1 Description

1.1 Introduction

The MRCC-series is a battery charge regulator for small to medium sized photovoltaic solar systems, which are used for industrial applications.
Main areas of application are:

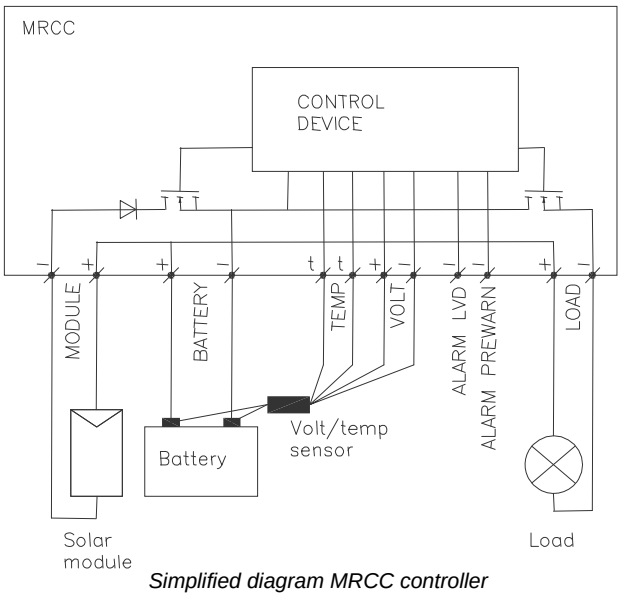
- Marine and aircraft beacons
- Wellhead control.
- monitoring and telemetry
- telecommunication

The MRCC-series features all functions and properties necessary in the industrial field to safeguard an optimum battery charge and discharge cycle. A unique facility enables field-testing of the proper functioning of its overcharge and deep discharge functions. It is also characterised by its extremely low energy consumption.

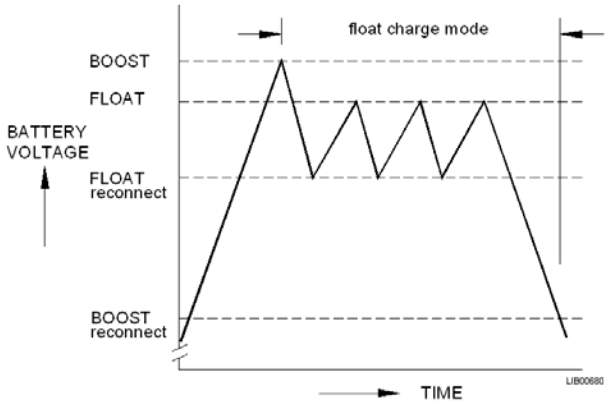
Main features are:

- Overcharge and deep discharge protection
- External temperature/voltage sensor
- 80A output MOSFET, fully electronic protected
- Functional test facility
- Possibility to connect alarm relays (LVD and/or pre-warning)
- Protection against:
  - Reverse current
  - Reverse polarity connection of solar modules and battery
  - Overload on output
- LED indicators for:
  - Operational
  - Battery charged
  - Load disconnect

1.1.1 Simplified diagram MRCC-series and boost and float charge diagram



Simplified diagram MRCC controller



Boost & float charge process

For maximum battery efficiency the charge controller performs a boost and float charge process.

The modules are switched “on” and “off” by a solid state switch in series. The battery is first charged up to the boost voltage. The green LED lights up as soon as the battery voltage reaches the boost level and stays on as long as the voltage is above the boost reconnect level.
The operational indicator (yellow LED) lights up as soon as the battery is connected. The module current is switched “off” and “on” at float and float-reconnect level.

1.1.3. Versions

The MRCC-series is available in 2 different versions:

- The MRCC-12 for 12V systems
- The MRCC-24 for 24V systems

1.2 Image of the MRCC

2 Specifications

2.1 Electrical specifications in airtight enclosure at different environmental conditions.

Electrical specifications	**Standard conditions @ 25°C**		**Extreme conditions @ 75°C**	
Model / Type:	**MRCC-12**	**MRCC-24**	**MRCC-12**	**MRCC-24**
Nominal system voltage	12 Vdc	24 Vdc	12 Vdc	24 Vdc
Maximum current solar input	40 A (45A out)	40 A (45A out)	40 A (21A out)	40 A (21A out)
Number of solar inputs	1	1	1	1
Maximum continuous output current at I input = 10 A	60 A	60 A	32 A	32 A
Maximum continuous output current at I input = 20 A	58 A	58 A	30 A	30 A
Maximum continuous output current at I input = 30 A	55 A	55 A	25 A	25 A
Maximum continuous output current at I input = 40 A	45 A	45 A	21 A	21 A
Maximum peak output current (for < 5 sec)	80 A	80 A	60 A	60 A
Dissipation at full input and output current	10,8 W	10,8 W	10,8 W	10,8 W
Typical operating current consumption	6 mA	6 mA	6 mA	6 mA
Temperature compensation	-30 mV/°C	-60 mV/°C	-30 mV/°C	-60 mV/°C
Current compensation	10 mV/A	20 mV/A	10 mV/A	20 mV/A
Maximum modules input voltage	70 Vdc	70 Vdc	70 Vdc	70 Vdc
Maximal battery input voltage	25 Vdc	40 Vdc	25 Vdc	40 Vdc
Maximum alarm relay output current	200 mA	200 mA	200 mA	200 mA
Boost level[(1)]	14,5 Vdc	29,0 Vdc	14,5 Vdc	29,0 Vdc
Float level [(1)]	14,2 Vdc	28,4 Vdc	14,2 Vdc	28,4 Vdc
Float reconnect level	13,7 Vdc	27,4 Vdc	13,7 Vdc	27,4 Vdc
Boost reconnect level	12,8 Vdc	25,6 Vdc	12,8 Vdc	25,6 Vdc
Pre-warning low voltage (alarm)	11,8 Vdc	23,6 Vdc	11,8 Vdc	23,6 Vdc
Load disconnect / LVD alarm (alarm)	11,5 Vdc	23,0 Vdc	11,5 Vdc	23,0 Vdc
Load reconnect level	12,2 Vdc	24,4 Vdc	12,2 Vdc	24,4 Vdc
Maximum wire diameter terminal block module, battery, load	16 mm² (6 AWG)			
Maximum wire diameter terminal block volt/temp sensor, alarms	1,5 mm² (16 AWG)			

[(1)] At 20°C

2.2 General specifications

General specifications		
Model / Type:	**MRCC-12**	**MRCC-24**
Operating temperature	-10°C to +70°C	
Operating relative humidity	5% to 95% non condensing	
Construction	open frame	
Mounting	Indoor	
Storage temperature	-30°C to +70°C	
Unit weight	± 0,4 kg	
Dimensions (L x W x H)	17,3 x 10,2 x 6 cm	

Explanation LED functions	
scription	**LED**
Operational	YELLOW
Battery charged *(float charge mode)*	GREEN
Load disconnect *(battery discharged)*	RED

Operating test switch		
Position	**Simulates/checks**	**Visual**
Left	Overcharge circuit	green LED on
Right	Load disconnect circuit	red LED on

Field adjustable float charge voltage

External battery temp/voltage sensor, to be mounted on minus (-) pole battery, red wire to be connected on (+) pole battery.

Connection of Low-Voltage-Disconnect and/or pre-warning low voltage relays.

3 Installation

3.1 Preparation

The battery and the open frame version of the MRCC-series should be situated (indoors) in a room or enclosure. Make sure that this room or enclosure is well ventilated because the battery may produce explosive gasses. The solar module must be placed as close to the controller (avoid long cable lengths) as possible.

Note: The controller will not function without a connected battery. It's not possible to power the loads directly by the modules without a connected battery. Make sure that the battery is connected before the solar module is connected.

3.1.1 Installation

Mount the controller on a wall or panel using four screws. The location should not be more than 3m from the battery. The controller can also be mounted on the small bracket side.

3.1.2 Wiring

The wiring should be of adequate cross-section, recommended is min 2.5mm² for max 10A and up to 6mm² for max 20A. Connect the wiring to the 6-way terminal according the simplified diagram (§1.1.1). To prevent short circuit connect the battery cable (use 6mm² cable) always first to the controller and after that to the battery. Arrange the wiring in such a way that there is no excessive force on the MRCC terminals when connected.

3.2 Electrical connections

Note: do not connect anything to the controller and the battery unless mentioned in these instructions.

1. Cover the solar modules.
2. Connect the cable of the temperature/voltage sensor to the 4-way terminal.
   Brown wire (+) voltage sense to terminal "+ volt sense".
   White wire (-) voltage sense to terminal position "- volt sense".
   Green and yellow wire (t) sense to positions "T temp sense" (no polarity).
   Black wire (screen) not connected.
3. Connect the module-cabling (not yet to the controller)
   Prepare the load cabling
4. Connect the positive (+) battery power cable to the 6-way terminal [battery +].
5. Connect the minus (-) battery power cable to 6-way terminal [battery -].
6. Mount the temperature/voltage sensor on the minus (-) pole of the battery together with the other end of the minus (-) battery power cable.
7. Connect the other end of the positive (+) battery power cable together with the red wire ((+) battery voltage sense) from the temperature/voltage sensor to the positive (+) pole of the battery. Check if the yellow LED (operational indicator) is on. If not, disconnect the cable again and check all connections.

8. Remove the cover from the solar modules. Check the polarity and voltage of the solar module-cable (16 to 22 volt for the MRCC-12 and 32 to 44 Volt for the MRCC-24). Replace the cover of the solar modules.
9. Connect the solar module cable to the 6-way terminal [module +] and [module -], mind polarity.
10. Remove the cover of the solar modules.
11. Check if all connections and polarities up to now are right. Measure the battery voltage, which should be approx. the system voltage ± 10%. Check the solar module voltage, which should be approximately the battery voltage. If you want to test the charge current you may connect an ampere meter (full scale 10A-20A) in series (between (+) pole of the solar module cable and the (+) solar module terminal).
12. Test the charge function.
    If it is bright weather, the amp-meter must show a current. The value of the current depends on the weather conditions, time of the day and type of solar module.
    Moving the test switch of the MRCC to the left simulates a high battery voltage. The charge current drops to zero and the green LED is on and the voltage on the solar module input-terminal is between 16-22 Volt (or 32-44 volt for the MRCC-24). Release the test switch. Normally the charge current is present again and the solar module input voltage is approximately the battery voltage. With rather high battery voltages the green LED is on, otherwise the LED is off after a few seconds.
13. Test the deep discharge protection.
    Move the test switch to the right and hold it in position. After 5-15 seconds the load switches off and the red LED is illuminating. Release the test switch. If the battery voltage is more than 12.3 V or 24,6 V the load switches on again and the red LED is off. If not, move the test switch to the left and hold it (approx. 10 seconds) until the output switches.
14. If you have a new battery normally the battery must be conditioned. Charge the battery until the green LED lights up, wait a few hours/days (depending on the sun's radiation) until the specific density of the electrolyte in the battery is the same in all the cells and does not change anymore (battery charged). See the separate instructions supplied with the battery for detailed information.
15. Cover the modules again, remove the ampere meter, connect the positive (+) solar module power cable to the (+) terminal of the solar module input. Remove the cover from the solar modules.
16. Now you can connect your application(s) to the load output, [load +] and [load -] of the 6-way terminal. To prevent damage, switch your applications off before connecting.
    After connecting, test your application(s).
17. Your system is ready for use now.

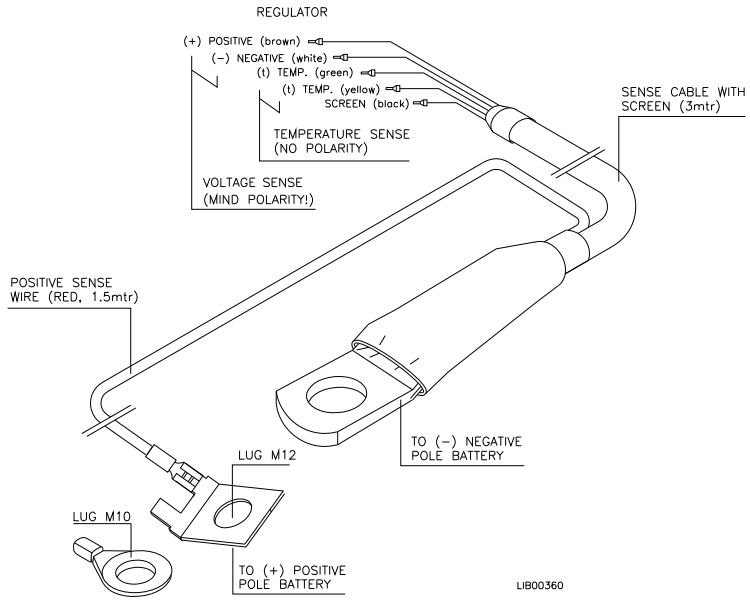
3.2.1 Alarm relays

Optional alarm relays with voltage-free contacts (suppressor diodes recommended) for pre-warning low voltage and Low Voltage Disconnect (LVD) alarm can be connected.
On the alarm output terminal the minus connection of an alarm relay can be connected (max. continuous current 200 mA). The positive side of the alarm relay should be connected to the positive output terminal via a 500 mA fuse). In the event that an alarm occurs the controller will switch on the alarm relay.

The alarm status for different system conditions is as follows:

Condition (at 24V)	Pre-warning Alarm relay	LVD Alarm relay	Load (at 24V)
Normal	Off	Off	On
Vbat < 23.6V	Active	Off	On
Vbat < 23.0V	Active	Active	Off

3.3 External Temperature and Voltage sensor



4 Operation

4.1 Voltage charge/cell potentiometer

The potentiometer is standard in the calibrated neutral position, i.e. 2.37 V/cell. The potentiometer affects both float and boost charge voltage setting. Dependent of the battery type, capacity, load and operating conditions the recharge time and water usage (flooded types) of the battery is optimised by adjusting the float charge setting. Therefore we recommend consulting Tss4U first before adjusting the float charge setting of the controller.

4.2 Short circuit and overload protection on output

In case of short circuit of the output, an electronic fuse will prevent any current flowing to the load, without other indication. This situation will be persistent until reset of the electronic fuse.

Reset procedure:

- Resolve the cause of the short circuit.
- Move and hold the test/reset switch to the “low” position until the red led is on. Wait two seconds extra and release the switch.
- As soon as the red led is off, test the loads by switching them on, one by one.

In case of overload, or operation in an extreme high temperature environment, the output protection circuitry will temporarily switch off the output. The MRCC will switch on again after a period of cooling down but will go into protect mode again when the overload persists. To resolve this issue, perform the following:

- Disconnect or switch of the loads connected to the output, one by one.
- Wait a few minutes in order to cool down the fuse. Then the output will switch on again.
- When the power to the load remains, the unit operates with acceptable load.

4.1 Maintenance

- For the best result the module surface should be clean and free of leaves, sand, dust, etc.
- Make sure that all terminals and electric connections are clean and free of oxidation (grease the battery poles with acid-free vaseline).
- Check (if applicable) the electrolyte level of the battery at least 2 x per year. If there is no mark to indicate the correct level, the electrolyte level should be approx. 1 cm above the metal plates. If necessary, add distilled water. Never use ordinary water or battery acid to refill the battery. If you don’t use the battery during the winter, charge the battery and then place it in a dry and frost-free area. At the beginning of the season charge the battery and it will be ready for usage.
- If the solar module is not used during the winter there’s no harm in keeping it outdoors.

5.1 Trouble shooting

A multimeter is required when trouble shooting.
The solar system size is calculated for the defined load and based upon the expected radiation with sufficient safety margins. However special unforeseen/unknown local circumstances may cause improper working. Although all system components are designed and produced for fault-free operation for a long time under normal conditions, problems might occur due to incidental external unforeseen events.
If anything is outside normal operation conditions, the system will react differently and display one or more malfunctions. With the help of the fault diagnosis below, the reason for malfunction can be found and a possible remedy is advised.

A) Diagnosis:
Battery voltage is too low (red LED is on).

Possible causes:

1. Too much load current.
2. Exceptional log period of low radiation by the sun.
3. (Partial) shading of the modules.
4. Dirty modules.
5. In proper cable connections.
6. Defect temp./voltage sensor
7. Defective MRCC.

CHECK / REMEDY:

1. Check the daily load of the system in Ah and compare this with the design values.
2. Check whether the solar radiation has been very low over a longer period than average.
3. Check that no shading of modules can occur. Even partial shading of modules during any time of the day will reduce the output considerably.
4. Check whether the modules are not dirty (e.g. leaves or bird droppings). Accumulated dust and dirt will decrease the module output considerably.
5. Check all cabling of the modules, the junction boxes, the MRCC and the battery on corrosion and tightness.
6. Measure at the voltage sense terminals (sense, brown/white) whether the battery voltage is present. If not, replace the sensor.
   When accidentally short circuiting the voltage sense wires the sensor will be destroyed. If this occurs the sensor has to be replaced.
   Measure the resistance of the temperature sensor by removing the wiring to the controller (sense terminals t-t) and measure with an Ohmmeter. If the sensor is defect (normally either short-circuit or open-circuit) it should be replaced.

Temperature of sensor (°C)	Resistance of sensor (Ohm)
40	2250
30	2080
20	1920
10	1775
0	1635
-10	1500

Table: Temperature dependence of resistance of temperature sensor (values ± 10%).

With the MRCC and the battery connected, measurement at the temperature sense terminals should show a voltage over the sensor of less than 1 volt (approx. 0.7V, but not zero). Approx. 2.5 Volt indicates bad or loose contacts, or a defective sensor.
Refer to resistance measurement.
0V indicates a bad contact to the MRCC or a defective MRCC, locate the fault and repair. If necessary replace the MRCC.

7. Check whether current from the array is flowing into the battery. If not, by-pass minus module inputs to minus battery.
   If current is flowing now, the MRCC is suspected to be defect, replace MRCC.

B) Diagnosis:
Battery Voltage is too high.

Possible causes:
1 Loose or defective battery temp/voltage sensor.
2. Defective MRCC.

CHECK / REMEDY:
1. Check the connections of the battery temp/voltage sensor.
2. At boost charge level (+ 1V), (see specifications and take the temperature compensation into effect) all module inputs should be switched off. If this is not the case and still current from module to battery is flowing, the MRCC has to be replaced.

C) Diagnosis:
No output voltage, overload protection active

CHECK / REMEDY
1. Hold the test/reset switch for approx. 10 seconds in the “low voltage test” position to reset the output overload protection.