Flameproof Diesel Machinery Electrical System Alternator Test Procedures (with DCBR fitted)

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1 OVERVIEW

1.1 Scope of this document

This document outlines test procedures for site assessment of DCBR modules when fitted to MR110 series flameproof alternator. The test procedures outlined here represent fundamental tests that can be conducted with a test bench, in order to confirm the basic alternator operation.

1.2 Applicability

These procedures are generally applicable to all versions of the DCBR released to date. Specific exclusions are detailed in the test procedures if applicable.

1.3 Test Outcomes

Passing these tests does not absolutely confirm that the alternator is functioning correctly. However success with these tests would strongly suggest that the alternator is functioning correctly.

If a fault persists with a vehicle and the alternator passes these tests, this is a strong indication that either

i) a fault exists with the vehicle wiring circuits and /or
ii) the operational speed is outside of the design range

1.4 Diagnostic procedure

A diagnostic flow chart is appended to this document to help with fault diagnosis.

1.5 Site Test Report

A copy of the site test report should be included with any factory return.

2 DCBR OVERVIEW

2.1 Description

The MR110 alternator is a self-excited three phase multi-pole alternator with integral rectification and regulation in a certified flameproof housing.

The alternator is rated at 13.8V DC and 30A at an ambient temperature not exceeding 40 deg C. The maximum rated speed is 7000 RPM. The DCBR is factory set for an overcurrent trip at 26A.

2.2 DCBR is a safety device

The DCBR is primarily a safety device.

- It is designed with redundancy in its circuit interruption capability by having two switched poles.
- It has comprehensive protection functions for ultra-low-voltage DC applications
- It has internal self-checks to ward against corrupted memory.
- It has internal self-checks to ward against processor failure.
- It is fail-safe to ensure if something does fail, the final state is a safe one.

If these features were compromised, it would not meet our high safety integrity level requirements.

2.3 Applications

The MR110 alternator with DCBR controller module is designed for use on mobile diesel plant operating in Group I zone classifications as typically used by the underground coal mining industry.

2.4 Certification

The MR110 with DCBR controller is certified Ex d I 150 deg C IP65 under

- ❑ IECEx TSA 06.0041X
- ❑ MDA Ex d 2477
- ❑ QMD 92 7116X

2.5 Integrated flameproof package

The MR110 when fitted with the DCBR module is a single flameproof component that embodies the functions of a

- Self excited alternator
- Circuit interrupter
- Protection relay
- Datalogger

The protection features include

- Instantaneous overcurrent
- Timed overcurrent

- Insulation impedance (+ve and – ve power rails to chassis)
- Overvoltage
- Circuit breaker fail
- Internal self checks

The protection settings are factory set and not accessible to the user.

The protection system is entirely solid state and free from selection switches, potentiometers or mechanical relays.

3 ASSOCIATED DOCUMENTS

(Attachment)	Site Test Record
Publication DCBR-004	DCBR User Manual
Publication DCBR-014	MR110 Series Test Bench, User Manual
QF 7.2.2c	DCBR FAULT REPORT

4 TEST EQUIPMENT

The following components are referred to in the test procedures.

MR110 Series Test Bench (kit)
DCBR Serial converter
Lap top computer with DCBR Panel application
DCBR Serial Converter
Shorting wires
Digital Voltage Meter (DVM)

5 SITE TESTS

The following tests are covered by this document

Test 1	Start Test	Four (4) cold lamps with negligible line impedance
Test 2	Start test	Four (4) cold lamps with negligible line impedance via line switch
Test 3	Excitation speed test	
Test 4	Dropout speed test	
Test 5	Short circuit test	Fault at cable end
Test 6	Short circuit test	Fault at supply end
Test 7	Chassis impedance test	
Test 8	Regulation test	
Test 9	Chassis self test	
Test 10	DCBR Remote Panel Test	

5.1 Test 1 - Start four (4) cold lamps with negligible line impedance

5.1.1 Purpose

This test is designed to replicate the condition most often used by mine vehicles, with a typical load.

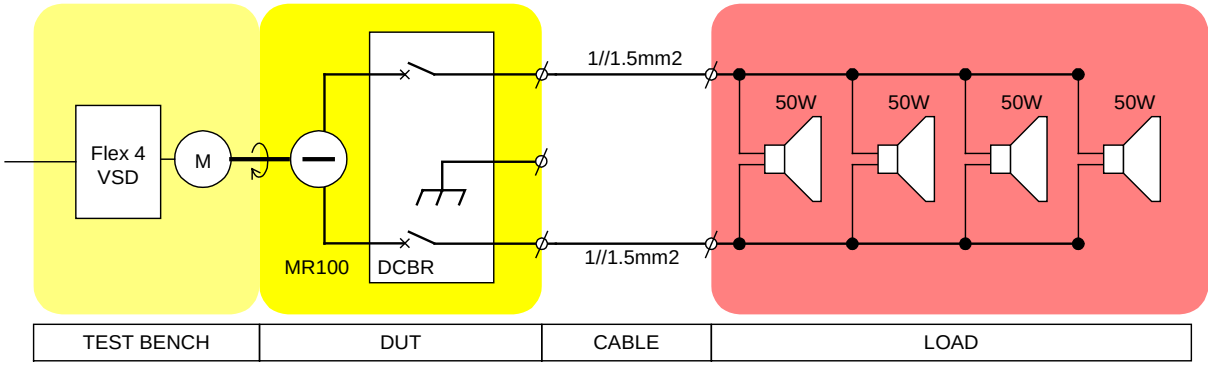
5.1.2 Background

Halogen lamps have an impedance that is typically reduced by 50% when hot. That is, they draw about twice rated current when they are cold. The alternator must be able to discriminate between cold lamps and a short circuit. The DCBR has a reclose feature which permits a second attempt to close onto the load. A failed first attempt will be evident as a flashing CURR(ent) led. A second successful attempt will be apparent as establishment of supply to the load. The DCBR is designed to successfully start 6 x 50W cold lamps with the test lead as supplied.

The DCBR requires 11 sec of operation before trip events are persistently stored.

5.1.3 Test Procedure

Connect the circuit as shown with four lamps. Run the alternator up to speed.



5.1.4 Pass Criteria

In the cold condition the alternator must reliably start the lamps without invoking a latched protection operation. An automatic circuit breaker reclose is permitted. The lamps must start at any speed above the excitation speed.

5.1.5 Test Results

Record the results in the Site Test Report.

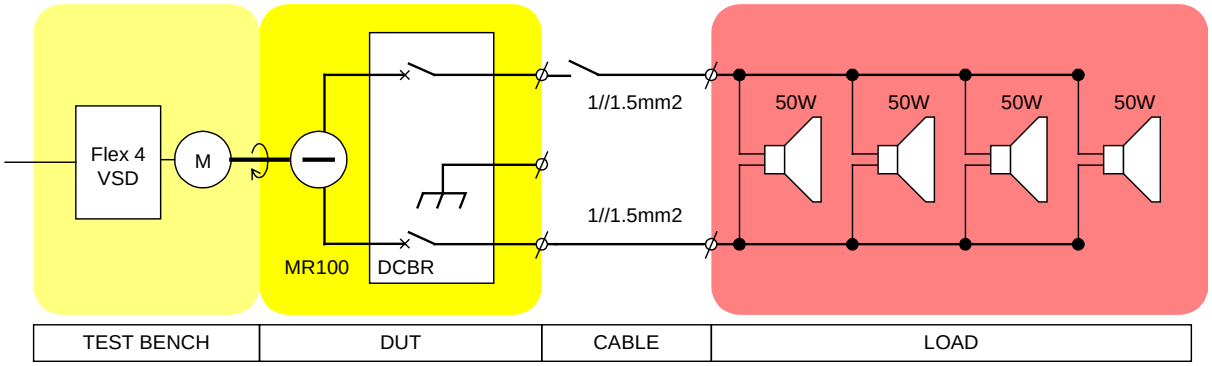
5.2 Test 2 - Start four (4) cold lamps with negligible line impedance via line switch

5.2.1 Purpose

This test is designed to test the starting ability of the alternator when fitted with a DCBR module to supply a low impedance load (such as with cold halogen lamps), assuming the load is switched.

5.2.2 Test Procedure

Connect the circuit as shown using cold halogen lamps. Run the alternator up to excitation speed and close the switch.



5.2.3 Pass Criteria

The load must be reliably supplied without invoking a latched protection operation. An automatic circuit breaker reclose is permitted.

5.2.4 Test Results

Record the results in the Site Test Report.

5.3 Test 3 – Excitation speed

5.3.1 Purpose

This test is designed to determine the speed at which excitation first occurs.

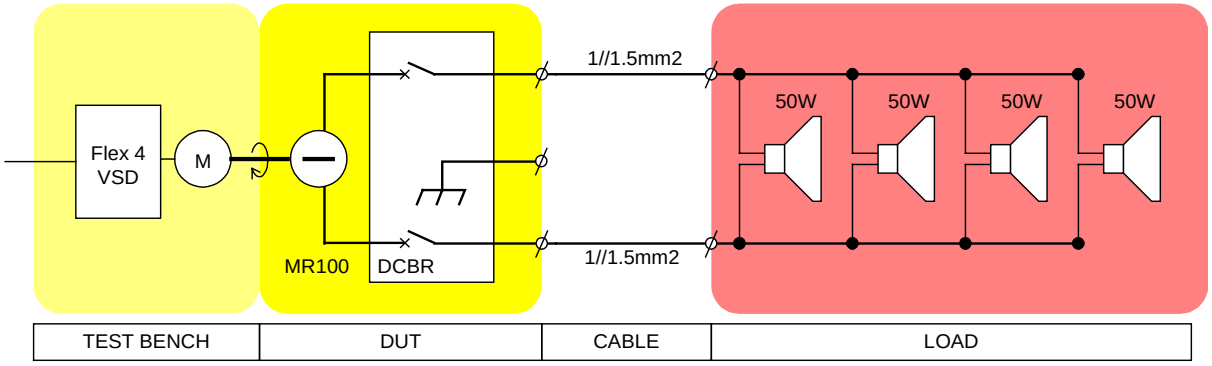
5.3.2 Background

The DCBR first excites when the residual magnetism in the rotor and the rotor speed are sufficient to supply the DCBR circuits. There is a delay of about 1 sec between powering the DCBR circuits and closing the supply circuit breakers.

The start-up routine for the controller briefly illuminates all LEDs on the DCBR panel.

5.3.3 Test procedure

Connect the circuit as shown. Ramp the speed up slowly and note the frequency at which excitation first occurs. Note the behaviour of all panel LED s. Excitation is the point at which the PWR led is illuminated rather than supply to the load.



5.3.4 Pass criteria

The test is successful if

- The excitation speed is less than 2200RPM / 38Hz
- All LED are seen to operate (fleetingly)

5.3.5 Test results

Record the results in the Site Test Report.

Record the excitation frequency / speed.

5.4 Test 4 - Dropout speed

5.4.1 Purpose

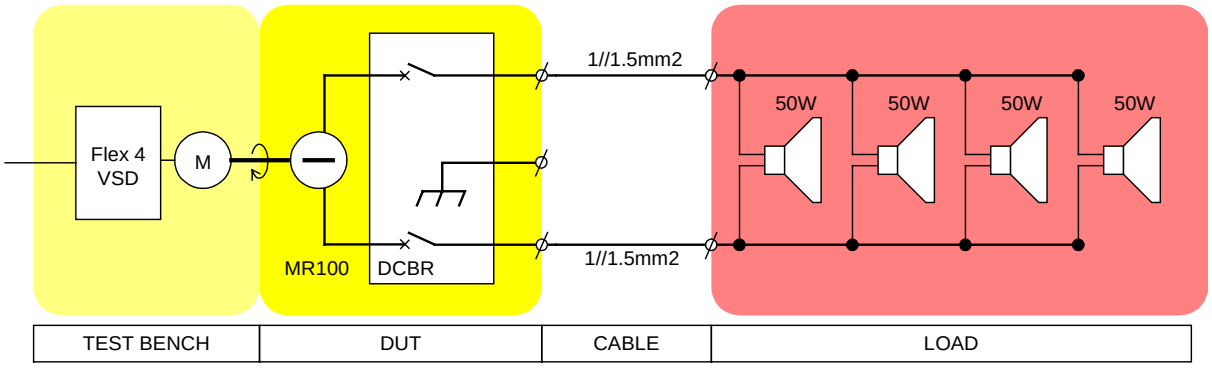
This test is designed to determine the speed at which excitation cannot be sustained because of low speed and so supply to the load is lost.

5.4.2 Background

The excitation speed is different than the drop out speed due to the hysteresis effects of the excitation circuits.

5.4.3 Test procedure

Connect the circuit as shown. Ramp the speed up above the excitation speed and then slowly reduce the speed until the load supply is lost.



5.4.4 Pass criteria

The test is successful if the dropout speed is about half the excitation speed.

5.4.5 Test results

Record the results in the Site Test Report.

Record the dropout frequency / speed.

5.5 Test 5 - Short circuit tests at cable end

5.5.1 Purpose

The purpose is to confirm that a short circuit at the cable end can be reliably detected, cleared and latched out.

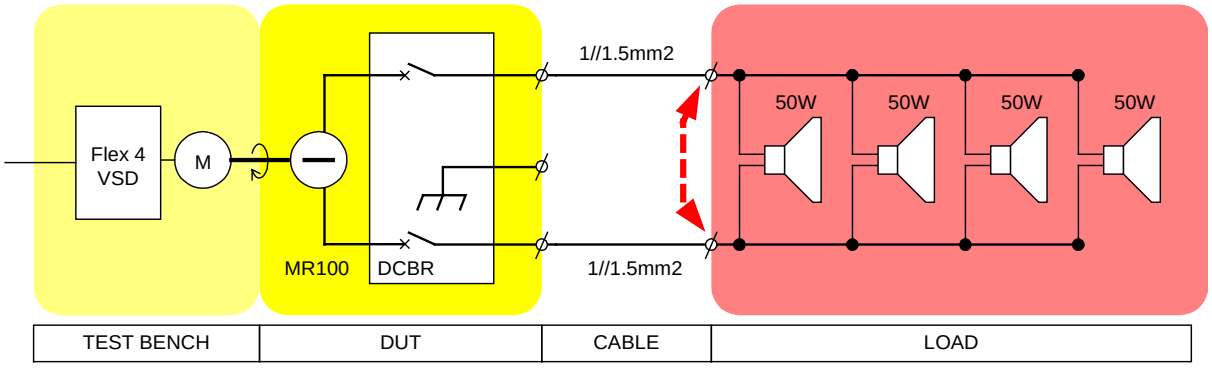
5.5.2 Background

The MR110 alternator has a shunt wound field. This means that a short across the main windings will collapse the field winding and prevent the delivery of fault current. However if the fault occurs at a

location where the cable impedance is capable of sustaining the field voltage, fault current can be delivered. In other words the length of the cable is important. The DCBR has two detection methods to cover both “close in” and “distant” faults. In this test, the cable impedance should hold up the field winding, so the protection mechanism is “short circuit”. This will be evident via illumination of the “CURR(ent)” led.

5.5.3 Test Procedure

Construct the following circuit. Run the alternator up to speed (2300RPM / 40 Hz). Apply a short at the end of the cable terminals.



5.5.4 Pass Criteria

The test is successful if

- The supply is disconnected without delay when the fault is applied
- The supply is not restored after a power cycle
- There is LED indication of the protection operation
- The supply is restored if the RESET pushbutton is operated (fault condition removed)

5.5.5 Test Results

Record the results in the Site Test Report.

5.6 Test 6 - Short circuit tests at supply end

5.6.1 Purpose

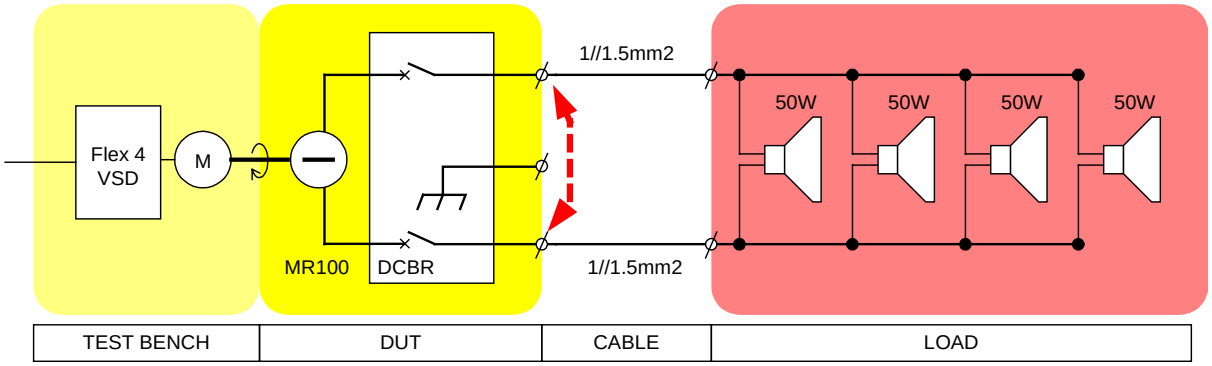
The purpose is to confirm that a short circuit fault at the alternator terminals can be reliably detected, cleared and latched out.

5.6.2 Background

A short at the alternator terminals has negligible “cable impedance” and the prevailing fault detection mechanism is voltage based. This will be evident via illumination of the “VOLT” led.

5.6.3 Test Procedure

Construct the following circuit. Run the alternator up to speed (2300RPM / 40 Hz). Apply a short at the alternator terminals.



5.6.4 Pass Criteria

The test is successful if

- The supply is disconnected without delay when the fault is applied
- The supply is not restored after a power cycle
- There is voltage LED indication of the protection operation
- The supply is restored if the RESET pushbutton is operated (fault condition removed)

5.6.5 Test Results

Record the results in the Site Test Report.

5.7 Test 7 - Chassis impedance test

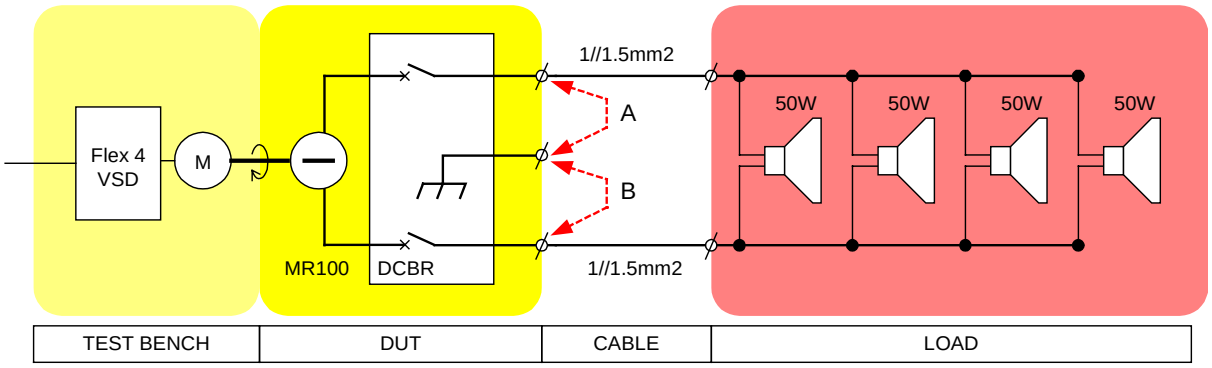
5.7.1 Purpose

This test is designed to verify the operation of the chassis protection feature.

5.7.2 Test Procedure

Connect the circuit as shown. Run two consecutive tests, A and B.

Test A - Apply a short between the positive terminal and the earth terminal
Test B – Apply a short between the negative terminal and the earth terminal



5.7.3 Pass Criteria

The test is successful if

- The supply is disconnected (circuit breakers open) without delay
- The CHASS LED flashed
- The supply is not restored after a power cycle (shut down the alternator, run up to speed again)
- The supply is restored if the RESET pushbutton is operated (short removed)
- The behaviour is the same for both positive (A) and negative (B) tests

5.7.4 Tests Results

Record the results in the Site Test Report.

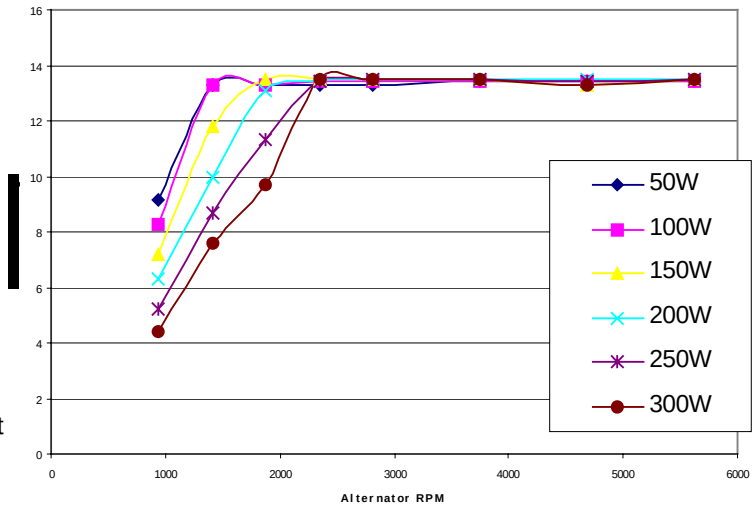
5.8 Test 8 - Regulation tests

5.8.1 Purpose

To confirm that the alternator is output voltage is within Regulation limits.

5.8.2 Background

The alternator output is proportional to speed below commutation point and constant for a given load above the commutation point. The commutation point is the speed at which the field needs to be switched from fully-on to partially-on to keep the output voltage at the rated level. You can also see from the attached chart (load compensation turned off) that the commutation point varies according to load.



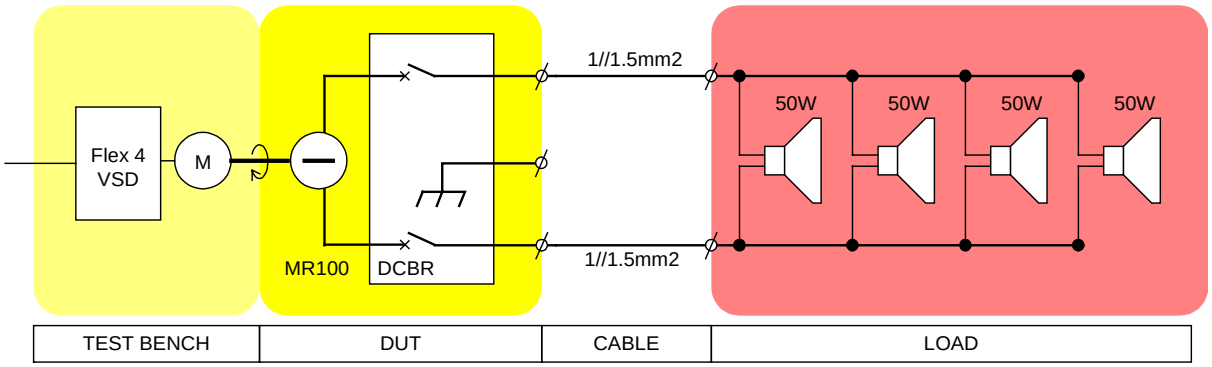
the

The alternator terminal setpoint voltage does vary slightly with load due to the load compensation characteristics of the DCBR. The compensation variation is about 0.5V between no load and full load.

The lamp voltage is typically 1.0V less than the alternator terminal volts for the test cable.

5.8.3 Test procedure

Connect the circuit as shown. Run the alternator up to speed (2300RPM / 40 Hz).



Measure the rms voltage at the alternator terminals and at the lamp terminals using a quality digital voltmeter.

5.8.4 Pass criteria

The measured alternator terminal voltage must be within the range 13.5 to 13.8V at 200W.

5.8.5 Test results

Record the results in the Site Test Report

5.9 Test 9 – Chassis self test

5.9.1 Purpose

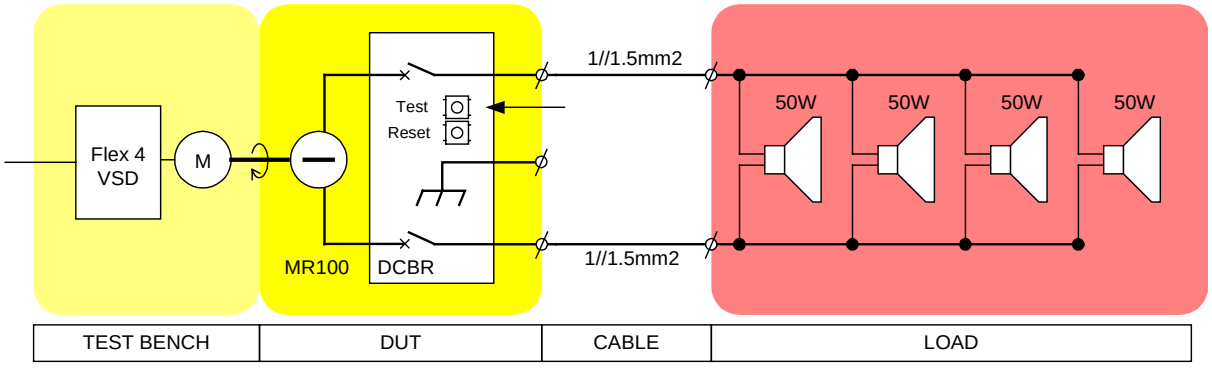
To confirm that chassis self test feature is functional.

5.9.2 Background

The DCBR contains an internal self-test feature that performs a primary injection chassis test (both high side and low side). The output is disconnected whilst the test is in progress, the CHASS(is) led will flash and supply will be automatically restored after about seven (7) seconds if the device under test passes the test.

5.9.3 Procedure

Connect the circuit as follows. Run the alternator up to speed (2300RPM / 40 Hz).
Press the “TEST” button



5.9.4 Pass Criteria

The test is successful if

- The supply is disconnected (circuit breakers open) without delay
- The CHASS led flashes for the duration of the test
- Supply is restored after about seven seconds

5.9.5 Test Results

Record the results in the Site Test Report.

5.10 Test 10 - Remote panel test

5.10.1 Purpose

The remote data panel test serves to verify that the data panel feature (with data logging) is operational.

5.10.2 Background

The DCBR is designed with communication ability to display DCBR parameters. The version of windows software is specific to the firmware in the DCBR. The compatibility table is as follows

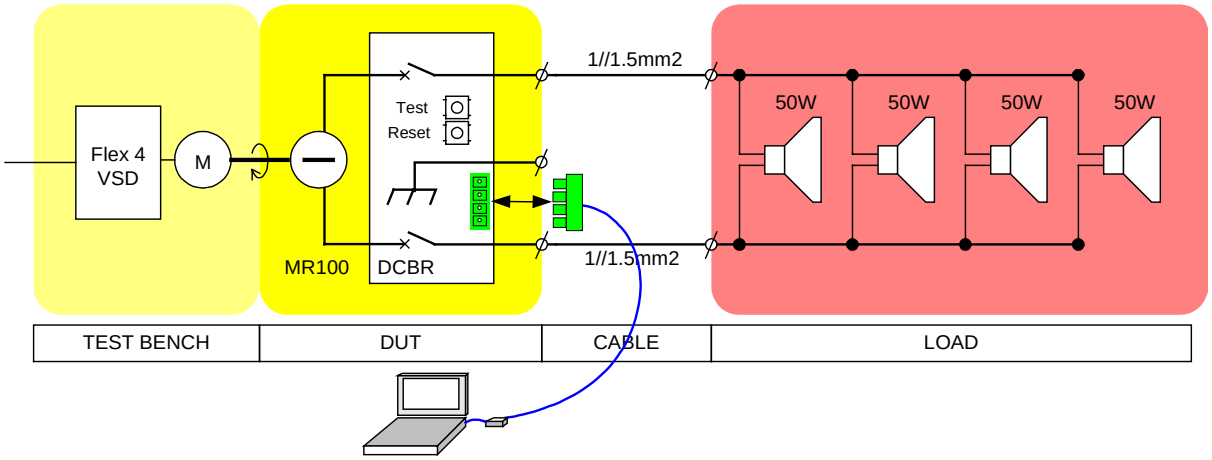
Firmware Version running in DCBR	Application Version running in Windows
V1.20	V1.21, V2.2
V1.21	V1.21, V2.2
V1.32	V1.21, V2.2
V1.33	V1.21, V2.2
V1.85	V1.21, V2.2
V1.86	V1.21, V2.2
V2.x	V2.2

The DCBR panel allows the following parameters to be displayed

- Firmware version
- Serial number
- Voltage status
- Current status
- Chassis status
- Protection status, (including internal protection)
- Protection event log
- Run hours

5.10.3 Procedure

Connect the circuit as follows



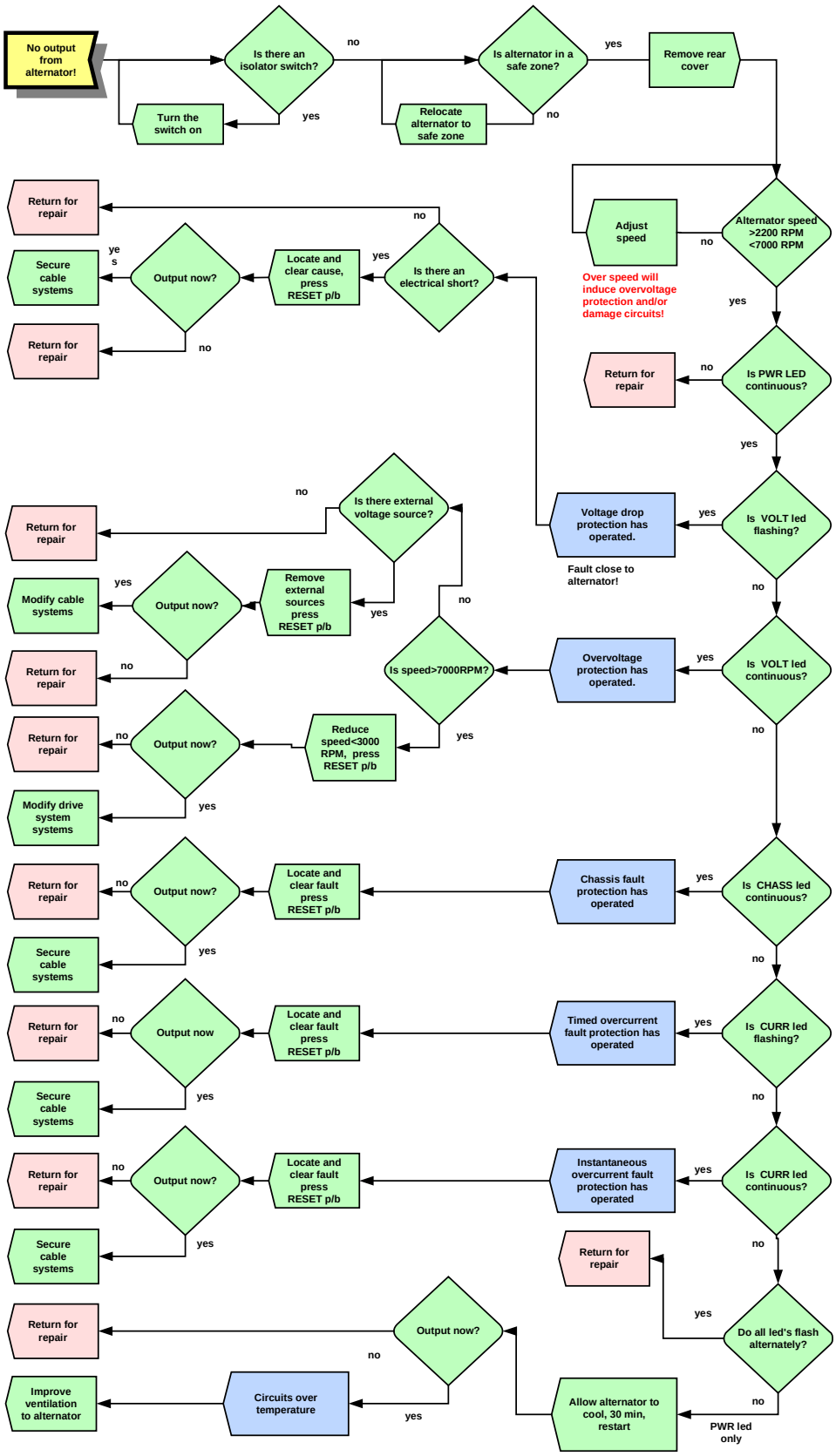
5.10.4 Pass criteria

The test is successful if communication sis established with the DCBR and the parameters are displayed.

5.10.5 Test results

Record the log values in the Site Test Report

6 DIAGNOSTIC FLOW CHART



7 GENERAL PRECAUTIONS

This is a reiteration of safety matters covered elsewhere. They are repeated here for emphasis.

7.1 Hot surfaces

The lamp module gets hot in normal operation! To avoid burns, do not contact the lamp module.

7.2 Rotating Machinery

Ensure shaft guard is fitted

7.3 Mains Power

Unplug the mains to isolate the AC mains supply before performing any maintenance on the test bench ac wiring system.

7.4 Stored Energy

The VSD contains potentially fatal levels of stored energy and must not be dismantled by unauthorised personnel.

MR110 ALTERNATOR SITE TEST REPORT

Mine Site			
Mine Reference			
DUT References	Alternator	DCBR	Firmware
Test Ref	By	*Date*	

Ref	Test	Test configuration / results	Pass Criteria	Pass / Fail
1	Start four (4) cold lamps with negligible line impedance, no line switch	Test load …….200W Test speed……..>2200RPM Load condition……warm / cold Reclose required……yes / no	Starts No fault	[ ]
2	Start four (4) cold lamps with negligible line impedance via line switch	Test load …….200W Test speed……..>2200RPM Load condition……warm / cold Reclose required……yes / no	Starts No fault	[ ]
3	Excitation speed	Test load …….200W Excitation speed…….[ ] rpm / hz	<2200RPM (38Hz) LED operation	[ ]
4	Drop out speed	Test load …….200W Drop out speed…….[ ] rpm / hz	<Excitation speed	[ ]
5	Short circuit tests (Load end)	Test load …….200W Test speed……..>2300RPM Trip type……...TOC/IOC/ UV LED ……..Flash / cont Latch…… .yes / no	Trip Latch with reset LED Indication	[ ]
6	Short circuit tests (Supply end)	Test load …….200W Test speed……..>2300RPM Trip type……...TOC/IOC/ UV LED ……..Flash / cont Latch…….yes / no	Trip Latch with reset LED Indication	[ ]
7	Chassis test	+Trip……..Short “A” - Trip……..Short “B”	Trip Latch with reset LED Indication	[ ]
8	Regulation tests	Test speed ……..>2300RPM Terminal voltage ……[ ] 200 watts Terminal voltage …… [ ] 300 watts	 13.5>V>13.8 13.7>V>14.0	[ ]
9	Chassis self test	Test load …….200W Test speed……..>2300RPM Press “Test”	Trip Restore after ~7 sec	[ ]
10	Remote panel test	Hours……[……] Overloaded hours…….[……] Instantaneous current…..[……] Timed current……[……] Chassis trips……..[……] Overvoltage……[……] Undervoltage……[……] Watchdogs……[……]	{Record only}	{Record only}

Notes

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