



## USER MANUAL

**COOLMAX SR – Rack Mount**  
Australian Energy Research Laboratories  
AER05.0013 – G1 v5  
25<sup>th</sup> January 2015

# COOLMAX SR MAXIMIZER™ RACK MOUNT

## Installation and Operation Manual



*Models*

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**SRMVR**

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# Important Safety Information

This Installation Manual contains important safety information and Installation instructions for the AERL COOLMAX SR MAXIMIZER Wall Mount MPPT.

The following symbols are used throughout this user manual to indicate ideal Installation methods, potential dangerous conditions and important operational information.



### Important

Indicates information that must be followed to ensure proper operation of the COOLMAX SR unit.



### Caution

Indicates a critical procedure for the safe Installation of the COOLMAX SR unit. Use extreme caution when performing this task.

## About this Manual

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### Important

- This User Manual provides detailed installation and usage instructions for the COOLMAX SR unit. It is recommended that all of the Instructions and Cautions in this User Manual be read before beginning installation.
- Only qualified electricians and technicians should install the COOLMAX SR System. This manual is intended for all Installation technicians and the system owner.
- Do not disassemble or attempt to repair the COOLMAX SR unit unless you are a qualified technician and have authority in writing from AERL to do so.
- AERL will not be held responsible in any way for the mishandling of this product or for installation of the product in a manner that does not follow the instructions in this manual or as advised by an AERL technician.

## **1 WARRANTY**

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1. AERL warrants that the Product will be free from manufacturing defects for a period of 24 months from the date of dispatch of the products by AERL to the customer.
2. The Products technical specifications are contained within the Product Datasheet. The Product will conform to the technical specifications contained in the Product Datasheet at the time of dispatch of the Products to the Customer. If the technical specifications as contained in the Product Datasheet are not met, AERL will repair, replace the Product, or refund the amount paid by the Customer in relation to the Product at the Customers option. AERL is under no obligation to provide assistance or advice to the Customer in relation to the technical specifications.
3. The Products must be installed in strict accordance with the Installation Recommendations listed in this Manual.
4. In no event will AERL be liable for:
  - a) any loss or damage which the Customer suffers arising from, or caused or contributed to by, the Customer's negligence or the negligence of the Customer's agents or servants; and
  - b) special, indirect or consequential loss or damage as a result of a breach by the Customer of these Standard Terms including, without limitation, loss of profits or revenue, personal injury, death, property damage and the costs of any substitute Products which the Customer obtains.
5. The Product is not covered for damage occurring due to water, including but not limited to condensation, moisture damage and other forms of precipitation.
6. The Product is not covered for damage occurring due to the Product being incorrectly installed or installed in a manner not in accordance with the Installation Recommendations listed in the Product Manual.
7. The Product is not covered for damage occurring due to failure on the part of the customer to operate the product in accordance with the technical specifications as listed in the Product Datasheet.
8. The Product is not covered for damage occurring due to lightning.
9. The Product is not covered for situations where it is used in a manner not specifically outlined in the Product Manual.
10. If any provision in this document is invalid or unenforceable this document will remain otherwise in full force apart from such provision, which will be deemed deleted

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## 2 SPECIFICATIONS

CHARACTERISTIC	SRMVR
Nominal Battery Voltage - Selectable	24 to 84V
Maximum Output Current	30A
Maximum Recommended PV Array	2500W @ 84Vout(nom) 1500W @ 48Vout (nom) 900W @ 24Vout(nom)
Maximum PV Voltage Open Circuit	180V
Power Conversion Efficiency	99%
Battery Temperature Compensation	Yes
Polarity	Common Positive
Master/Slave Configurability	Yes
Low Battery Alarm/Automatic Low Battery Switch Off	Yes
Passive Cooling – no moving parts	Yes
Operating Temperature Range	-20° to 50+°C
Storage Temperature	-30° to 70° C
Self Consumption	75mA @ 20V
Data Logging	356 days
Communication Protocol Options	CAN
Enclosure type	19" Sub Rack (Indoor Type1)
Weight	2kg
Outer dimensions (L x W x H)	294 x 125 x 92 mm

### 3 OVERVIEW

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The AERL COOLMAX SR is a high efficiency, buck only, common positive maximum power point tracker. It is the latest development in the MAXIMIZER™ range, pioneered by AERL in 1985. The SR blends the famously reliable AERL power stage with easy to use digital features such as system performance logging, fully configurable alarms and remote system monitoring and control.

The COOLMAX SR employs a maximum power point tracking strategy which has been proven to be highly robust, immune to local extrema, and results in power losses of less than 0.5% over the whole operating temperature range of a PV Array.

- Increase PV output by approximately 30%
- Super high conversion efficiency — 99%
- Built-in logging — 1 million sample points
- 12 months of daily statistic logged internally
- Common positive wiring configuration
- Passive cooling
- CAN bus interface
- High power density — 4kW/l & 4kW/kg
- Modular subrack mounting design

### 4 WHY USE AN MPPT?

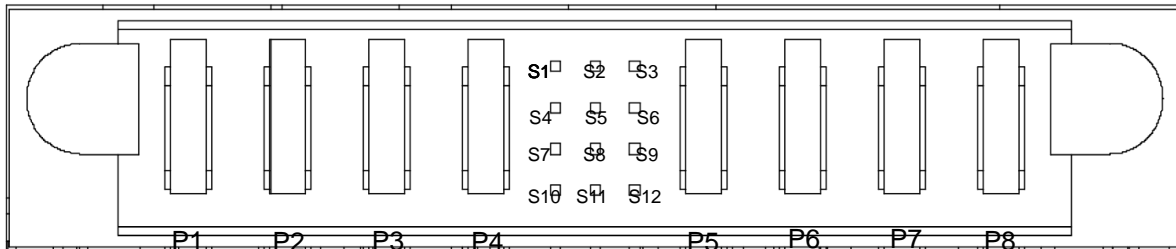
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In simple terms, a Maximum Power Point Tracker sets the voltage of the solar panels to the ideal operating point of the panels. This is the maximum power voltage, or the voltage at which the solar cells can deliver maximum power to the load. This means that by using MPPT technology, the COOLMAX SR can harvest up to 35% more energy from a solar array compared to a non-MPPT regulator.

The bottom line for solar system installers is that a cheaper, less powerful solar array can always be installed when using an MPPT – this saves cost, wiring and solar area. Because the MPPT boosts the panel output by 35%, the required array size and cost is reduced.

The other benefit of MPPT converters is that a high voltage solar array can be converted down to a low voltage battery pack. This is advantageous because solar arrays are designed to be wired in series, and require much lighter wire when doing so. Additionally, a low voltage battery pack is intrinsically safer than a lethal, high voltage pack.

## 5 CONNECTOR PINOUT



### 5.1 POWER PIN ASSIGNMENT

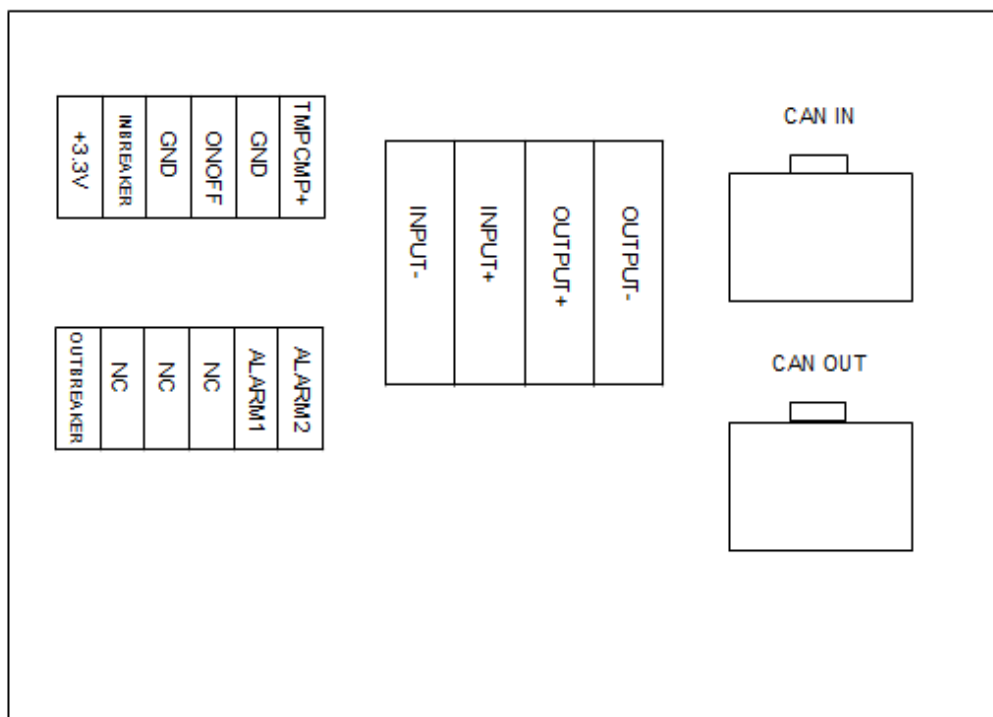
PIN	ASSIGNMENT
P1, P2	INPUT NEGATIVE
P3, P4	INPUT POSITIVE
P5, P6	OUTPUT POSITIVE
P7, P8	OUTPUT NEGATIVE

### 5.2 SIGNAL PIN ASSIGNMENT

PIN	ASSIGNMENT	FUNCTION	ISOLATED
S1	+12V-CAN	CAN power	YES
S2	CANH	CAN signal high	YES
S3	TMPCMP	For temp comp thermistor	NO
S4	GND-CAN	CAN ground	YES
S5	CANL	CAN signal low	YES
S6	+3.3V	MCU power	NO
S7	ALARM+	Alarm relay contact +ve	YES
S8	OUTBREAKER	Output breaker open/closed sense	NO
S9	GND	MCU ground	NO
S10	ALARM-	Alarm relay contact -ve	YES

PIN	ASSIGNMENT	FUNCTION	ISOLATED
S11	ONOFF	Remote enable signal	NO
S12	INBREAKER	Input breaker open/closed sense	NO

### 5.3 TERMINAL BOARD PINOUT

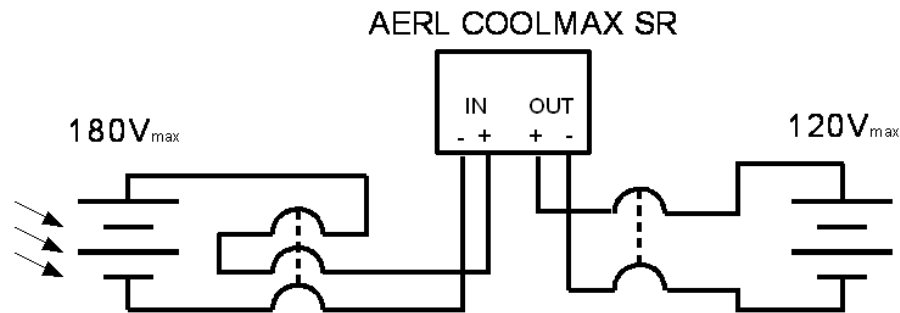


## 6 CIRCUIT BREAKERS

AERL recommends the use of 6kA, 8kA or 10kA DC rated circuit breakers with an appropriate voltage rating on both input and output. Double or triple ganged circuit-breakers can be connected in series to give the desired voltage rating as shown below.

It is important that the peak voltages are taken into account when selecting breakers. For example a 120V nominal battery pack will be close to 150V at top of charge, so the breaking capability of the circuit breakers will need to be selected accordingly.





*Figure 1 - Standard DC breakers with 60V rating per pole are used in triple-gang configuration to break 180V on the PV side and double gang configuration to break 120V on the output side.*

## 7 MOUNTING

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### 7.1 LOCATION

- The COOLMAX SR enclosure is not intended to be mounted where splashing water or direct sunlight can reach the unit.
- The terminal board should only be used in dry locations.
- Cables should always be routed downwards away from the COOLMAX SR so that moisture which condenses on the cables does not run back into the product.
- The COOLMAX SR should be mounted to allow convection airflow to move past the metal enclosure.
- If using a version of the COOLMAX SR with a heatsink, it is best practice to mount the Coolmax such that the heatsink fins are in a vertical orientation, so that convection air currents can flow up between them.

## 8 INSTALLATION

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**CAUTION: DO NOT EARTH THE ARRAY** in any way if a negative earth is used for the batteries or DC system.

### 8.1 EARTHING

- AERL recommends that the COOLMAX SR MAXIMIZER™ be utilized in a floating system (no earthing) whenever possible. For very exposed systems, it is recommended that a lightning conductor be provided nearby to prevent damage to PV equipment, batteries and the MAXIMIZER™.

- For systems using Sunpower PV arrays, it is necessary to provide a positive earth for the array.

### 8.2 CONNECTIONS

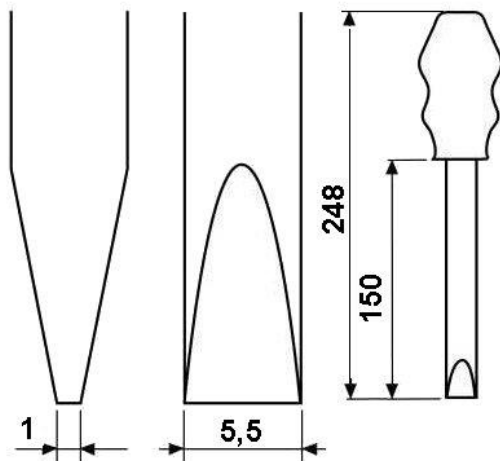


**CAUTION: Reversing polarity of input or output will cause damage to the COOLMAX SR MAXIMIZER™ and void product warranty.**

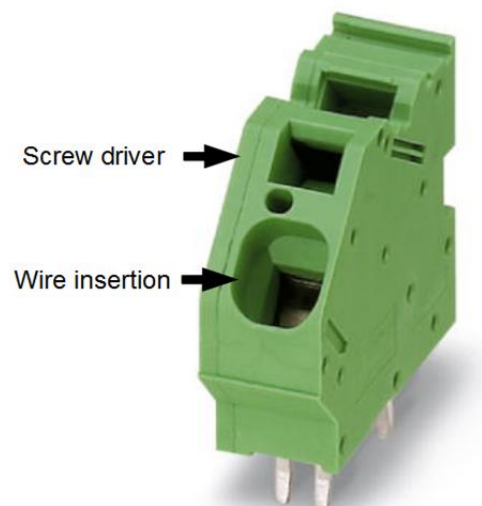
- Use appropriately rated wire to connect PV input and battery bank output. Check the polarity in the diagram provided in this user's manual.
- Install circuit breakers as described in Section 6.
- Check the polarity of the input and output with a multimeter before switching on the COOLMAX SR.

### 8.3 SPRING CAGE TERMINAL BLOCKS

- The spring cage terminal blocks are operated with a screwdriver. The recommended part is SZF 3-1,0 x 5,5 manufactured by Phoenix Contact. A flathead screw driver with the same rough dimensions can be used as shown below.
- The screwdriver is used to lever the spring cage downwards. This opens the terminal and allows the wire to be inserted.



**Figure 2.1 - Dimensions of flathead screwdriver to actuate spring cage terminals**



**Figure 2.2 - Using the terminal block**

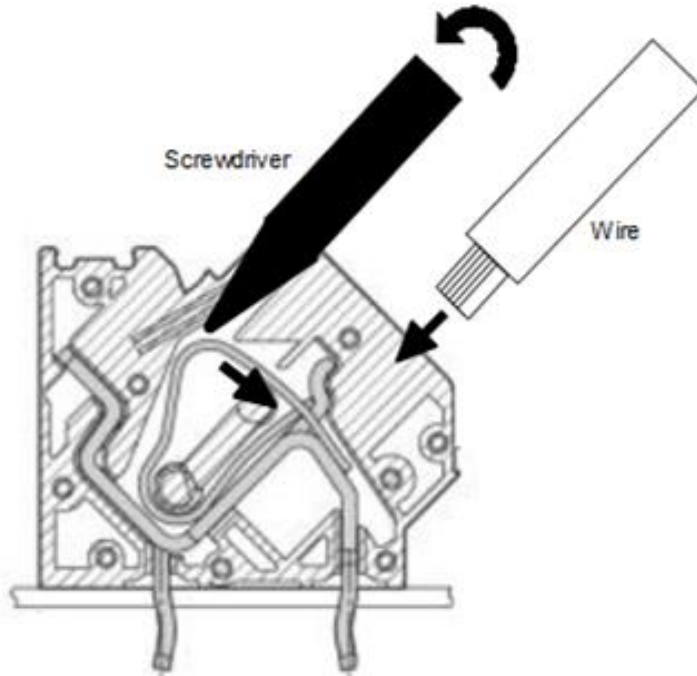
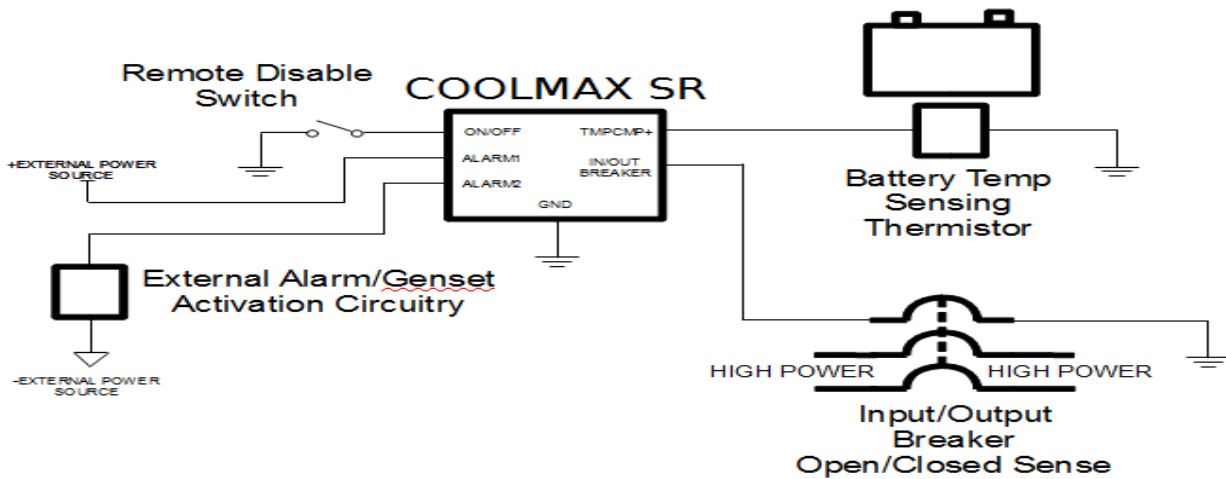


Figure 2.3 - Screwdriver is used to lever down spring cage to allow insertion of wire

### 8.4 AUXILIARY CONNECTIONS

The COOLMAX SR has a number of inputs and outputs to add functionality to the product. The correct way to connect these circuits is shown below.



## 9 CAN COMMUNICATIONS

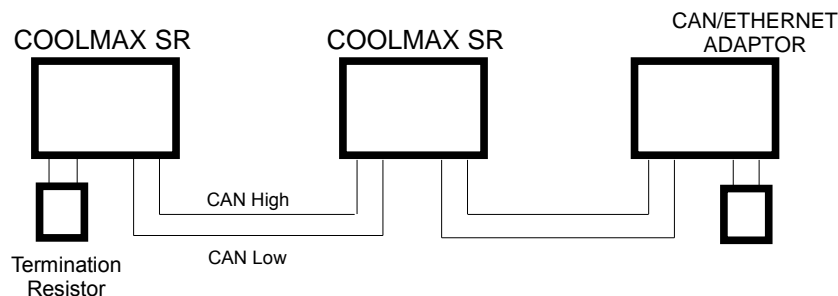
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### 9.1 CAN NETWORK TOPOLOGY

The CAN bus is structured as a linear network, with short stubs branching from 'T' connectors on the main bus backbone to each device. The CAN bus data lines must be terminated at each end of the main bus with 120 ohm resistors between the CAN-H and CAN-L signals.

The AERL COOLMAX SR CAN connections are implemented with an 'in' and an 'out' connector, therefore placing the 'T' on the device, resulting in a very short fixed-length stub on the circuit board of each device. This is ideal from a signal integrity and network performance point of view.

Multiple COOLMAX SR units can exist on the same CAN bus and this can be connected to other networks using a CAN-Ethernet adaptor.



### 9.2 CAN WIRING

The CAN data lines (CAN-H and CAN-L) must be implemented with twisted-pair wire for proper data integrity. The wire should have a characteristic impedance of 120 ohms.

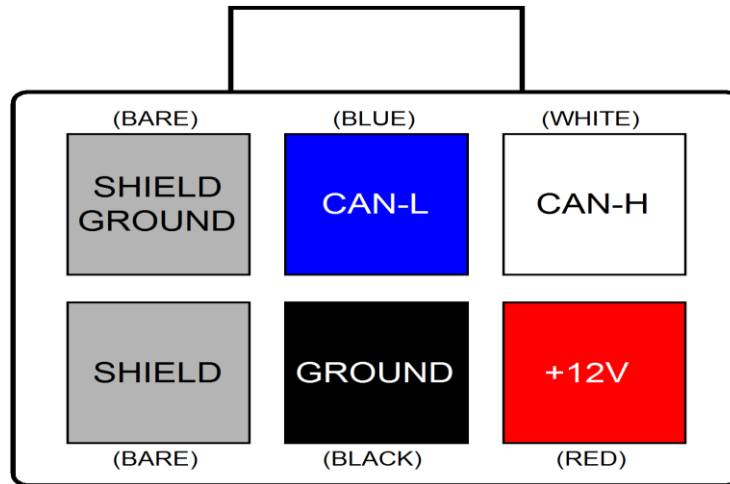
Power should also be provided along the CAN cable, ideally with another twisted pair to minimise noise pickup. An overall shield can also be advantageous.

The recommended choice of cable is 7mm Devicenet CANbus 'thin' cable, with 24AWG (data) + 22AWG (power) twisted pairs and a braided shield. Using this cable will result in a robust installation.

Standard CAT5 network cabling (which has an impedance of 100 ohms) can be used, but may become unreliable in longer networks or in the presence of electrical noise from DC/DC converters and other electrical devices in the system.

### 9.3 CAN CONNECTOR

The connector used on the COOLMAX SR and CAN-Ethernet adaptor is a 6-way 3mm pitch Molex MicroFit connector. The pinout is shown below, as viewed from the wire side – as you would look at it while inserting crimps. The colours shown match those in the standard DeviceNet CAN cabling pairs.



### 9.4 SHIELDING

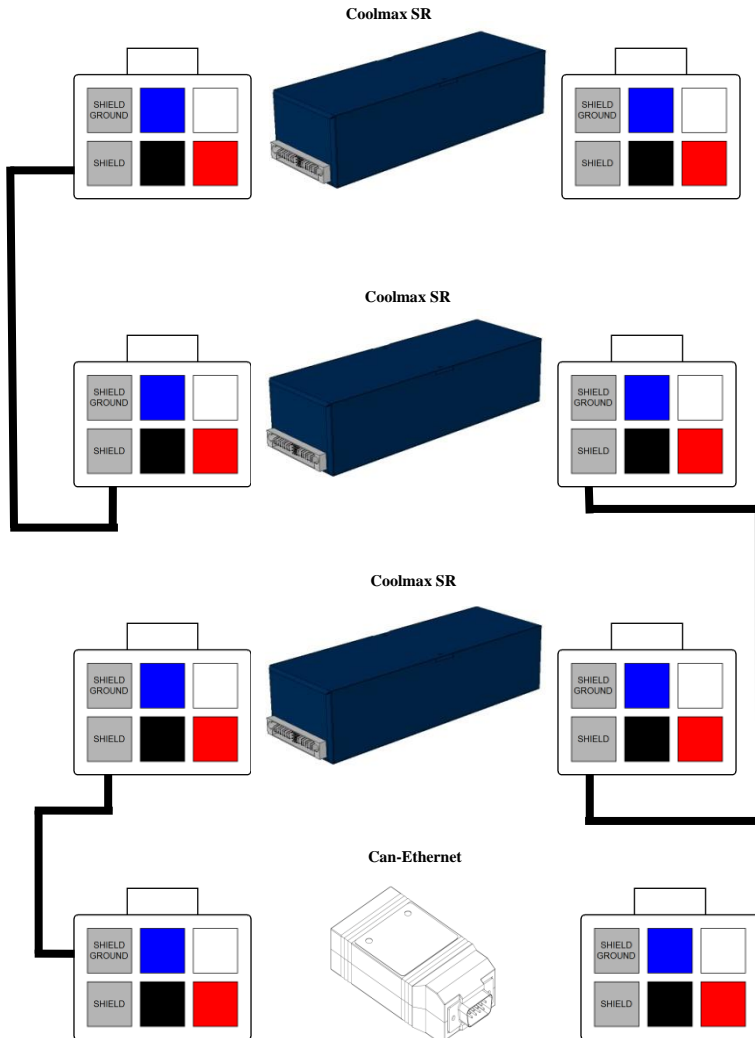


**Important: Correct shielding practice is important for error free communications. Incorrect shielding can cause more interference than unshielded cables would experience. Shields should be linked between each wire segment along the network but only grounded in one place. The following paragraphs explain how to achieve this.**

Shields from multiple lengths of CAN cable can be joined together through each device. This is done by crimping the shield from the CAN IN cable into the “Shield” pin (see above labelled diagram), and plugging the shield from the CAN OUT cable also into the “Shield” pin.

At one point in the network, and only one point, all shields should be connected to ground. This is done by crimping the shield from the CAN IN and CAN OUT cables into the ‘Shield Ground’ pin.

If there is a CAN-Ethernet bridge on the network, this should be the point where shields are grounded (there will also be a terminating resistor on this node).



## 9.5 CAN TERMINATION

To implement the required 120 Ohm termination resistor at each end of the CAN bus, plug a connector into the unused CAN connector on the last device at each end of the network with a resistor crimped into the appropriate locations.

## 10 OPERATING GUIDELINES

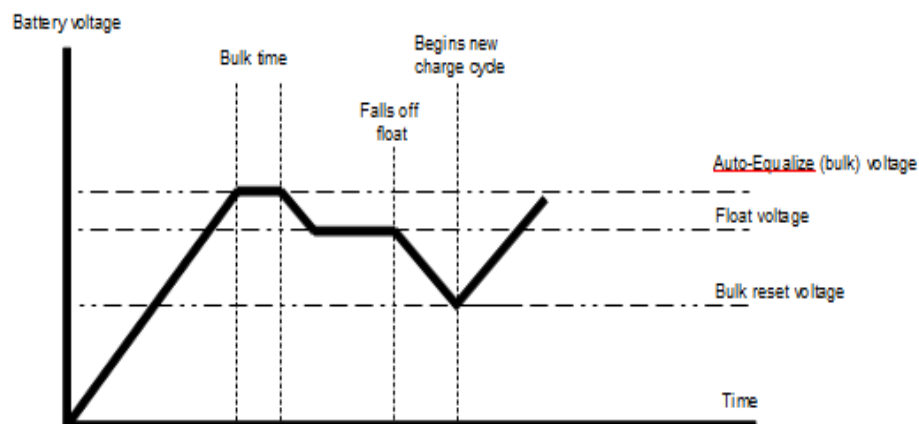
### 10.1 BATTERY CHARGING SETUP



**CAUTION:** The COOLMAX SR has been specifically designed to charge Lead Acid Batteries and the battery charge profile information detailed below is in relation to charging Lead Acid batteries only.

Installers wishing to use the COOLMAX SR with battery chemistries other than Lead Acid **MUST** contact AERL to discuss this first prior to any installation and operation of the unit. Failure to do so will void all product warranty.

- The batteries are charged using an automatic equalise / anti-sulphation charging profile. This profile is designed for lead-acid batteries, which can be equalised automatically by allowing each battery to vent for a short time.
- Bulk voltage
- Float voltage
- Bulk reset voltage
- Bulk time
- An example charge profile for the Coolmax is shown below to illustrate the charge profile parameters above.
- To edit charge profile parameters, refer to the documentation for the COOLMAX SR communication software.



**Important:** The charge profile can be edited for other battery chemistries by manipulating the various parameters. However, battery chemistries other than lead acid should be used with extreme caution as there is a high risk of overcharging individual cells. It is always recommended to employ a battery monitoring system as an unbalanced battery pack can result in damage to batteries due to overcharging. Please contact AERL prior to using the COOLMAX SR with battery types other than lead acid to avoid loss of warranty.

## 10.2 TEMPERATURE COMPENSATION

- Temperature compensation measures the temperature of the batteries and adjusts the float voltage set point to the ideal voltage for batteries at that temperature.
- The thermistor is connected as shown in Section 7.4. The Coolmax measures the voltage between TMPCMP+ and GND to determine the temperature of the batteries.
- Using the temperature of the batteries, the Coolmax adjusts the float voltage by a user specified factor in millivolts per degrees celcius.
- The temperature compensation factor is adjusted using the Coolmax software, refer to its documentation for more information.

## 10.3 RELAY ALARM / GENSET CONTROL

- The ALARM1 and ALARM2 pins are the contacts of an isolated 12V, 1A relay. When an alarm state is in effect, ALARM1 and ALARM2 will be connected inside the Maximizer. When the alarm state is removed, ALARM1 and ALARM2 will be completely disconnected from each other.
- An external alarm or genset control circuit can be used to sense whether ALARM1 and ALARM2 are open or closed.
- Many different events can be attached to the relay. These are
  - System init (system starts up after a reset or off period)
  - Low output voltage warning
  - Low output voltage fault
  - Low output voltage genset start
  - High output voltage fault
  - High output current fault
  - High discharge current fault
  - Input breaker open
  - Output breaker open
  - Temperature sensor fault
  - Regulation fault
  - Log file full
  - Panel missing
- These are configurable so that multiple faults could trigger the relay. There is also a time hysteresis which prevents the relay from triggering on spurious readings.
- To configure the events, consult the documentation for the Coolmax software.



### 10.4 REMOTE ON/OFF CONTROL

- The remote ON/OFF control can be implemented with a single switch connected between the ONOFF pin and GND pin.
- The Coolmax will sense if the ONOFF pin has been connected to GND when the switch closes and this will disable the Maximizer.
- 

## 11 PV ARRAY CONFIGURATION NOTES

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### 11.1 OPTIMAL PV ARRAY CONFIGURATION

A Maximizer runs at peak efficiency when connected to a PV panel with the minimum recommended open circuit voltage specified in its datasheet.

The input open circuit voltage (Voc) must be above the minimum voltage listed in the datasheet for the Maximizer to run.

### 11.2 PV INPUT BLOCKING DIODE

A PV Input blocking diode should not be used as long as the open circuit voltage of the PV array is within the range specified by the datasheet for the appropriate Maximizer model and battery voltage. The idea of the blocking diode is to prevent night time reverse leakage from the battery into the PV array. However the diode introduces power wastage during operation which outweighs the leakage, resulting in a net power loss.

### 11.3 PV MODULE POWER RATING AND MOUNTING CONSIDERATIONS

The nominal power output rating of a particular PV Module is specified by the PV Module Manufacturer, at One Sun (1000W/sq.m of sunlight radiation) and 25 degrees Celcius.

PV Module Maximum Power Voltage (and consequently maximum power) falls off by 4% per every 10 degrees celcius that the PV panel rises above this 25C specification, so typical panel temperatures on a hot summers day of 65C will result in a panel power derating of 16% of the manufacturers rating.

It is best to mount the PV Array in a way that the hot air behind the panels can easily escape via the natural breezes or convection. So don't mount the PV Array flat against the roof surface, but ensure there is at least 400mm spacing below the panels.

Small gaps (20-30mm) left between adjacent panels are also a good idea to let out the hot air from the sides.



**Important: Around 80% of the sun-light energy falling on the solar cells is converted directly into heat, not electricity, and heat is the power output enemy of PV modules.**

## 12 TROUBLE SHOOTING

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### 12.1 LOW BATTERY ALARM TRIGGERS OFTEN

This could indicate that the PV system is underpowered, never reaching a full 108% equalise value. The battery life will be severely compromised in this situation. The more often the Low Battery Alarm triggers, the more power should be added to the PV array.

Solution: Add more PV modules to the array to increase the power output.

If the array is sufficiently powerful, but the LED is still very often on, check that the Maximizer is set up for the correct voltage of the battery pack. Also check that the Maximizer is charging the battery by checking the output current.

### 12.2 BATTERY BANK USING EXCESSIVE WATER (ELECTROLYTE)

The battery bank is lightly loaded compared to the input PV power and rarely comes off float voltage. Adjust the float voltage down by a few volts using the COOLMAX SR software.

## 13 APPENDIX A – CAN COMMUNICATION PROTOCOL

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### 13.1 OVERVIEW

#### 13.1.1 Hardware

The CAN hardware interface used is compatible with the CAN 2.0B standard. The supported bit rates (bits per second) are 1 Mbps, 500 kbps (default), 250 kbps, 125 kbps, 100 kbps and 50 kbps

#### 13.1.2 Software

The CAN protocol uses data frames for most communication. Remote frames are also enabled. All measurement data is transmitted using IEEE single-precision 32-bit format (IEEE 754) with most significant byte (MSB) sent first.

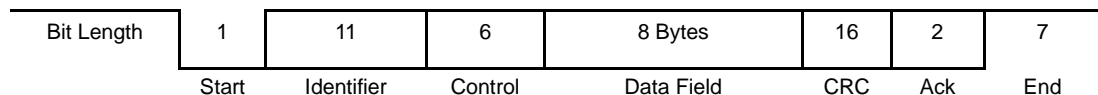
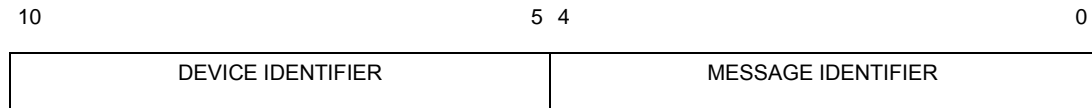


Figure 1. CAN data frame

**13.1.3 Identifier**

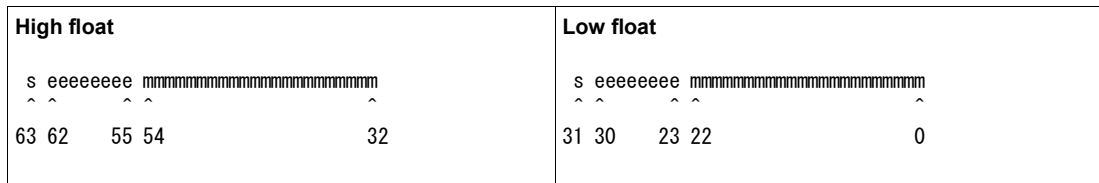
The identifier field has been split into two sections for the Coolmax SR. Bits 10-5 contain the device identifier and bits 4-0 contains the message identifier associated with that device, as shown in Figure 2.



**Figure 2. CAN device identifier address format**

**13.1.4 Data Field**

The data field in all frames is fixed at 8 bytes (64 bits) which allows space for two IEEE 754 32-bit floating point variables as shown in Figure 3. The data field is sent and expected to be received least significant byte first. This allows a direct overlay of a float[2] array and char[8] array on a little endian processor.



**Figure 3. Format of the data field in a data frame**

**13.2 COOLMAX BROADCAST MESSAGES**

Data frames containing telemetry values are periodically broadcast onto the bus by the Coolmax.

**13.2.1 Identification Information**

**ID:** Coolmax Base Address + 0

<i>Variable</i>	<i>Bits</i>	<i>Type</i>	<i>Description</i>
Serial Number	63 .. 32	Uint32	Device serial number, allocated at manufacture.
Product ID	31 .. 0	Uint32	“A001” stored as a string.

**13.2.2 PV Voltage/Current Measurement**

**ID:** Coolmax Base Address + 1

Variable	Bits	Type	Description
PV Current	63 .. 32	float	PV Current
PV Voltage	31 .. 0	float	PV Voltage

**13.2.3 Output Voltage/Current Measurement**

**ID:** Coolmax Base Address + 2

Variable	Bits	Type	Description
Output Current	63 .. 32	float	Output Current
Output Voltage	31 .. 0	float	Output Voltage

**13.2.4 PV Open Circuit Voltage/Output Charge Measurement**

**ID:** Coolmax Base Address + 3

Variable	Bits	Type	Description
Output charge	63 .. 32	float	Output charge
PV OC Voltage	31 .. 0	float	PV OC Voltage

**13.2.5 PV Power/Battery Temperature Measurement**

**ID:** Coolmax Base Address + 4

Variable	Bits	Type	Description
Battery Temperature	63 .. 32	float	Battery Temperature
PV Power	31 .. 0	float	PV Power

**13.2.6 Active Flags**

**ID:** Coolmax Base Address + 5

<i>Variable</i>	<i>Bits</i>	<i>Type</i>	<i>Description</i>
Unused	63 .. 13	-	-
Panel missing	12	Boolean	Input voltage indicates panel missing
Log file full	11	Boolean	Log file full
Maximizer fault	10	Boolean	Regulation or power stage fault
<i>Variable</i>	<i>Bits</i>	<i>Type</i>	<i>Description</i>
Bat tmp sensor fault	9	Boolean	Battery temperature sensor fault
Output breaker open	8	Boolean	Output breaker open
Input breaker open	7	Boolean	Input breaker open
Hi bat temp	6	Boolean	High battery temp fault
Bat current	5	Boolean	High battery discharge current fault
Iout fault	4	Boolean	High output current fault
Vout high fault	3	Boolean	High output voltage fault
Genset start	2	Boolean	Low output voltage genset start
Vout low fault	1	Boolean	Low output voltage fault
Vout low warning	0	Boolean	Low output voltage warning

**13.2.7 Time**

**ID:** Coolmax Base Address + 7

<i>Variable</i>	<i>Bits</i>	<i>Type</i>	<i>Description</i>
Time	63 .. 0	UInt64	System unix time

### 13.3 COOLMAX COMMAND MESSAGES

#### 13.3.1 Reset Command

**ID:** Driver Controls Base Address + 23

Variable	Bits	Units	Description
Unused	63..32	Unit32	-
Reset command string ALL – full reset RCO – remote config reset	31..0	Uint32	Send 'ALL' or 'RCO' as a string ("00000ALL") Coolmax replies with Y or N in byte 0