battery positive terminal

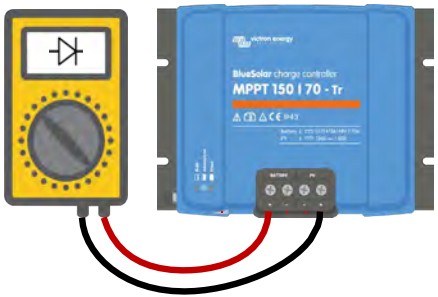
Fail: Open circuit (OL) - The reverse FET has failed in open circuit

Fail: Below 0.3 V - The reverse FET has failed in open circuit

Fail: Between 0.3 and 0.6V - The reverse FET has failed in short circuit

Pass: Above 0.6 V

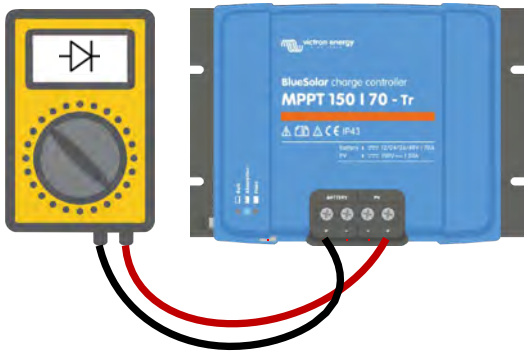
Pass: Overload (OL)



- Report the result of this test in the RMA

PV to battery - high side FET test

- Set the Multimeter to Diode position.
- Connect the positive (red) multimeter lead to the PV positive terminal
- Connect the negative (black) multimeter lead to the battery positive terminal.



Fail: Open circuit (OL)

Fail: Below 0.3 V - The high side FET and the reverse FET have failed in short circuit

Fail : Between 0.3 and 0.6V - The high side FET failed in short circuit

Pass: Above 0.6 V

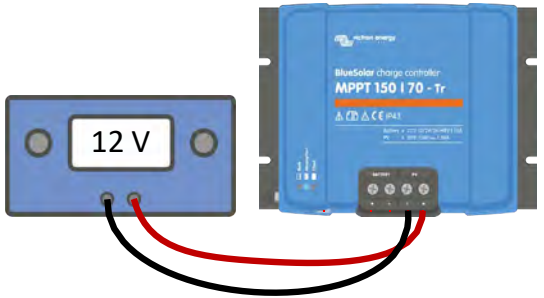
Pass: Overload (OL)

- Report the result of this test in the RMA

Short circuit test PV and battery

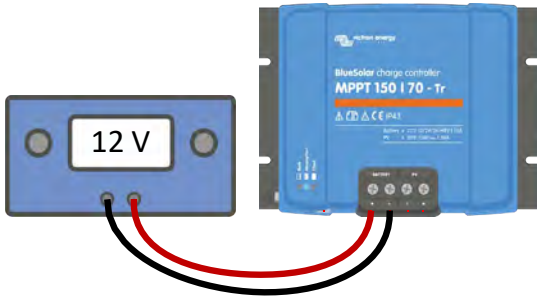
- Set the power supply voltage to 12 Vdc
- Set the current limit to 0.2 A
- Connect the power supply to the PV Input

Passed if the power supply remains at 12V



- Connect the power supply to the battery Input

Passed if the power supply remains at 12V

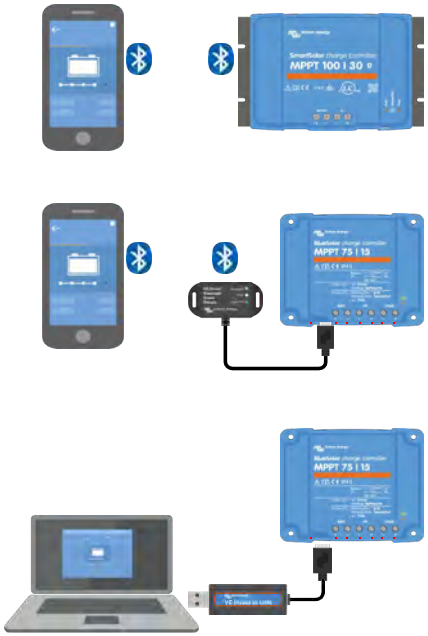


- If any of these tests **failed**, lodge an RMA and don't continue with the other tests

Victron Connect Test

- Set the power supply voltage to 12 Vdc
- Connect the power supply to the PV Input (or battery input in case PV input is not working)
- Connect with VictronConnect to the unit. It will ask to update, but don't let it update firmware just yet

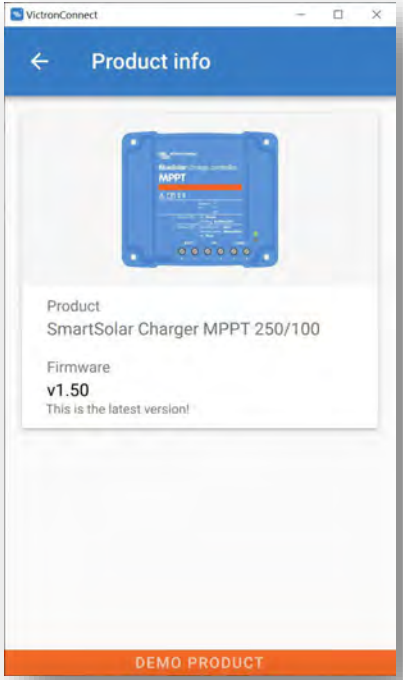
- Can a connection with VictronConnect be made?
- Try both via Bluetooth, the Bluetooth dongle or via the VE.Direct cable.
- See connection examples on the right.
- If no connection can be made at all report this in the RMA



Updating Firmware

- On first connection VictronConnect wil probably ask to update the firmware of the Bluetooth interface and the MPPT. But before updating do the following:

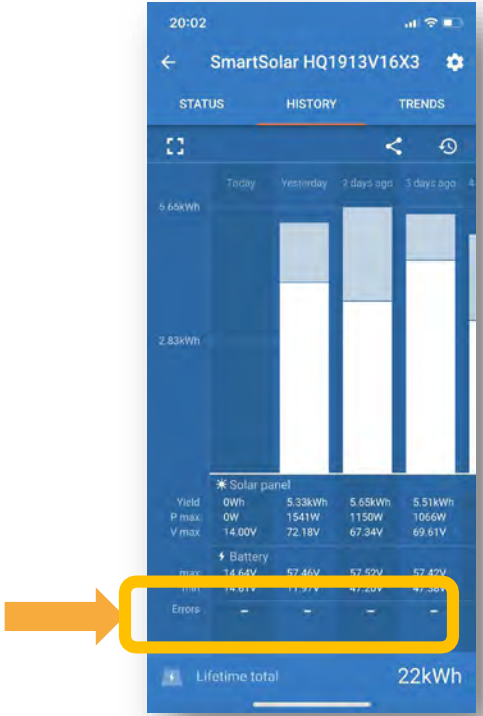
- Write down the Bluetooth interface firmware version number. If it asks for an update , let it do the update and then write down the updated version number
- Write down the solar charger firmware version number. If it asks for an update , let it do the update and write down the updated version number
- Was the unit updated in the field after the unit failed? If so, write down the previous firmware version



Victron Connect Test

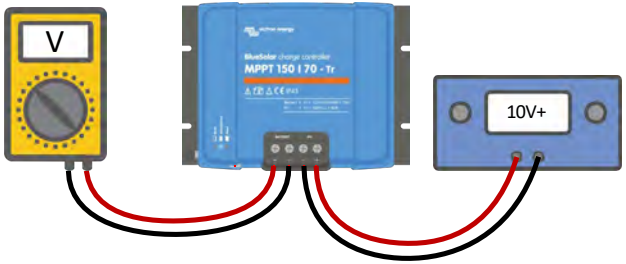
- Once connected to the MPPT do the following:

- Check the last 4 errors in the VictronConnect history tab, look at bottom of graph
- If there are errors, write down the last 4 errors
- See the Solar Charger Error document for details
- If needed take the suggested steps to resolve the error
- Check the MPPT settings
- Save a copy of the history file and the settings file



Charge voltage test

- Set a power supply at least 10V above the battery voltage as set in the unit.
- Use VictronConnect to find out what the battery voltage it is set at
- For testing purposes, it might be easier to first set the unit to a lower battery voltage, i.e. set the unit to 12V instead of 48V
- Connect the power supply to the PV terminals
- Connect a multimeter in Vdc mode to the battery terminals



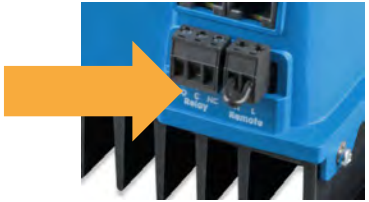
Charge voltage test

- Turn the power supply on and measure the battery output voltage and does the voltage correspond with the expected absorption, float or equalization voltage as set in VictronConnect?

If **yes**, then this test is passed. Go to next test

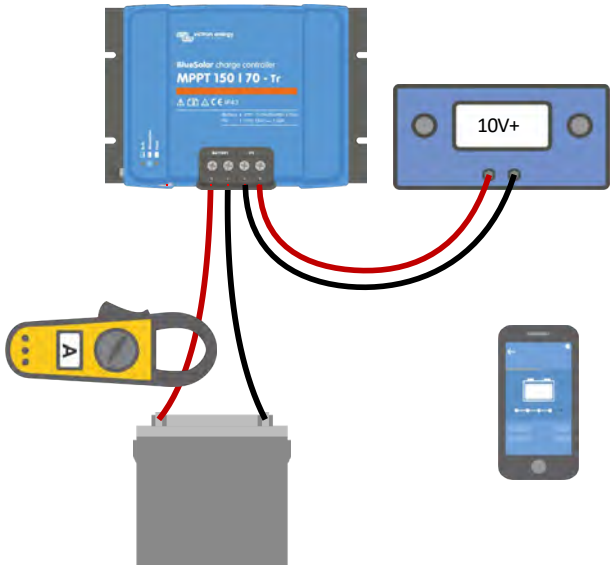
if **not**, do the following:

- If the unit is of a type that is equipped with a remote connector, check if the connector and the wire loop are present. Resolve the issue if the connector and/or the loop is missing
- Check VictronConnect settings to see if the charger is enabled, if so, enable the charger
- If still not , report in the RMA



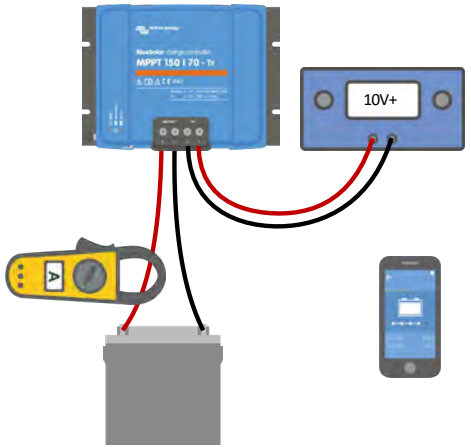
Charge current and PV voltage test

- Leave the power supply connected to the PV terminals
- Increase the current limit of the power supply to the solar charger PV current rating
- Connect an empty battery (or battery with DC load) to the battery terminals
- Connect a current clamp to one of the battery cables (or use VictronConnect)
- Check in VictronConnect that the set battery voltage corresponds with the voltage of the connected battery



Charge current and PV voltage test

- Measure the current going into the battery using VictronConnect
- Is the unit capable of delivering the expected current?
- Please note that the expected current flowing into the battery can be limited due to one of these factors:
  - The available power from the power supply is limited
  - The accepted current by the battery or the drawn current by the DC load connected to the battery
  - The maximum charge current setting in VictronConnect
- Measure the voltage on the PV terminal
- Does the voltage displayed in VictronConnect correspond with the actual PV voltage?



Accessories and special features

- Check if any of the accessories or special features have failed. Please note that these accessories or feature might not all present in all solar charger models. If any of these have failed report in RMA

- Remote on/off connector - Remove the connector with the wire loop and see if unit turns off, replace it again and see if the unit turns on again
- Pluggable display and the display port - Connect a pluggable display and see if it works
- Load output - Measure the load output voltage. This should be the same as the battery voltage. Check if the load output can provide full current. Check the VictronConnect load output and streetlight settings
- Alarm relay - Program with VictronConnect and check functionality. Also check the VictronConnect RX port setting

Accessories and special features

- VE.Direct Port data communication - Connect to a CCGX and see if the unit shows up on the CCGX. If not, check that TX port function in Victron Connect is set to “Normal communication”
- VE.Direct TX port – Check if ASS030550500 TX digital output cable is operational and check the VictronConnect TX port function setting
- VE.Direct RX Port - Check external BMS functionality by using an ASS030550310 non inverting cable and check the VictronConnect RX port setting
- VE.Can port communication - Connect to a CCGX and see if the unit shows up on the CCGX (don’t forget the terminators)
- Bluetooth - Check if Bluetooth is switched on in Victron Connect. Use a VictronConnect with USB-VE.Direct interface. Then check if there is a Bluetooth communication issue. Follow the trouble shooting section in the VictronConnect manual. Please note that the Bluetooth interface in the unit hardly ever fails. Do not submit an RMA for Bluetooth issues

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