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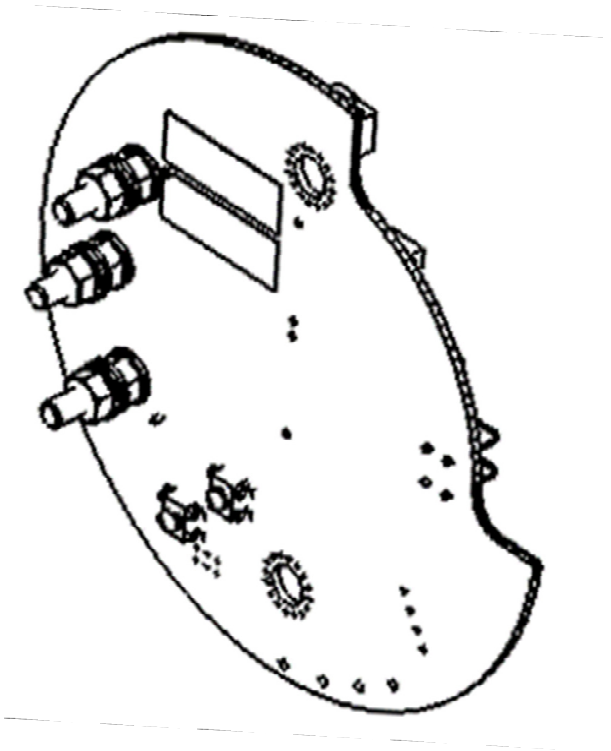

colour inside

USER MANUAL

2062 DCBR MODULE

Revision 1.0

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

1 FEATURES

- Multi-function electronic controller for battery-less flameproof alternator
  - output voltage regulation
  - electrical protection
  - circuit interrupter
  - data logging
- 13.8 V_{RMS}, 26A
- Integrated test feature
- IrDA communications[1]
- >10,000,000 hours of use

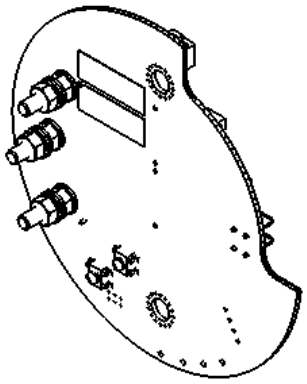

Figure 1 – 2062 DCBR Module

2 DESCRIPTION

2.1 OVERVIEW

The product is a multi-function electronic card that manages the output from the windings in flameproof alternators and disconnects external circuits when faults are detected.

The application is typically for extra-low voltage lighting supplies for diesel mobile plant.

The module features electrical protection to minimize the risk of undetected ignition sources on load circuits

The logger enables the record of usage to be examined.

A test facility is provided for verification of chassis earth fault protection.

2.2 FUNCTIONALITY

The module performs the core functions of

(i) output voltage regulation
(ii) electrical protection
(iii) circuit interruption
(iv) data logging

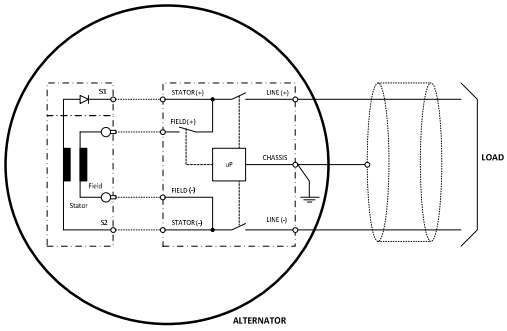

Figure 2 - Application schematic

The electrical protection features include –

- Instantaneous overcurrent
- Timed overcurrent
- Insulation impedance (Positive and negative power rails to chassis)
- Overvoltage

The output regulation function includes load compensation.

The configuration is factory set and not accessible to the user.

[1] *Requires 2082 Infrared Daughterboard card*

A manual test feature is provided which may be used to validate chassis protection features at any time.

If an electrical fault arises, the protection circuits will operate to isolate and latch out supply to the load.

When the fault is remedied, a manual reset is required to re-establish supply.

A certified tool is available that facilitates both test and reset functions without need to open the flameproof enclosure minimising flamepath damage.

2.3 COMPLIANCE

The module is a component fitted inside a flameproof enclosure. It is not a certification component.

The module complies with the legislative requirements under Recognized Standard RS-01 (Queensland) Clause 4.15 for use on diesel underground vehicles.

The module complies with the legislative requirements under AS/NZS 4871.6:2013 for NSW

3 OPERATION

3.1 CIRCUIT INTERRUPTER

3.1.1 POLES

The circuit interrupter has two independent poles.

Note – For the ratings of the interrupters, please refer to the specification section of this document

3.1.2 CLOSING THE INTERRUPTER

The module automatically closes the interrupter to connect the alternator supply to the load only after the alternator is excited.

The module does not make an assessment of the load circuit before closing the interrupter. If a fault condition exists, the interrupter will close and then re-open if the fault persists (according to the nature of the fault and the protection settings).

The interrupter implements a 'soft close' behaviour.

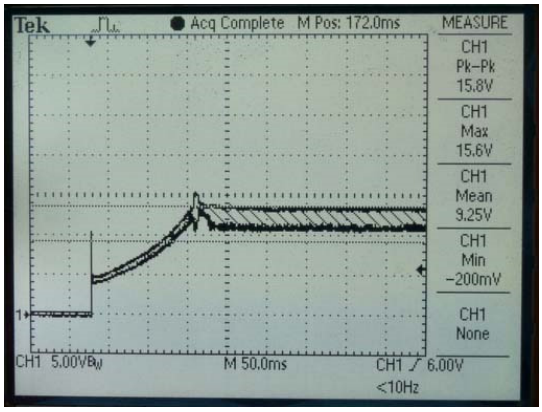

Figure 3 - Typical start transient with 200W halogen load

3.1.3 OPENING THE INTERRUPTER

In the event of a fault the protection circuits will initiate immediate opening of the circuit interrupter to disconnect the alternator from the load circuits.

3.1.4 LATCHING AND RESETTING

The interrupter may be latched open by the protection operation.

Note - Please refer to the specification section for protection operations which are latching

Manual intervention is required to reset a latch. Latching is not reset by cycling the power to the module. A certified remote reset tool is available.

3.2 VOLTAGE REGULATION

3.2.1 EXCITATION

The module is powered from the alternator windings. The alternator characteristics largely determine the excitation behaviour.

3.2.2 OUTPUT VOLTAGE REGULATION

The module regulates the output voltage of the alternator according to the factory pre-set value.

The regulator also compensates for line losses in proportion to the load current.

Two levels of overvoltage protection are provided to ensure that if the regulator fails and runs away, the output is quickly isolated. Furthermore, power clamps are provided to guarantee a maximum output voltage.

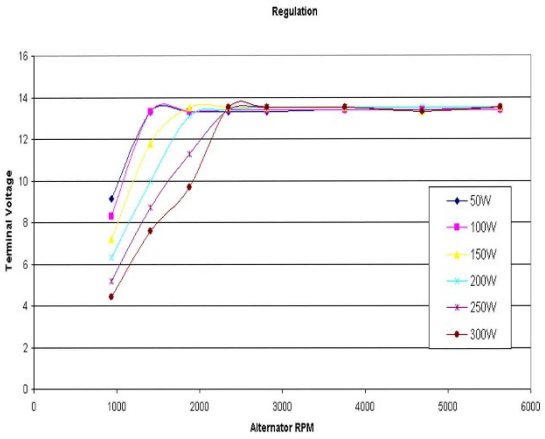

Figure 4 - Regulation curves

3.2.3 OUTPUT RIPPLE

The alternator produces harmonic currents that are related to frequency (RPM) and load. The alternator flux cannot be changed by the regulator at a fast enough rate to smooth output. The module is not a harmonic filter at these power levels.

High noise levels may be present on the output terminals under some load and frequency conditions.

V3 features a filter capacitor to reduce the noise level under most conditions.

3.2.4 OUTPUT TRANSIENTS

The module manages transient voltages that are associated with switching. In normal switching operation, transient voltages do not arise in excess of the intrinsic ripple.

V3+ features a hardware clamp tested to limit the peak voltage during transients such as 'load dump' to <24V at rated loads and rated speed.

The module's loop controller is effective at minimising any overshoot that may be associated with closing onto variable impedance loads (such as halogen lights).

3.3 POWER RATINGS

The rated power available from the alternator is set by the overcurrent limits and voltage settings in the module.

The module is suited to electronic components because of its ability to tightly manage output voltages under regulation and switching operation. Electronic loads should be designed with diode-protected front end low pass filters.

3.4 OVERCURRENT PROTECTION

3.4.1 TIMED OVERCURRENT PROTECTION

The module continuously monitors the current flow. If the current exceeds a threshold value for threshold duration the interrupter will latch open after a set delay period.

Line impedance is an important factor in limiting fault current, so timed overcurrent faults typically occur at the end of the circuit.

The module has an automatic re-close attempt following detection of timed overcurrent. If the re-close also results in an overcurrent condition, a latched trip will occur.

The time delay to operate is factory set.

The "CURR" indicator on the module will flash following a timed overcurrent protection

operation. To clear the latch and indicator, a reset is required.

The protected zone for all overcurrent faults is the load side of the interrupter (alternator terminals).

3.4.2 INSTANTANEOUS OVERCURRENT PROTECTION

Instantaneous overcurrent faults typically occur at the alternator end of the circuits where there is negligible line impedance.

The general performance is similar to the delayed overcurrent settings, except that the protection operates at a higher threshold current and operates without programmed delay.

If the current exceeds the instantaneous threshold, the interrupter will immediately open.

The "CURR" indicator on the module will be on solid following an instantaneous overcurrent protection operation. To clear the latch and indicator, a reset is required.

3.4.3 TERMINAL FAULTS

For alternators with shunt field windings, a short on the terminals collapses the excitation.

Special consideration is given in the module firmware to handling faults that arise at the alternator terminals.

In order to detect pre-existing shorts at the alternator terminals, and to differentiate this condition from a heavy halogen load, the module will make a number of staggered attempts to close onto the fault. If all close attempts fail, the module will register and latch a trip condition preventing further operation until the latch is reset. These attempts take about 9 seconds to cycle, but the individual close attempts are substantially instantaneous.

The "VOLT" indicator will flash whenever a close-in short is detected and is sustained for a short period (even if the fault is transitory)

A short applied directly to the terminals of an unloaded alternator after excitation will appear to the module as a large load and a staggered sequence of close attempts is made until the module can be determine if the load is indeed a fault. The trip is not latched in memory during this period to avoid nuisance lock-outs but is armed immediately the close is successful. The module will detect shorts at the alternator terminals at start-up.

A cable (2 || 1.5mm^2 cores) length of about 1m offers enough load impedance for the module to consider this simply a large load and current that flows will be either instantaneously tripped or delay tripped depending on its magnitude.

A fault applied to the terminals of a loaded alternator will be detected and trip the interrupter but does not latch for approx. 7 sec. This allows the module to discriminate between a genuine fault and shutdown behavior.

3.5 CHASSIS PROTECTION

The module is suited to alternators that are insulated from chassis (i.e. the earth of the machinery). Without chassis fault detection a single insulation failure may not provide a complete circuit for fault current.

DCBR chassis protection can detect a single insulation failure and is therefore very good in

ensuring that faults currents are contained through defined paths.

If the resistance to chassis of either of the power rails falls below the threshold value, the interrupter will immediately latch open.

ℹ	The chassis protection is equally sensitive to both persistent and transient faults
ℹ	A static megger test of the wiring may indicate sound insulation. However in operational use the insulation integrity may be compromised by vibration and temperature. A static megger test is NOT conclusive evidence of sound insulation integrity.
⚠	The zone of protection is both on the load side and the source side of the interrupters, which includes the alternator windings. The protected zone does not include the test / reset circuits (though these have intrinsic protection through low voltages and low currents)

The interrupter is prevented from restoring supply after clearing a chassis fault by the latching feature.

The "CHASS" indicator will flash following a chassis fault. To clear the latch and indicator, a reset is required.

If the fault condition remains when the reset switch is operated, the protection will immediately open the interrupter again.

3.5.1 INTEGRATED TEST FEATURES

The module has an integrated test feature which may be manually invoked at any time to prove correct chassis protection operation.

This test temporarily inserts an insulation fault (protected by the flameproof alternator) and monitors the system for correct response.

Supply is only re-established if the test sequence is successful. A failed test will prevent re-supply of the load circuits.

(i) In a safe environment the test may be conducted by using pushbuttons on the module when the circuit is activated (i.e. alternator must be operational)

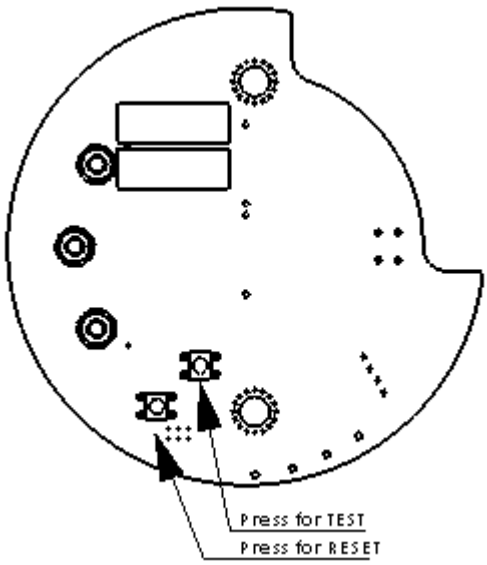

Figure 5 - Identification of test pushbutton

☠	Opening the flameproof enclosure in a potentially hazardous environment, then exciting the circuits in order to conduct the test is strictly prohibited

(ii) In a hazardous environment, the certified, intrinsically safe remote tool (Part 2079) may be used to provide a RESET command to the module.

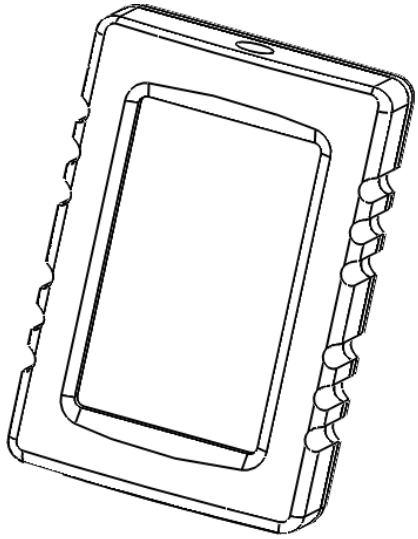

Figure 6 – 2079 - DCBR Remote

Note – Please refer separate documentation for details of product 2079 – DCBR Remote

3.5.2 OTHER CHASSIS IMPEDANCES

The module is designed for DC source power systems that are floating and unbonded to the chassis. The existence of other impedances between the power rails and the chassis may be detected and interpreted as a fault.

If for instance, the 0V DC rail is connected to the chassis, this would be interpreted as an earth fault – i.e. a low earth impedance.

3.6 OVERVOLTAGE PROTECTION

The module continuously monitors the output voltage and latches out the supply if overvoltage conditions are found to be outside of tolerable limits.

The overvoltage protection is principally to detect a runaway control loop, which delivers a sustained output voltage that is out of range.

If the output voltage is measured to be in excess of the catastrophic limit, the module is placed into a forced maintenance state and must be returned for service.

The "VOLT" indicator will be continuously illuminated after an overvoltage fault. To clear the latch and indicator, a reset is required.

⚠	The alternator speed limitation is important to ensure that overvoltage does not arise from the fixed flux component provided by permanent magnets. If the alternator is spun at high speed, the resultant voltage will exceed the overvoltage thresholds and a nuisance trip will occur.
☠	Over speeding the alternator may cause mechanical failure, which has the potential to rupture the flameproof enclosure. Please observe the speed limitations as specified.
⚠	Experience has shown that hydraulic drives are capable of delivering over speed transients where low oil or malfunctioning drives are found

3.7 UNDERVOLTAGE PROTECTION

Undervoltage operation is in general, evidence of a short circuit fault.

The module is able to distinguish between undervoltage caused by a stalled engine and undervoltage caused by a short circuit.

The "VOLT" indicator will flash following an undervoltage protection operation. To clear the latch and indicator, a reset is required.

3.8 THERMAL OVERLOAD PROTECTION

The temperatures internal to the alternator may rise under high load conditions. The module implements measures based on load current to limit this condition.

The module permits overloads (not faults) to occur for a short time up to the overload time limit and pays back the overload debt if the

load is reduced under the current threshold. If the overload limit is exceeded the module will reduce the output voltage to manage the load current.

If the overload limit is exceeded the module will reduce the output voltage to manage the load current.

If the alternator is stopped, the debt is set to zero (even though the alternator might still be quite hot).

Note – Please refer to the thermal specification section of this document for parameters

3.9 RESET COMMAND

The module has various protection functions which latch open the main circuit interrupter. The latch must be cancelled by resetting before load can be resupplied.

The latch is a safety mechanism that isolates the output in the presence of a detectable fault.

A protection operation is latched in persistent memory to ensure that even if the power is cycled, the protection operation is strictly enforced.

Resetting the latch should only be performed when the fault has been cleared

The manual RESET is only active if the alternator is running and energised.

The RESET can be performed manually or remotely.

(i) Momentarily actuate the RESET pushbutton on the module which is only accessible by removal of the end cover.

(ii) A RESET may be remotely conducted using the certified intrinsically safe tool "DCBR Remote" (Part 2079). The remote reset tool uses infrared signals to communicate with the module inside of the flameproof alternator

The reset pushbutton on the module may only be operated by an authorised competent person. Since activation requires the cover to be removed from the flameproof alternator, the reset operation must be conducted in a safe zone (or where the risk of igniting an explosive gas and / or dust mixtures has been assessed and found to be safe).

Failure to observe this requirement could be fatal in the presence of an explosive atmosphere.

The module (i.e. alternator) must be energised before the RESET can be recognized.

If the module has registered a protection trip, it is essential that the fault be repaired before any attempt is made to reconnect supply.

3.10 VISUAL INDICATORS

An indicator panel is provided to assist with diagnosis of faults

The indicator panel on the Remote (2079) will mimic the indicators on the module

The indicator panel will identify counterfeit products which cannot be reset with the reader.

3.10.1 NORMAL OPERATION

The panel provides the following annunciation

Indicator	Duty	Meaning
POWER	Continuous	Power ON
	Flashing	Runtime > 4500 hours

CHASS	Flashing	Chassis trip
CURR	Continuous	Instantaneous overcurrent trip
	Flashing	Timed overcurrent trip
VOLT	Continuous	Overvoltage trip
	Flashing	Short circuit trip
All	Dimmed	Extra low voltage

To conserve power when terminal volts are low (e.g. when the alternator is shutting down or when a terminal fault has been applied), all indicators are run in dimmed mode until the voltage position is recovered.

On power, up all indicators are momentarily illuminated.

3.10.2 FAULT INDICATION

An internal fault with the module is indicated by alternate flashing of all indicators ("fairy lights"). If the "fairy lights" condition is apparent, the module has become corrupt and non-functional for safety

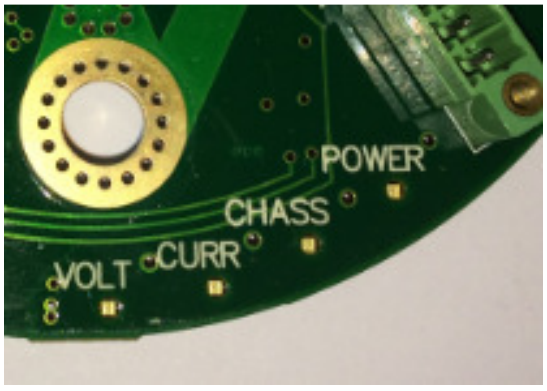

Figure 7- Indicator panel

3.10.3 SERVICE REQUIRED

A service indicator for the alternator is built into the module. If the POWER indicator is observed to flash, the module has reached its recommended service interval.

The module should be returned for service.

Power LED	Nominal Output Voltage	Meaning
On	12V	Normal 12V operation
Flashing	12V	Runtime[2] > 4500 hours

Accumulated runtimes age critical module components, and returning the units at the recommended intervals facilitates a service which ensures that:

- safety features of the device remain accurate and responsive, and that
- efficiency-related components remain conditioned to assist prolonging the alternator's life.

3.11 DIAGNOSTIC FLOW CHART

A diagnostic flow chart is appended to this manual to assist with the analysis and interpretation of the indicators.

3.12 TESTING

3.12.1 CHASSIS PROTECTION TEST

The module features circuit and controls that enable the chassis fault protection to be tested and validated. When activated the test is fully automatic and runs to completion in about 5 sec.

The test may be initiated either-

(i) By momentarily pressing the TEST button

(ii) Command over the infrared communication port (using the remote reader product 2079).

The manual test pushbutton is mounted on the module

The remote test pushbutton is mounted on the "module Remote"

The test can only be conducted if the alternator is running in a fully excited state above the minimum speed threshold

Figure 8 - TEST and RESET pushbuttons

Operation of the test switch at any time will initiate a test sequence which applies a low impedance across the output terminals within the module of less than the threshold value.

(i) While the test is in progress the load will be disconnected.
(ii) A successful test sequence will result in closure of the interrupter and automatic resumption of supply
(iii) A failed test sequence will result in operation and latching of the interrupter in the open state.

With the alternator running, conduct the chassis test by activating the TEST pushbutton. The supply will be lost for about 5 sec and then restored to confirm correct operation of the module chassis protection features. Failure to restore supply indicates a failure of the module which should be immediately returned for repair or service.

A failed test means that the module has a defect and it should be replaced.

An alternator which fails the chassis protection tests MUST NOT be used in service.

The chassis test confirms the correct operation of the chassis protection and thereby confirms that chassis faults do not exist on the vehicle wiring.

The test facility does not increment the fault event log. Externally simulated faults will however increment the event log. The event log can only be reset in the factory.

3.12.2 MEGGER TEST

The high voltage produced by a megger, inappropriately applied, may damage circuits and / or cause malfunction.

The use of a high voltage megger to test insulation integrity when the alternator is connected is expressly PROHIBITED and will void warranty.

If the circuit must be megger tested then isolate the electronics by disconnecting both line conductors at the alternator terminals.

A static megger test of the wiring may indicate sound insulation. However in operational use the insulation integrity may be compromised by vibration and temperature. A static megger test is NOT conclusive evidence of sound insulation integrity.

3.12.3 RESET[3]

The reset pushbutton is used to reset latched protection.

4 INSTALLATION

The module is an integral component of a flameproof alternator. It is not designed to be maintained except by authorised personnel who are trained and competent service technicians.

If there is a suspicion that the module has failed, then the complete alternator should be returned to an authorised agent for attention.

A flameproof alternator shall be routine tested whenever a module is fitted. A test report shall be kept.

4.1 CONDITIONS OF USE

The apparatus shall only be used within the following limitations.

Failure to observe the conditions of use is an express failure to comply with the manufacturers recommendations

.

Severity	*Condition of use*	Explanation
	Impact	There is no special limitation on use on account of impact. The module it fitted into a flameproof alternator
	Ambient temperature	There is no special limitation on use on account of temperature. The standard ambient conditions shall apply.
	Service temperature	There is no special limitation on use on account of temperature. The standard ambient conditions shall apply.
	Atmospheric pressure	There is no special limitation on use on account of atmospheric pressure.
	Entity assessment	The module must only be used where an assessment of entity parameters has been conducted and compatibility has been found and documented by a competent person.
	Connector, P1	Connector P1 shall achieve an ingress protection rating of IP20 or greater. (The use of the recommended connector meets this requirements)
	Wiring	Wiring shall be identified (either by number or colour) and the details recorded in the installer's documentation.

5 SPECIFICATIONS

5.1 ENVIRONMENTAL LIMITATIONS

[3] *A reset can be conducted remotely using the optional certified DCBR Remote*

The module is designed for mounting inside of a flameproof enclosure where it is protected from mine environment.

Operational use of the apparatus outside of these limits cannot be assured and may prevent the apparatus from functioning as intended

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
T_A	Ambient temperature		-40		+125	˚C
H_A	Ambient humidity		0		90	%
P_A	Atmospheric pressure (Ambient)			100		kPa
	Tolerance to dust		Moderate			
	Tolerance to mine water		Low			
	Tolerance to vibration		High			

5.2 STORAGE LIMITATIONS

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
T_A	Ambient temperature		-40		150	˚C
T_{SHELF}	Shelf life	Indefinite if stored unopened in original packing				

5.3 ELECTRICAL SPECIFICATION

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
Regulation						
V_{RATED}	Output voltage	Above regulation knee		13.8		V_{RMS}
V_{200W}	Output voltage	200W		13.3		V_{RMS}
V_{RIPPLE}	Output ripple	Load and RPM dependency		0.8	2.9	V_{RMS}
V_{COMP}	Load compensation	Factory preset		5		%
V_{CLAMP}	Output voltage	Hardware clamp at $T_{ambient}$ = 125˚C			<24	V_{PEAK}

Main circuit interrupter						
V_{INT}	Rated interrupter voltage				100	V
I_{INT}	Rated interrupter current				280	A
Overvoltage protection						
V_{OVP}	Overvoltage protection threshold			16		V_{RMS}
T_{OVP}	Overvoltage trip timer			1.0		s
	Latching		Yes			
	Unlatching method		Manual			
	Catastrophic overvoltage threshold[4]			40.0		V
	Catastrophic timer			0.9		s
	Catastrophic latch		Yes			
	Catastrophic unlatching method		Factory only			
Timed overcurrent protection						
	Overcurrent threshold			26.0		A
	Overcurrent trip delay			0.3		s
	Latching		Yes			
	Unlatching method		Manual			
	Recommended max cable length	2 || 1.5mm² cores			25	m
Instantaneous overcurrent protection						
	Instantaneous overcurrent threshold			56.1		A

[4] Legacy *firmware* feature of pre V3 cards, effectively reduced to 24V by the V3 V_{CLAMP} hardware and only active in case of a catastrophic physical damage to regulation circuits and/or V_{CLAMP} hardware.

	Latching		Yes			
	Unlatching method		Manual			
Instantaneous chassis protection (earth fault)						
	Chassis fault impedance	+ve rail to chassis	500		1k	Ω
	Chassis fault impedance	-ve rail to chassis	500			Ω
	Latching		Yes			
	Unlatching method		Manual			

5.4 THERMAL SPECIFICATION

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
Main circuit interrupter						
T_{RISE}	Temperature rise at 22A	Fitted to alternator			<90	˚C
Field power						
T_{RISE}	Maximum temperature rise of associated components	Fitted to alternator, 350W load			<135	˚C
Ambient						
T_{LIMIT}	Absolute temperature limits		-20		125	˚C
T_{AMB}	Ambient temperature limits		-20		40	˚C
Thermal management						
	Overload current threshold			22.0		A
	Turndown voltage			8.2		V
	Overload timer			600		s
	Overload payback rate			0.5		s/s

6 REFERENCE PUBLICATIONS

Publication reference	Type	Title	Link
RS-01	Recognised standard	Underground electrical equipment and electrical installations - Coal Mining Safety and Health Act 1999 - April 2015	https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0019/240382/recognised-standard-01.pdf
AS/NZS 4871.6:2013	Recognised standard	Electrical equipment for mines and quarries Part 6: Diesel powered machinery and ancillary equipment	https://infostore.saiglobal.com/en-au/Standards/preview-1675073/

7 LEGEND

In the context of this document, the following apply.

	Denotes good practice recommendations or guidelines
	Denotes an unambiguous NO /DO NOT
	Denotes information
	Denotes cautionary advice or recommendations
	Denotes the probability of damage to the equipment or its surrounds if this advice is ignored
	Denotes the possibility of serious injury or death if this course of action is pursued

8 GLOSSARY OF TERMS

Term	Definition
CoC	Acronym for 'Certificate of Conformity'. This is the definitive certificate issued by the explosion protection regulation body e.g. IECEx or ANZEx
Ex ia	Acronym for the intrinsically safe method as defined by IEC60079 Part 11, where safety is maintained even after two countable failures
Ex d	Acronym for the flameproof method as defined by IEC60079 Part 1.
Certified	In the context of this document, certified means that the apparatus is covered by a Certificate of Conformity (CoC) under the IECEx certification scheme.

9 ATTACHMENTS

Drawings

Flow chart

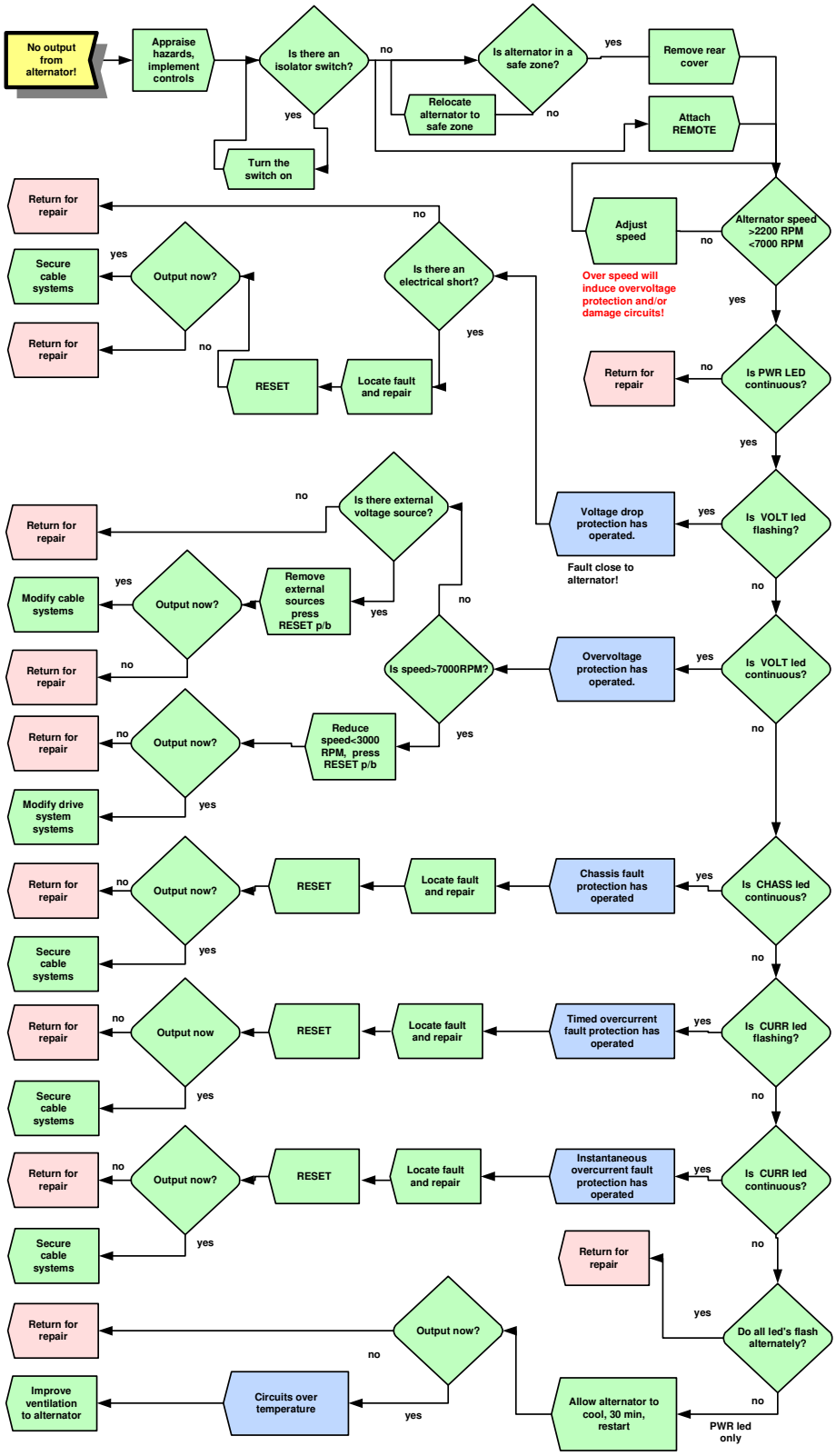

Figure 9 - Fault Diagnostic Flowchart

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