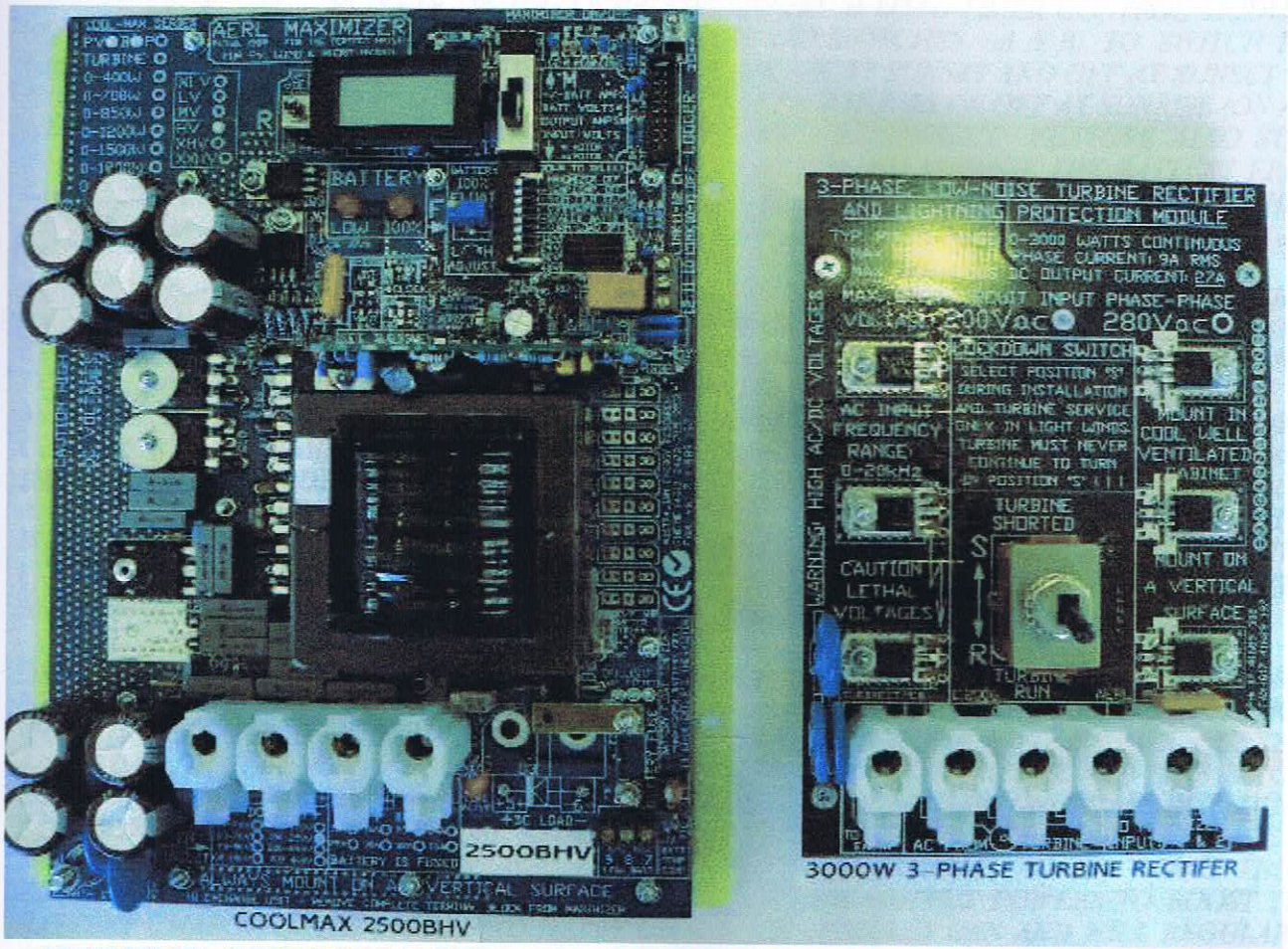
A.E.R.L. COOLMAX MAXIMIZER™ OPERATING MANUAL AND PRODUCT SPECIFICATIONS

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HIGHER OUTPUT POWERS WHEN THEY ARE NEEDED MOST

A NEW WORLD RECORD 99+% POWER TRANSFER EFFICIENCY *THE NEW COOLMAX MAXIMIZER RANGE OF MAXIMIZERS, USED FOR EXTRACTING 100% OF THE AVAILABLE POWER FROM ALL TYPES OF PHOTO-VOLTAIC (PV) MODULES AND GREATLY BOOSTING THE OUTPUT POWER OF MICRO-HYDRO/WIND TURBINES, NOW HAVE UNMATCHED POWER TRANSFER THROUGHPUT EFFICIENCIES, ABOVE 99%. THEY THUS NO LONGER REQUIRE ANY BULKY EXTERNAL ALUMINIUM HEATSINKS USED ON OTHER OR OLDER TRACKERS AND THE NEW COMPACT COOLMAX MAXIMIZERS NOW ALL WEIGH IN AT ONLY 1.5KG.*

THE COOLMAX MAXIMIZERS'S WORLD RECORD THROUGHPUT POWER EFFICIENCY, MEANS THAT LESS VALUABLE PHOTO-VOLTAIC (PV) POWER IS LOST IN THE UNIT AND MORE IS PASSED DIRECTLY FROM THE SOURCE (PV, MICRO-HYDRO/WIND TURBINE) TO THE BATTERY BANK OR WATER PUMP MOTOR. THANKS TO THE COMBINATION OF THE BENEFITS OF SOURCE MAXIMUM POWER TRACKING AND THE ULTRA-HIGH THROUGH-PUT EFFICIENCY, WHEN USED WITH PV MODULES AS THE POWER INPUT SOURCE, THEY BOOST THE TYPICAL DAILY AVERAGE BATTERY CHARGING ENERGY BY 10%-30%, WHEN COMPARED TO THE ENERGY DELIVERED WITH CONVENTIONAL NON-MAXIMUM POWER POINT TRACKING PV REGULATORS. THERE IS LITTLE POINT MAXIMUM POWER POINT TRACKING, IF YOUR TRACKER IS IS ONLY 92% or 93% EFFICIENT AND REQUIRES A LARGE BULKY ALUMINIUM HEATSINK WITH FAN COOLING!

NEW COOLMAX LOAD CONTROL OPTION *THE NEW COOLMAX PV BATTERY CHARGING MAXIMIZER RANGE, NOW HAVE THE OPTION TO CONNECT AND CONTROL A MODERATE SIZED DC POWER LOAD TO THE BATTERY BANK, VIA CONNECTION TO NEW BATTERY LOAD TERMINALS 5 & 6 ON MAXIMIZERS FITTED WITH THIS OPTION. (REFER TO THE CURRENT & POWER RATINGS FOR THIS OPTION, ON PAGE 3). THIS MOST USEFUL FEATURE, MEANS THAT THE UNITS CAN BE USED AS FULLY STAND-ALONE PV POWER STATIONS, ALONG WITH THE BENEFITS OF AUTOMATIC MAXIMUM POWER TRACKING, BATTERY REGULATION AND FULLY AUTOMATIC LOW-BATTERY LOAD DISCONNECT AND RE-CONNECT. (NOTE: ON TURBINE UNITS, LOAD TERMINALS 5 & 6 ARE USED FOR CONNECTION TO THE LOAD-DUMP BATTERY REGULATION LOAD RESISTOR).*

NEW DIGITALLY PROGRAMMABLE LOAD TIMER – STREET OR VILLAGE LIGHTING CONTROL OPTION *A FURTHER EXTENSION OF THE ABOVE LOAD CONTROL OPTION, IS THE EXTRA NEW OPTION, OF A SMALL PLUG-IN DIGITALLY PROGRAMMABALE LOAD-TIMER CONTROL MODULE, THAT CAN BE SIMPLY PROGRAMMED, (VIA TWO LOGIC DIP SWITCHES – A & B), TO SWITCH THE DC (LIGHTING) LOAD CONNECTED TO TERMINALS 5 & 6, ON AT SUNSET AND OFF AT SUNSET + 1 HOUR, SUNSET + 2 HOURS, SUNSET + 4 HOURS, SUNSET + 8 HOURS OR OFF AT SUNRISE (ON ALL NIGHT). (THE AUTOMATIC LOW-BATTERY DISCONNECT / RECONNECT FEATURE ALSO STILL APPLIES WITH THIS OPTION, TO AUTOMATICALLY PROTECT AND MANAGE THE BATTERY FROM DEEP DISCHARGE IN THE EVENT THAT INSUFFICIENT ENERGY REMAINS IN THE BATTERY WHILE THE LIGHTING LOAD IS SWITCHED ON).*

LOW PV MODULE TEMPERATURES *THE COOLMAX PV MAXIMIZERS, DC-DC CONVERT HIGHER PV MODULE VOLTAGES & CURRENTS, WHENEVER MODULE TEMPERATURES DROP IN COOL / CLOUDY / WET / WINDY / WINTER &/OR DIFFUSE SUNLIGHT CONDITIONS, DIRECTLY INTO HIGHER OUTPUT POWERS – JUST WHEN THE EXTRA POWER IS NEEDED MOST! FOR EXAMPLE: IF THE PV MAX POWER VOLTAGE RISES 16% DUE TO THE MODULE TEMPERATURE DROPPING 40 DEGREES CELCIUS, THE MAXIMIZER AUTOMATICALLY BOOSTS THE OUTPUT POWER BY 16%. WITH 1000W INPUT, THIS IS 160W OF EXTRA FREE OUTPUT POWER THAT WOULD OTHERWISE BE SIMPLY LOST AS EXTRA HEAT IN THE PV MODULE, IF A NON-MAXIMUM POWER POINT TRACKING REGULATOR WERE USED. AS A RESULT, THE MAXIMIZER ACTUALLY MAKES THE PV MODULE RUN SLIGHTLY COOLER, COMPOUNDING FURTHER, THE PV POWER BOOST RESULTING FROM ACTIVE MAXMIMUM POWER POINT TRACKING WITH THE MAXIMIZER.*

DIFFUSE POWER MAGNIFICATION *WHEN LIGHT OR HAZEY CLOUD IS PRESENT, THE PANEL TEMPERATURES CAN DROP MARKEDLY, BOOSTING PV VOLTAGES, AS THE UNWANTED INFRA-RED HEAT IS BLOCKED BY THE HAZE AND THE CLOUD-SHEET ACTS AS A VOLTAGE & CURRENT BOOSTING DIFFUSE MULTI-POINT SHEET LIGHT SOURCE, WHEN COMPARED TO THE SINGLE POINT SOURCE OF THE SUN UNDER CLEAR SKIES. UNDER THESE UNUSUAL, BUT QUITE COMMON CONDITIONS OF DIFFUSE RADIATION AND SUBSEQUENT POWER MAGNIFICATION, PV MODULE POWER OUTPUTS CAN RISE 25-35% AND THE MAXIMIZER, AGAIN, TURNS THESE ELEVATED PV VOLTAGES & CURRENTS INTO 25-35% HIGHER OUTPUT POWERS TO BOOST THE BATTERY CHARGE. WITH LIGHT AND HAZEY CLOUD, PV MODULES CAN AND WILL REGULARLY OUTPUT WELL OVER THEIR MANUFACTURER RATED POWER WITH THE MAXIMIZER, AS IT TAKES FULL ADVANTAGE OF THIS VERY COMMON PHENOMENUM OF DIFFUSE PV POWER MAGNIFICATION. THIS ACTION IS ONE OF THE SUBTLE AND LESS OBVIOUS, BUT HIGHLY SIGNIFICANT BENEFITS, OF USING THE MAXIMIZER IN PV POWER SYSTEMS, PARTICULARLY WHERE CLEAR SKIES ARE AN EXCEPTION.*

BATTERIES UNDER LOAD *IN PV & TURBINE BATTERY CHARGING SYSTEMS, IF THE BATTERY WERE TO DROP FROM CHARGING AT IT'S FLOAT VOLTAGE LEVEL, TO A NET STATE OF DISCHARGE (UNDER LOAD), TYPICALLY A BATTERY TERMINAL VOLTAGE DROP OF 11-12%, THE MAXIMIZER OUTPUT CURRENT IMMEDIATELY RISES BY THIS 11-12% VOLTAGE DIFFERENTIAL. A CONVENTIONAL REGULATOR WILL DELIVER NO EXTRA OUTPUT CURRENT AND IN FACT, IF A BATTERY WERE TO FULLY DISCHARGE (DOWN TO 1.8V/CELL), THE MAXIMIZER STILL FURTHER BOOSTS THE OUTPUT CURRENT BY ANOTHER 13% TO AROUND 25%, THUS GREATLY REDUCING THE LIKELYHOOD OF TOTALLY FLATTENING THE BATTERY BANK IF IT CONTINUES TO BE DISCHARGED. IF FOR EXAMPLE, THE BATTERY WERE TO CONTINUE TO DROP TO SAY 1.2V/CELL, THE MAXIMIZER WOULD ACTUALLY DOUBLE THE BATTERY CHARGING CURRENT, WHEN COMPARED DIRECTLY TO A CONVENTIONAL REGULATOR. COMBINE THESE POWER BOOSTING ADVANTAGES FROM PV PANEL / BATTERY VOLTAGE DIFFERENTIALS, WITH THOSE FROM THE DIFFUSE POWER MAGNIFICATION PHENOMENUM AND 40%-50% CHARGING POWER BOOSTS CAN BE MEASURED, WHEN THE BATTERY IS UNDER LOAD IN DIFFUSE HAZEY CLOUD CONDITIIONS.*

REDUCED CABLE LOSSES *THE HIGH-FREQUENCY STEP-DOWN DC-DC CONVERSION USED IN ALL MAXIMIZERS, MEANS THAT THE INPUT VOLTAGE IS ALWAYS ABOVE THE OUTPUT VOLTAGE AND THUS INPUT CABLE LOSSES, PROPORTIONAL TO (CURRENT)^2 , ARE GREATLY REDUCED. IF THE INPUT PV MAX POWER VOLTAGE IS AT 90V, FOR EXAMPLE, AND THE OUTPUT IS AT 52V (48V BATTERY BANK), INPUT CABLE POWER LOSSES ARE REDUCED BY 300%. THIS MEANS A 300% INPUT CABLE COST SAVING FOR THE SAME CABLE POWER LOSSES, SIGNIFICANT FOR LONG INPUT CABLE RUNS, WHEN COMPARED TO DIRECT CONNECT REGULATORS, WHERE INPUT PV CURRENT EQUALS OUTPUT CURRENT.*

AERL COOLMAX MAXIMIZER™ MODELS

ALL COOLMAX MAXIMIZERS INCLUDE BUILT-IN LCD DIGITAL METERING AS STANDARD.
ALL MAXIMIZERS ARE COVERED BY A FULL COMPREHENSIVE TWO YEAR WARRANTY.
ALL BATTERY MAXIMIZERS ARE FITTED WITH BATTERY TEMPERATURE COMPENSATION.

COOLMAX Low-Voltage LV MAXIMIZERS™

MODEL	Max. PV Power (manf. 25^C rating)	PV $V_{o/c}$	Battery (nominal)	Max. I_{batt}	Max. I_{load}
850BXLV	425 /850 /1300 Wp	**20-70 V**	12/24/36 V	**32A**	32A (optional)
850BLV	850 /1275 /1700 Wp	**40-90 V**	24/36/48 V	**32A**	32A (optional)

COOLMAX Mid-Voltage MV MAXIMIZERS™

MODEL	Max. PV Power (manf. 25^C rating)	PV $V_{o/c}$	Battery (nominal)	Max. I_{batt}	Max. I_{load}
400PMV	520Wp	**60-145 V**	Pumping only	I_{motor} **12A**	N/A
700PMV	850Wp	**60-145 V**	Pumping only	I_{motor} **16A**	N/A
850BMV	520 /780 /1040 / 1300Wp	**60-145 V**	24/36/48/ 60V	**20 A**	32A (optional)
1200BMV	620 /940 /1250/ 1560Wp	**60-145 V**	24/36/48 60V	**24 A**	32A (optional)
1500BMV	730 /1100 / 1500 /1820Wp	**60-145 V**	24/36/48/ 60V	**28 A**	32A (optional)

COOLMAX High-Voltage HV, XHV, XXHV MAXIMIZERS™

MODEL	Max. PV Power (manf. 25^C rating)	PV $V_{o/c}$	Battery (nominal)	Max. I_{batt}	Max. I_{load}
1800BHV	850 /1700 /1870 / /1900 /2000Wp	**180–260 V**	48/96/108-110/120V	**16 A**	12A (optional)
2500BHV	1060 /2130 /2340 / 2380 /2500Wp	**180–260 V**	48/96/108-110/120V	**20 A**	12A (optional)
2500BXHV	2130 /2340 /2380 /2500Wp	**200-290 V**	96/108-110 /120V	**20 A**	12A (optional)
2500BXXHV	2500Wp	**300-400 V**	156-230V	**12A**	12A (optional)

PV WATER PUMPING : SPECIFY WATER PUMPING APPLICATION WHEN ORDERING.

COOLMAX MAXIMIZER™ MODELS FOR MICRO-WIND & MICRO-HYDRO TURBINE APPLICATIONS

COOLMAX MICRO-TURBINE MAXIMIZERS, with manually adjustable Turbine (T) Input Set-point Volatges are available for Micro-Turbine Applications and now also have A FULLY AUTOMATIC CYCLIC BATTERY LOAD DUMP BATTERY BANK REGULATION OPTION.

(NOTE: The Micro-Turbine MAXIMIZERS are are not designed or intended for charging 12V Battery Banks. For charging 24V Battery Banks, the Turbine Power must be strictly limited, so as not to exceed the listed Output Current Ratings of the particular MAXIMIZER, listed below).

COOLMAX 850BHV 24V/36V/48V/60V u-Hydro Turbine MAXIMIZER™

User adjustable nominal DC Turbine Maximizer Input Voltage Range: 60-200Vdc.
Maximum non-destructive input voltage : 300Vdc. (Surge Arrestor Threshold Voltage = 320Vdc).
Rated maximum power and current output: 1000W/20Amp. (1000W into a 48V Battery Bank).
(Note : With a 24V Battery Bank, Maximizer Turbine Input Power must be limited to 600W)
Built-in Battery Load Dump Regulation capability = 32 Amp maximum continuous.
Optional 3-Phase Input Rectifier and Lightning Protection Module, shown on the front page.
These u-Hydro Turbine Units can also be used on u-Wind Turbines as long as the Rectified PEAK DC Open-Circuit Turbine Output Voltage can not exceed 300Vdc.

COOLMAX 1200BHV 24V/36V/48V/60V u-Hydro Turbine MAXIMIZER™

User adjustable nominal DC Turbine Maximizer Input Voltage Range: 60-200Vdc.
Maximum non-destructive input voltage : 300Vdc. (Surge Arrestor Threshold Voltage = 320Vdc).
Rated maximum power and current output: 1200W/24Amp. (1200W into a 48V Battery Bank).
(Note : With a 24V Battery Bank, Maximizer Turbine Input Power must be limited to 700W)
Built-in Battery Load Dump Regulation capability = 32 Amp maximum continuous.
Optional 3-Phase Input Rectifier and Lightning Protection Module, shown on the front page.
These u-Hydro Turbine Units can also be used on u-Wind Turbines as long as the Rectified PEAK DC Open-Circuit Turbine Output Voltage can not exceed 300Vdc.

COOLMAX 1800BHV 96V/108V/110V/120V u-Hydro Turbine MAXIMIZER™

User adjustable nominal DC Turbine Maximizer Input Voltage Range: 100-200Vdc.
Maximum non-destructive input voltage : 300Vdc. (Surge Arrestor Threshold Voltage = 320Vdc).
Rated maximum power and current output: 2200W/16Amp. (2200W into a 120V Battery Bank).
Built-in Battery Load Dump Regulation capability = 16 Amp maximum continuous.
Optional 3-Phase Input Rectifier and Lightning Protection Module, shown on the front page.
These u-Hydro Turbine Units can also be used on u-Wind Turbines as long as the Rectified PEAK DC Open-Circuit Turbine Output Voltage can not exceed 300Vdc.

COOLMAX 1800BXHV 96V/108V/110V/120V u-Wind Turbine MAXIMIZER™

User adjustable nominal DC Turbine Maximizer Input Voltage Range: 100-250Vdc
Maximum non-destructive input voltage: 400Vdc. (Surge Arrestor Threshold Voltage = 430Vdc).
Rated maximum power and current output: 2200W/16A. (2200W into a 120V Battery Bank).
Built-in Battery Load Dump Regulation capability = 16 Amp maximum continuous.
Optional 3-Phase Input Rectifier and Lightning Protection Module, shown on the front page.
These u-Wind Turbine Units can also be used on u-Hydro Turbines as long as the Rectified PEAK DC Open-Circuit Turbine Output Voltage can not exceed 400Vdc.

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MULTI-MODE INPUT AND OUTPUT LIGHTNING SURGE PROTECTION

All MAXIMIZERS are now fitted with Multi-Mode Input and Output Lightning Surge Protection. Ensure that an Earth Cable of at least 2.5mm^2 is firmly bolted to the EARTH STAKE BOLT on the left-hand bottom corner of the MAXIMIZER and in turn connected to a solid local low-resistance earth-stake ground connection. (Copper-clad stainless-steel earth stakes are available from any electrical wholesaler).

COOLMAX PHOTO-VOLTAIC (PV) BATTERY CHARGING MAXIMIZERS™

1. MOUNTING THE NEW COOLMAX MAXIMIZER

Always mount the Maximizer on a vertical surface, (cabinet or switch-board wall) with the LCD Digital Meter at the top, to ensure that convection cooling is maximised.

If the MAXIMIZER is to be cabinet mounted, always locate it in a large, well ventillated, preferably metal cabinet, that does not constrict natural vertical convection air-flow over the Maximizer Circuit Board, in any way.

NEVER MOUNT THE MAXIMIZER IN A FULLY SEALED ENCLOSURE – IT WILL OVER-HEAT.

The cooler the Maximizer is allowed to operate, through sensible ventilated mounting, the more efficiently it transfers the power from Input to Output. A cool Maximizer is an efficient Maximizer!

The Maximizer must not be mounted where rain or direct sunlight can reach the unit, nor in a moisture condensing (dew forming) environment or location.

2. BATTERY CHARGE REGULATOR AND CONTROL CENTRE WITH 108% AUTO-EQUALISE AND AUTOMATIC BATTERY VOLTAGE TEMPERATURE COMPENSATION

All Coolmax Battery Charging Maximizers can be used to charge the wide selection of battery bank voltages listed in the tables above and marked beside the lower four Piano Dip Switches, on the 10 Position Piano Switch, on each unit.

All Battery Charging MAXIMIZERS, employ a proven and simple 108% of Final 100% Float Voltage, Automatic Equalise Voltage / Anti-Sulphation charging profile. This profile, combined with the built-in Fully Automatic Battery Voltage Temperature Compensation feature, ensures that the Battery Bank achieves its maximum useable life-time.

The small removable Temperature Compensation Thermistor is located in a screw terminal block (13 & 14) at the bottom right hand corner of the unit.

PRECISE BATTERY CASE TEMPERATURE COMPENSATION:

If precise battery case temperature sensing is required, unscrew the Thermistor from 13 & 14 and solder it to a suitable light 2 core cable and adhere the thermistor to the battery case with neutral-cure silicone rubber adhesive. Connect the other ends of the two core cable back into the thermistor terminal block 13 & 14.

If the Temperature Compensation Feature is not required, simply press down the 2nd Piano Dip Switch (TEMP COMP. OFF) to take it out of circuit. This also drops the Float and Auto-Equalise Voltage Levels by approximately 1%.

3. FULLY SEALED AND GEL-TYPE LEAD-ACID BATTERY BANKS

The MAXIMIZERS are all tested and shipped with the 100% BATTERY FULL float level set to 2.35V/2V lead-acid cell, suitable for flooded lead-acid batteries. By pressing down the piano switch marked SEALED BATTERIES, the 100% Final Float & 108% Auto-Equalise levels are precisely reset to 2.5% lower levels.

The new lower Float Level is then nominally 2.30V/2V lead-acid cell – a safe and recommended level for Sealed or Gel-type Battery Banks at 25C.

4. LOW BATTERY DETECTION AND RELAY ALARM (Not applicable to Turbine Units fitted with The Load-Dump Regulation Option).

All battery charging units have a build-in LOW BATTERY VOLTAGE detection circuit that lights the red LOW BATTERY LED at approximately 1.9V/lead-acid cell, (excepting units fitted with the Load-Dump Option, i.e. Micro-Turbine units).

A small ISOLATED ALARM RELAY also changes STATE and its isolated contacts are accessable at screw terminals 7, 8 & 9, located at the lower bottom right hand corner of the unit. The relay contacts are rated at 1Amp/30V (30W) maximum, with 1000V isolation and may be used for generator control, as the relay remains SET until a full 108% charge equalise cycle is completed. (i.e. until the Battery Bank is once again completely re-charged and FULL).

On Micro-Turbine Units, fitted with the Load-Dump Option, this relay, (terminals 7, 8 & 9), can be used to either monitor the status of the Battery Load-Dump Resistor (IN or OUT of circuit), or to control an external load-dump relay and alternative load-dump resistor.

If the Low Battery Alarm is being used to control an external Gen-Set Battery Charger and this needs to be temporarily disabled for some reason, it can be done simply by pressing down the 6th piano switch marked TURN LOAD OFF. The GEN-SET will then no longer start automatically, with a LOW BATTERY condition.

If the LOW BATTERY LED remains lit, day after day, the PV system is under-powered – never reaching a full 108% equalise level, and thus the battery life will be severely compromised in the long-term. The situation should be addressed by adding more PV Power or via re-management of the load.

Because the MAXIMIZER delivers pure ripple and spike-free, low-R.F.I., DC Current and Voltage, it maintains an ideal smooth continuous regulation characteristic, while floating at the 100% BATTERY FULL voltage level. This highly desirable continuous trickle charging, further gently charges, equalises and conditions the battery, once the battery bank is FULL and floating at the 100% BATTERY FULL FLOAT LEVEL, compared to ON/OFF regulators.

COOLMAX MAXIMIZER™ OPERATING GUIDE-LINES

Ensure that the MAXIMIZER is switched OFF, at both the Toggle Switch located at the top right-hand corner of the MAXIMIZER and that the 1st Piano Dip-Switch is pressed down to the OFF position on the 10 Position Piano Switch, before making any electrical connections or closing any Input and Output Circuit-Breakers.

WARNING: THE DC VOLTAGE LEVELS AT WHICH THE MAXIMIZER CAN OPERATE, CAN BE POTENTIALLY LETHAL IF HANDLED WITHOUT ADEQUATE CAUTION. INSTALLATION MUST BE CARRIED OUT ONLY BY A QUALIFIED ELECTRICIAN AND ALL APPLICABLE SAFETY CODES ADHERED TO.

5. DO NOT EXCEED THE CURRENT AND VOLTAGE RATINGS LISTED IN THE TABLES ON PAGES 3 & 4 AND MARKED ON EVERY MAXIMIZER. TO DO SO, IMMEDIATELY VOIDS THE WARRANTY.

In particular the PV Input Open-Circuit Voltage and Power rating must not be exceeded. Always measure the PV Open-Circuit Voltage and Polarity and Battery Polarity before closing the circuit-breakers and making the final connection to the MAXIMIZER.

6. ALWAYS FIT DC RATED INPUT AND OUTPUT PROTECTION CIRCUIT BREAKERS – DO NOT USE FUSES

Appropriately rated DC Input and Output Circuit breakers must always be fitted to the MAXIMIZER.

Most 240Vac Domestic M.C.B.s (Miniature Circuit Breakers) are conservatively rated at 48Vdc, so dual and triple gang breakers can be connected in series for systems with nominal battery voltages of up to 120Vdc.

Always select at least 6kA rated breakers, as these have a better DC arc quenching capability than the only slightly less expensive and more common 4kA breakers. If avaialable, 8kA or 10kA breakers are the very best choice for DC systems.

The low-cost, 6kA Siemens Brand MCB's, are a very good quality, budget circuit-breaker to use for DC, as they have an ultra-fast sub-cycle 3 to 4 millisecond trip-time, with excellent DC Arc quenching capabilities. Otherwise specially rated DC breakers can be used – however they may be very much more expensive.

Double-pole, mechanically linked, 6kA Siemens MCB's are suitable for nominal 12V to 120V Battery Systems, with a pole in each + & – Input & Output line.

DO NOT USE FUSES INSTEAD OF BREAKERS. Re-settable circuit-breakers are far superior, a much safer means of cicuit isolation, being both a switch and circuit-breaker, and offer much faster fault interruption protection for the MAXIMIZER, in the event of a Lightning Surge or accidental PV Array short-circuit.

7. REVERSE BATTERY SAFETY CROWBAR PROTECTION FUSE

Always check, with a digital voltmeter, that the battery polarity is correct before making the final connection to the MAXIMIZER via the Output Circuit-Breaker.

All battery charging MAXIMIZERS are fitted 4 x 600Amp CROWBAR protection diodes (D1a/b and D2a/b), which, in combination with the 50 Amp On-board PCB Battery Output Safety Back-up Fuse, located in the lower right hand corner of the Maximizer, protect the MAXIMIZER'S Power Mosfets and Power Diodes, in the event that the battery bank is accidentally connected in the reverse polarity or a short-circuit is placed on the PV Array Inputs. An accidental short on the PV Array, effectively shorts the Battery Bank, through the power MOSFET's integral body diode, which are protected in this event, by CROWBAR diodes D1a/b.

These low-cost Crowbar Diodes usually save the expensive Power Mosfets from destruction. A spare fuse is located on one of the fuse terminal bolts and should be bolted in place, metal side down, if the on-board PCB fuse is blown during such an accident.

Ensure the unit is switched OFF and Input and Output circuit-breakers are open before fitting this replacement PCB fuse.

If after fitting the new fuse, the PV Input Voltage is equal to the Battery Voltage (with the unit still OFF), then the 600A CROWBAR DIODES and/or the POWER MOSFETS, may be blown, so return the unit to AERL for (a non-warranty) repair.

Very often, in the event of an accidental polarity reversal or an input short, the two Crowbar Protection Diodes (D2a/b) blow destructively in short-circuit and so sacrifice themselves to save the Power Mosfets. This results in a low-cost and simple (non-warranty) repair – requiring only the replacement of Crowbar Diodes, not the expensive power mosfets.

8. USING AMORPHOUS THIN-FILM AND SUNPOWER™ BRAND TYPE SOLAR CELLS

Press down the 3rd Piano Dip Switch marked THIN FILM SILICONE, if the PV Panels being used are of the Amorphous Thin Film type.

Press down the Fourth Piano Dip Switch marked SUNPOWER SILICONE, if the PV Panels being used are the high performance SUNPOWER™ BRAND. (This setting is also suitable for GaAs Panels).

9. BATTERY VOLTAGE SELECTION

If not already selected, press down one of the LOWER four Piano Dip Switches (7, 8, 9, 10), on the 10-Position Piano Switch, to select the correct system Battery Bank Voltage.

10. 100% BATTERY FLOAT ADJUSTMENT

All COOLMAX MAXIMIZERS are 100% tested at full rated power and the 100% BATTERY FULL FLOAT LEVELS are at this time factory set to 2.35V/lead-acid cell. This FLOAT LEVEL is however also adjustable over a wide range via the 20-turn Battery 100% FLOAT Trimpot – F.

Do not re-adjust this Float Trimpot, unless you have very good reason to do so. Only when the RED BATTERY 100% LED is lit, is the Battery Bank in Float Mode and the Trimpot F adjustment can be made, using the Built-in LCD Meter set to read BATTERY VOLTS.

The Battery Voltage will only move very slowly, so this adjustment has to be done patiently over several minutes and always with the 100% FULL LED lit up and with only one MAXIMIZER operating at a time.

***EXCESSIVE WATER USEAGE:** If the Battery Bank is using too much electrolyte, usually because it is very lightly loaded compared to the PV Input Power and rarely comes off FLOAT, then rather than randomly attempting to adjust the FLOAT to a lower level to reduce water useage, simply drop the FLOAT LEVEL by a precise 2.5%, by pressing down the 5th Piano Dip Switch marked SEALED BATTERIES.*

11. REMOTE ON/OFF CONTROL

All Maximizers can be two-wire remotely switched ON and OFF at Terminals 10, 11 & 12. Link 10 & 11 for OFF or on Pumping Units UN-LINK 11 & 12 for OFF.

This feature is mainly used for remote controlling Pumping Maximizers via a float or pressure switch. These 3 terminals are Lightning Surge protected.

Never parallel connect multiple REMOTE CONTROL TERMINALS (10,11, & 12) of different MAXIMIZERS. To do so will damage all of the MAXIMIZER control circuits.

12. DO NOT FIT A POWER WASTING INPUT PV ARRAY BLOCKING DIODE

As long as there is at least one more PV Module is series connection on the input to the MAXIMIZER, than the nominal 12V battery voltage grouping, no PV input power wasting input blocking diode, need be fitted.

For example: 3 modules in a series string on a nominal 24V battery bank or 5 modules in series strings on a nominal 48V battery bank, or 11 modules in series strings on a nominal 120V battery bank, ensures no night-time battery power back-flow into the PV modules.

13. OPTIMAL PV ARRAY CONFIGURATION

To ensure the Maximizer can always Maximum Power Track the PV Array, it is best to configure the Array with at least one more PV module in the series strings than the Nominal 12V Battery Voltage grouping.

The Maximizer runs at peak efficiency when there is just one extra PV panel in the series string, compared to the nominal 12V battery number grouping.

The losses in the MAXIMIZER rise a little, the more the Maximizer has to Step-Down from the PV Max Power Voltage to the Battery Bank Voltage.

For example: With a nominal 120V Battery Bank, (10 x 12V nominal), 11 module series strings gives the lowest MAXIMIZER losses, yielding 99.5+% efficiency.

However 12 or 13 or 14 modules-in-series are still an acceptable configurations (just not ideal), but with increasing losses as the PV Max Power Voltage / Battery Voltage differential increases and the Maximizer has to work harder to DC-DC convert the Input Voltage into higher Output Currents. (Slightly lower, 99% typical efficiency results).

Generally the PV Array is designed and configured with 1 or 2 extra modules in the series strings, than the nominal Battery Bank 12V / 6-cell grouping, when using a MAXIMIZER. That is, 11 or 12 modules on a nominal 120V battery bank system, for example.

14. BUILT-IN LCD DIGITAL MULTIMETER

All COOLMAX MAXIMIZERS ARE FITTED WITH AN ACCURATE LCD DIGITAL MULTI-METER, TO PERMIT A RANGE OF ON-BOARD VOLTAGE AND CURRENT MEASUREMENTS. THIS MULT-METER IS USEFUL FOR MAXIMIZER SET-UP AND OPERATIONAL ON-SITE DIAGNOSIS BY THE INSTALLER &/OR END-USER.

INPUT VOLTS: Reads the Input Voltage being fed into the the MAXIMIZER. To read PV Open-Circuit Volts, turn the MAXIMIZER OFF. To read MAX POWER VOLTS or TURBINE SET-POINT VOLTS, turn the unit ON, but without the BATTERY 100% LED being lit up. i.e. with the MAXIMIZER not regulating.

Toggle the VOLTAGE RANGE switch to read voltage values above 199.9V.

OUPUT AMPS: Reads the BATTERY CHARGING AMPS (or DC pumping MOTOR AMPS). (Range-change not applicable on Amps setting).

BATT. VOLTS: Reads the BATTERY BANK VOLTAGE (or the DC PUMPING MOTOR VOLTS).

+/-BATT. AMPS: Reads the net current flowing into (charge) or out of (discharge) the Battery Bank. (Range-change not applicable on Amps).

Unless the DC LOAD OPTION or Turbine Load-Dump Option, connected to Load Terminals 5 & 6, is being used, this setting reads the same as OUTPUT AMPS. It will also be used in the future by the Optional Data-Logger, for Battery Bank A.Hr tracking.

15. PV MODULE POWER RATINGS AND MODULE MOUNTING CONSIDERATIONS

The nominal power output rating of a particular PV Module is specified bt the PV Module Manufacturer, at One Sun (1000W/sq.m of sunlight radiation) and 25 degees 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 25^{C} specification, so typical panel temperatures on a hot summers day of 65^{C} 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. Always bear in mind that 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!

16. DIGITALLY PROGRAMMABLE LOAD TIMER – STREET OR VILLAGE LIGHTING CONTROL OPTION

A compact, self-contained, plug-in, Digital Programmable Load-Timer Control Module, can be simply programmed via 2 on-board logic dip-switches A & B, to automatically switch the DC (Lighting) Load connected to Terminals 5 & 6: (Logic 1 is pressed down).

(A=1 B=1) ON AT SUNSET & OFF AT SUNSET+1 HR
(A=0 B=1) ON AT SUNSET & OFF AT SUNSET+2 HRS
(A=1 B=0) ON AT SUNSET & OFF AT SUNSET+4 HRS
(A=0 B=0) ON AT SUNSET & OFF AT SUNSET+8 HRS
ON AT SUNSET, OFF AT SUNRISE (ALL NIGHT)

This Load-Timer Option must be ordered with the Battery Load Option.

Refer to the Specifations in the Tables on Page 3, for the allowable maximum (lighting) load currents that can be switched ON & OFF via the timer module. For 12V to 48V battery banks, the maximum load current is 32A. This permitts the following maximum continuous DC load powers :

12V BATTERY BANK: 350 WATTS
24V BATTERY BANK: 700 WATTS
36V BATTERY BANK: 1000 WATTS
48V BATTERY BANK: 1350 WATTS

The DC Load connected to 5 & 6 can be either direct DC loads, like 12V halogen lamps, or it can be a conventional DC-AC inverter used to supply a 240V AC lighting circuit to operate compact fluorescent lamps in a standard distributed AC lighting system – in a typical permanent or temporary village / camp situation, for example.

FOR EXAMPLE: ***With a 24V Battery Bank, up to 30 x 23 Watt high-output Philips Tornado Compact Fluorescent Lamps can be connected to a single 1000W inverter to provide a fully automatic and substantial temporary / emergency or permanent village house and/or street lighting system.***

Approximately 800-1000Wp of PV panels would be required, charging a 24V / 500A.Hr Battery Bank, if the SUNSET + 4 hours timer setting is selected and all lamps were to be operated for 4 hours.

A 48V Battery Bank, with a 2000W inverter, would allow up to 60 x 23W Philips Compact Tornado Fluorescent Lamps to be operated, for a large and useful village lighting system.

Approximately 1600-2000Wp of PV panels would be required charging a 48V / 500A.Hr Battery Bank, if the SUNSET + 4 hours timer setting is selected and all lamps were to be operated for 4 hours.

THE AUTOMATIC LOW-BATTERY DISCONNECT / RECONNECT FEATURE ALSO STILL APPLIES WITH THIS LOAD-TIMER OPTION, TO AUTOMATICALLY PROTECT AND MANAGE THE BATTERY FROM DEEP DISCHARGE IN THE EVENT THAT INSUFFICIENT ENERGY REMAINS IN THE BATTERY WHILE THE (LIGHTING) LOAD IS SWITCHED ON.

GUIDE-LINES FOR USING THE MAXIMIZER™ FOR DRIVING DC BRUSH MOTORS IN WATER PUMPING APPLICATIONS

17. ALL BATTERY MODELS CAN BE USED FOR WATER PUMPING APPLICATIONS

Select the pump/motor drive ratio such that the output motor current is minimised for maximum pumping system performance.

Never exceed the MAXIMIZER Output Current Rating nor the DC Motor Name-plate Current Rating.

ALWAYS FIT A MOTOR CIRCUIT-BREAKER WITH A TRIP CURRENT NO GREATER THAN THE MAXIMIZER OUTPUT AND/OR MOTOR CURRENT RATINGS.

DO NOT use LOW VOLTAGE DC MOTORS, if a higher voltage PV Array configuration will allow the use of a higher voltage / lower current motor types.

For example don't use a 24V motor with 12 PV modules configured 3-in-series / 4-in-parallel when a 60V or 90V motor could be used with a more efficient, 6-in-series / 2-in-parallel PV module configuration.

Ideally, the Motor / PUMP Pulley Drive Ratio is selected, (usually in the field, at Mid-Day Peak PV Output), so that the DC Motor is operating at 110-120% of it's name-plate voltage rating. This ideal drive ratio, results in maximum overall system operating efficiency and easy, early morning starting of the pump motor. Use the built-in

LCD Multimeter to set-up this MOTOR VOLTAGE and then set to MOTOR AMPS to check the MOTOR CURRENT.

NEVER EXCEED THE MOTOR NAME-PLATE CURRENT AND MAXIMIZER OUTPUT CURRENT RATING AND ALWAYS FIT AN OUTPUT CIRCUIT-BREAKER TO PROTECT THE DC PUMP MOTOR FROM OVER-LOAD.

GUIDE-LINES FOR USING THE MICRO-TURBINE MAXIMIZERS™

18. SELECTING THE LOAD-DUMP REGULATION POWER RESISTOR FOR CONNECTION TO TERMINALS 5 & 6

The Micro-Turbine Maximizers, use a very different Battery Regulation method than the PV MAXIMIZERS, which simply unload the PV panels to limit the power flow to the battery bank, once it reaches the 108% of Float Equalise Level and subsequently drops to the 100% FLOAT/FULL battery voltage level.

The DUMP-LOAD method, ensures that the Turbine remains always fully loaded and does not run away to high open-circuit voltages that may damage the Turbine and/or Maximizer, once the battery bank is FULL.

Instead of the 108% equalise level, the Float Trimpot – F, is set to the top or final battery equalise level, at which point the DUMP LOAD is switched-in and cycles the battery bank down approximately 12% in terminal voltage and is then switched-out again.

This BATTERY FULL cycling automatically repeats itself, as long as the Turbine is outputing more power than is required to keep the battery at the FULL Voltage, pre-set via the 100% Float Trimpot – F.

FOR EXAMPLE: With a PV System, charging a 48V Battery Bank, where F is typically set to 56.5V (2.35V/cell), giving a 108% battery equalise voltage of 60.4V. On a Turbine System, F is typically set to 59.0V (2.46V/cell) and cycles between this voltage and 52.0V (2.16V/cell) while in the cyclic DUMP-LOAD BATTERY REGULATION MODE.

The Turbine Load-Dump Resistor must be selected to match or exceed the expected Peak Turbine Output Power. Use the simple formula V^2 divided by Turbine Peak Power equals Load Dump Resistance, where V is the Final FULL Battery Charge Voltage selected by the Battery 100% Float Trimpot – F.

For a 48V nominal Battery Bank, with V_{full} = 59V, V^2 = 3481. For a Peak Turbine Power of say 1000W for example; Load Dump Resistance = 3.5 ohms. For a Peak Turbine Power of 500W; Load Dump Resistance = 7 ohms. Slightly lower than calculated resistance values can be used, but not higher values, as they will not fully load the Battery at peak Turbine power output.

Set the Built-in Digital Multi-Meter to read +/- BATT AMPS to check that the load-dump resistor current is a small negative value (battery slightly loaded and discharging), as expected, so as to ensure correct cyclic battery regulation. Confirm the cyclic regulation.

On u-Turbine Units fitted with the Load-Dump Option, the Low Battery Circuitry is actually re-calibrated (to the voltage values listed above) and used to switch the Load-Dump power MOSFETs On & OFF. This means the isolated Low Battery STATUS Relay terminals 7, 8 & 9 can now be used to either monitor the status of the battery load-dump resistor (IN or OUT of circuit), or to control an external load-dump relay and alternative load-dump resistor. They no longer indicate a LOW BATTERY State, on Micro-Turbine MAXIMIZERS.

19. SETTING THE TURBINE OPERATING SET-POINT VOLTAGE

Switch the MAXIMIZER ON (at both ON switches) and select the LCD Multi-Meter to read BATTERY AMPS. For Wind Turbine MAXIMIZERS, using the AERL 3-PHASE TURBINE RECTIFIER BOARD, fitted with the Turbine Lock-Down Switch, unlock the Wind Turbine by opening this switch, if not already open. For u-Hydro units, turn the water feed fully ON to the Turbine.

Trim-pot T is factory set during testing, for a MAXIMIZER Input Volatge of 100V, as a typical Turbine starting set-point. Slowly adjust, (clockwise to raise, anti-clockwise to lower), the 20-turn SET TURBINE TRIMPOT - T, located just below the BATTERY LOW / 100% LEDS, until the maximum BATTERY AMPS value is reading on the LCD meter. The Turbine is now running at it's 100% Maximum Output Power, for the given water-flow or wind-speed.

This T Voltage Setting can be re-optimised or checked at any time to yield maximum charging current, but is best left set for typical seasonal location condition.

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