Instruction Manual

Automatic Mains Failure System (AMF)
for
Diesel Powered Generator Units

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INTRODUCTION

This manual is provided to cover the following aspects for the Blandon Systems range of AMF Control Modules. This manual contains the following information:

- Basic Functional Description.
- Installation Guide.
- Operation.
- Testing/Fault Finding Guide lines.

Safety Precautions

Before Operating/Installing the equipment, read and become familiar with the manual and equipment.

Safe and efficient operation will only be achieved with safe and correct installation.

Disable starting circuits before attempting any installation/repair.

Isolate battery.

Company Details

Blandon Systems.
Unit 18,
Daniels Mill Industrial Estate,
Bath Road,
Stroud,
Glos.
GL5 3TJ.

Telephone….. +447465987206

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Identification

This manual provides operating and fault finding instructions for the following controllers.

Controller Part number	Description	Dc Voltage (Vdc)	Ac Voltage (Vac)
MOD-A12PD-230/1	AMF	12	230
MOD-A24PD-230/1	AMF	24	230

Each control module variation is identified by:

- A unique part number
- A unique serial number.

Description

Through out this text the term generator refers to a diesel engine in combination with an alternator of a suitable type.

The AMF range of Diesel Generator controllers have been developed using microprocessor based technology to provide for the automatic control, monitoring, & protection of diesel engine driven generator units.

The unit is housed in a plastic enclosure incorporating a rotary switch for control purposes.

The fundamental purpose of the AMF controller is to allow automatic operation of unmanned stand-by generators. The AMF continually monitors the local mains supply and will start the generator if there is a disruption in this supply. The AMF will then run and monitor vital engine and alternator parameters, whilst the supply interruption continues. The generator will automatically be stopped by the AMF once the local mains supply has been restored to within acceptable limits.

Incorporated into the controller are outputs to automatically control load transfer from the local supply to the generator alternator, and vice-versa.

The module is dedicated for either 12Vdc or 24Vdc and should be powered from the engine battery. Separate modules are available for either 230Vac or 115Vac plant voltage operation (line to neutral).

Features

Module Type..... Automatic Mains Failure
Module Dimensions (HxWxD).....142x65x125mm
Housing..... Plastic Case
Panel cut out 36.5x67.5mm
Switch ..... 6 position – Off, Inhibit, Automatic, Remote, Off, Test
Start ..... 4 x Start Attempt
Fuel Control.....Output Relay
Timed Pre-heat Control .....Output Relay
Starter motor Control ..... Output Relay
Plant Contactor Control ..... Output Relay
Mains Contactor Control..... Output Relay
Remote Start Function.....Yes
Low oil pressure shutdown.....Input
High Coolant temperature shutdown ..... Input
Under voltage sensing.....Input
Charge fail indication .....Input
Starter motor lock out .....Via W/L or AC rise
Automatic Load Transfer ..... Yes
Plant Sensing .....Single Phase
Mains Sensing.....3 Phase
Adjustment Timers.....Pre-Heat/Crank Timer
Plant Settle Timer
Mains Restoration Timer
Cool Down Timer
Microprocessor Controlled .....Yes

1.1 Environmental conditions

Ambient operating Temperature –20°C to +70°C

Installation/Dimensions

The unit is intended to be panel mounted via a through hole panel cutout. Dimensions and Panel cutout as Figure 1 *Dimensions and Panel cutout*

Prior to installation and use checks should be made to ascertain compatibility of the controller to the generator set. The following must be checked:

- Correct Dc voltage
- Correct Ac voltage
- Engine switch operation modes.

The controller is to be inserted in to the control panel from the front side via the panel cutout. The two securing clips provided are then attached to the top and bottom of the controller case. They should then be turned until the screw head comes into contact with the front fascia, and tightened until secure.

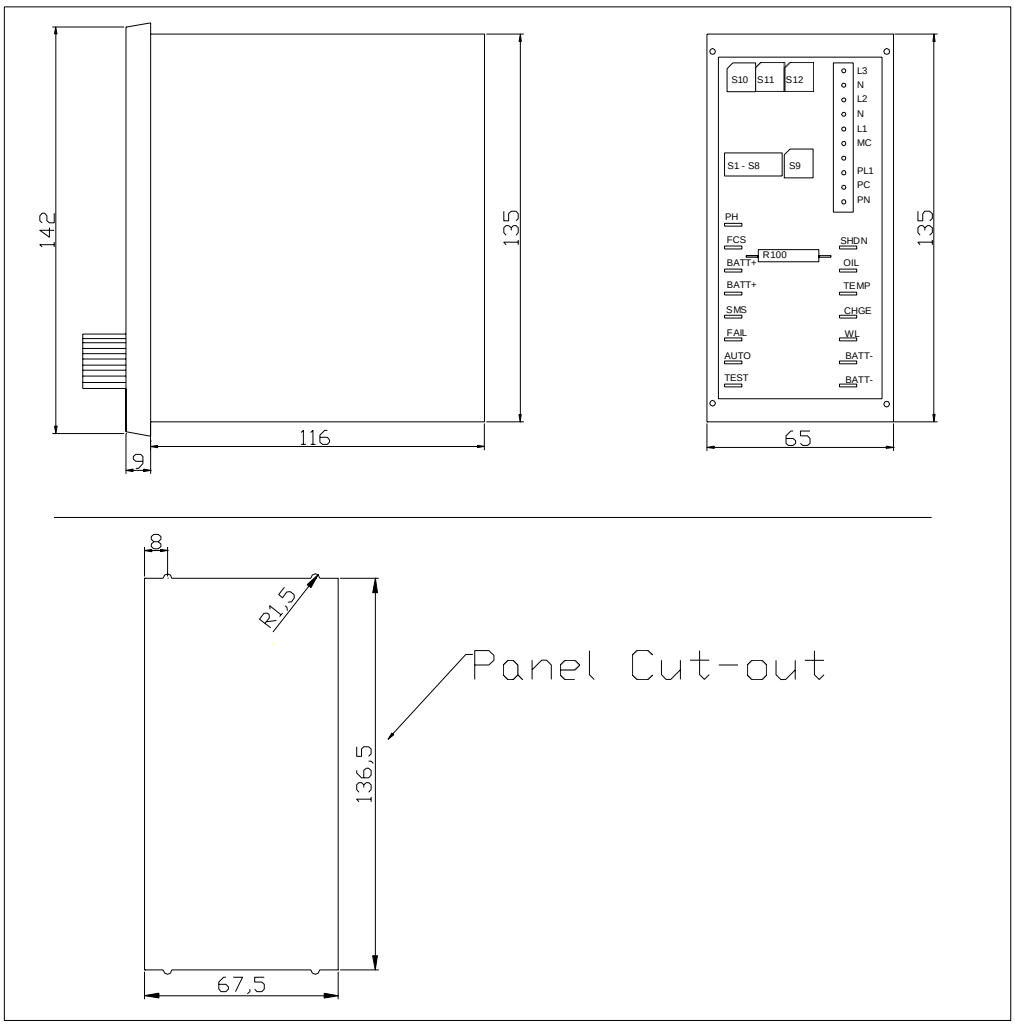

Figure 1 *Dimensions and Panel cutout*

Switch Controls

Control is via a 6-position rotary switch (located on the front fascia), allowing for quick and simple operation from the front panel.

Switch positions are as follows.

OFF — This position removes all power to the module, disabling the ignition circuits. The fuel control output is also disabled, thus stopping the generator. The remote start function is disabled.

ENGINE INHIBIT

This position enables the mains sensing circuits with in the module. The three phases of the local supply are monitored. If all phases are healthy the mains available and mains on load LED's will illuminate, the mains contactor control relay within the module will be energised. Should any phase of the local mains supply fail the mains fail led will illuminate and the mains contactor control relay de-energise. The engine will be inhibited from starting

AUTOMATIC — This position switches the module into AMF mode. (The load transfer circuits in the module are enabled). The unit may be left unattended in this mode and all operations are automatic. As with the inhibit switch position the three phases of the local supply are monitored. If the mains supply is healthy the mains contactor control relay within the module will be energised. Should one of the incoming mains phases fail the mains contactor control relay will de-energise. The ignition circuits of the module will be enabled and the generator automatically started. Once the generator has stabilised load will be transferred to the generator by engaging the plant contactor control relay within the module. The generator will run until the local mains power is restored. On return of the local supply load will automatically be transferred back to the mains by de-energising the plant contactor control relay within the module and energising the mains contactor control relay.

REMOTE — This feature allows the module to be controlled from a remote switch. This operates by linking terminals AUTO and TEST through an external contact. The module remains operational whilst the fascia switch has the Remote mode selected and the external remote switch is closed. The generator may be stopped at any time by opening the external remote switch, or alternatively by a local operator moving the front fascia switch to an OFF position

OFF — As stated above.

TEST — This position gives the operator start/stop control of the generator. Switching to this position will enable the ignition circuits of the module and the generator will be started. Should mains be available at this time the mains contactor will remain energised (there will be no load transfer). A mains failure whilst the generator is running in this mode, will initiate a load transfer to the generator. The generator may be stopped by switching to the OFF position.

LED Layout

The front fascia of the module contains twelve high intensity LED's with pictorial icons, enabling a quick status check of the generator module. The layout is as follows:-

Position	LED Colour	Condition/Status
1	Green	Mains Available
2	Green	Mains On Load
3	Red	Mains Failed
4	Green	Plant Available
5	Green	Plant On Load
6	Red	Generator Failed
7	Red	Start Failure
8	Red	Plant Under Voltage
9	Red	Engine Overspeed
10	Red	High Coolant Temperature
11	Red	Low Oil Pressure
12	Red	Charge fail*[1]

*[1] LED position 12 has a dual function

- With the generator stationary LED 12 will illuminate should the static battery charger fail.
- With the generator running LED 12 will illuminate should the charging alternator fail.

Dip Switch Settings

The rear of the controller houses an eight position Dual in Line (DIL) dipswitch and four timer adjustment switches. This allows the controller to be correctly configured for the generator application. To register new settings the module must be reset, by selecting the an OFF position.

1.2 Dip Switches (S1-S8)

N/O = Normally Open Contact N/C = Normally Closed Contact

Dip Switch	Parameter	Switch set to ON	Switch set to OFF
S1	N/A	N/A	N/A
S2	Oil pressure Fail	N/O	N/C
S3	Coolant Temp Fail	N/C	N/O
S4	Static Charger	Ground = Fail	Open-circuit = Fail
S5	Charge Fail Shutdown	Enabled	Disabled
S6	Charging Alternator	No Charge Alternator fitted	Charge Alternator fitted
S7	Over Speed Sensing	Disabled	Enabled
S8	Nominal Operating Frequency	60Hz	50Hz

Note for S4

This switch configures input CHGE for use with a static battery charger.

A) With dip switch S4 set to OFF

LED 12 Charge fail indication will illuminate should the CHGE input be open circuit, thus indicating the static battery charger has failed. This input closed circuit to ground indicates the battery charger is operating correctly.

B) With dip switch S4 set to ON

LED 12 Charge fail indication will illuminate should the CHGE input be pulled to ground, thus indicating the static battery charger has failed. This input open circuit indicates the battery charger is operating correctly.

Note for S5

This switch configures the way the module responds when the W/L signal is lost, possibly due to the alternator belt failing, whilst the generator is running.

A) With dip switch S5 set to OFF

LED position 12, charge fail, illuminates the generator will continues to run.

B) With dip switch S5 set to ON

The generator will be shutdown indicating plant fail plus Charge fail indication.

Note for S6

Use to set if the engine used has a charging alternator fitted.

With dipswitch S6 set to OFF

A charge alternator is fitted. The W/L signal must be connected to the WL terminal of the module. The W/L signal will be used as follows:

- To lock out the starter motor
- To determine if the engine is running.
- Illuminates LED 12, should the alternator fail whilst the engine is running

With dip switch S6 set to ON

The module will not interrogate the charge alternator input – terminal - WL.

Note for S8

A) With dip switch S8 set to OFF

The module is configured to operate with generators having a nominal frequency of 50Hz.
The shutdown frequency is 57Hz.

B) With dip switch S8 set to ON

The module is configured to operate with generators having a nominal frequency of 60Hz.
The shutdown frequency is 69Hz

1.3 Rotary switch settings (Timers)

S09 – Pre-Heat/Crank Timer
S10 - Plant settle Timer
S11 - Mains restoration Timer
S12 - Adjustable Generator cool down Timer.

Timer settings are as follows:

Position of S9 Pre-Heat/Crank Timer	Delay Crank (Pre-Heat)Time (Seconds)	Crank Period (Seconds)
0	3	10
1	10	10
2	10	15
3	15	10
4	15	15
5	25	10
6	25	15
7	25	25
8	50	15
9	50	25

Position of S10 Plant settle timer	Time (Seconds)
0	10
1	15
2	20
3	25
4	30
5	35
6	40
7	50
8	55
9	60

Position of S11 Mains restoration Timer	Time
0	10 Seconds
1	20 Seconds
2	40 Seconds
3	1 Minute
4	2 Minutes
5	3 Minutes
6	5 Minutes
7	7.5 Minutes
8	10 Minutes
9	15 Minutes

Position of S12 (Cool Down)	Timer (Minutes)
0	1
1	2
2	3
3	4
4	5
5	6
6	7.5
7	10
8	12.5
9	15

Functional Block Diagram

Blandon Power Systems range of Generator Controllers use microprocessor-based technology to provide Generator Start/Stop Control, Engine & Alternator Monitoring / Protection.

Shown below in *Figure 2* is the functional block diagram for the AMF module. The diagram is divided as follows:

- Inputs
- Outputs
- Microprocessor

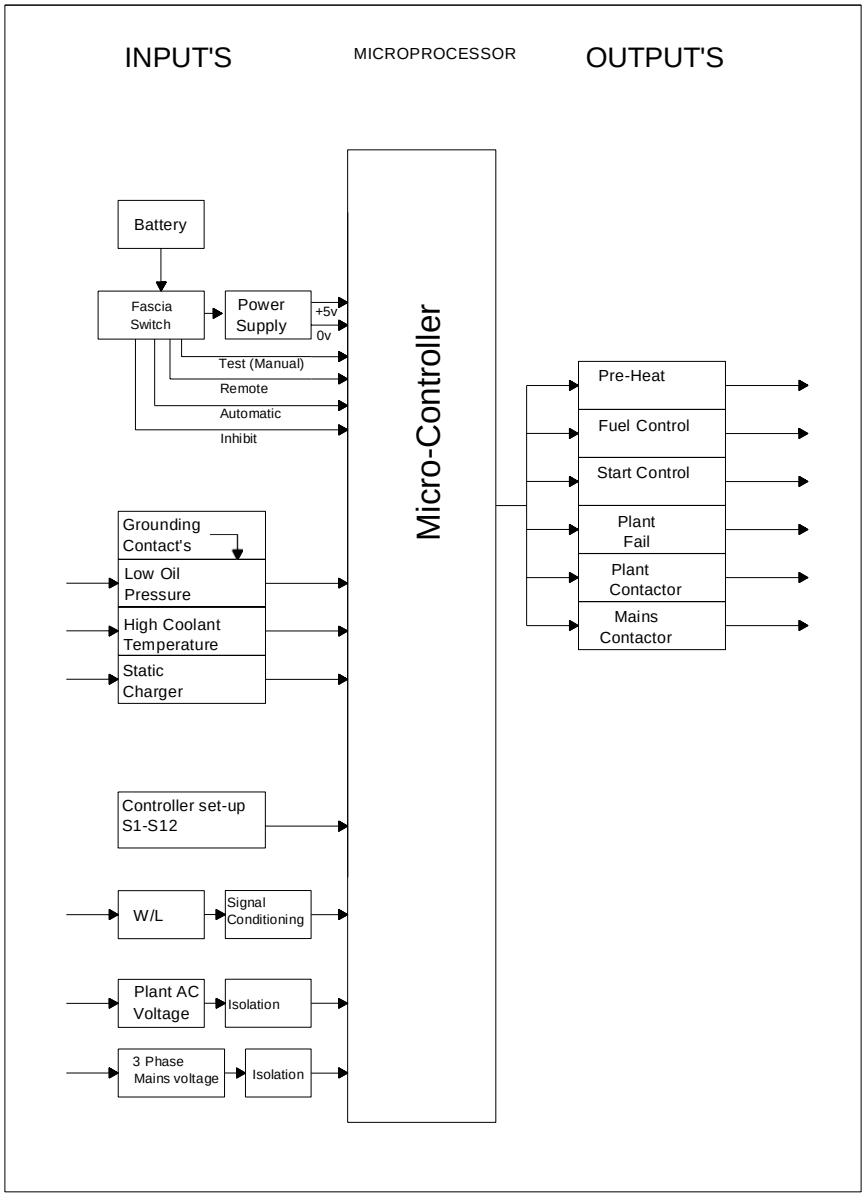

Figure 2 Block Diagram AMF

Terminal Connections

1.4 Connection Chart

Connections are made via either 6.3mm spade, or a 10 way 5.08mm pitch connector block.

Terminal Number	Connection	Connection type	Number of terminals	Input/output	Recommended cable Size
BATT+	Battery Positive	6.3mm spade	2	Input	2.5mm^2
SMS	Starter Motor	6.3mm spade	1	Output	2.5 mm^2
TEMP	High Coolant temperature	6.3mm spade	1	Input	1 mm^2
OIL	Low oil pressure	6.3mm spade	1	Input	1 mm^2
BATT-	Battery Negative	6.3mm spade	2	Input	2.5 mm^2
FCS	Fuel Control	6.3mm spade	1	Output	2.5 mm^2
WL	Charging alternator	6.3mm spade	1	Input	1 mm^2
PH	Pre-Heat Control	6.3mm spade	1	Output	2.5 mm^2
FAIL	Plant Fail	6.3mm spade	1	Output	2.5 mm^2
AUTO	Remote Signal	6.3mm spade	1	Output	2.5 mm^2
TEST	Remote Input	6.3mm spade	1	Input	2.5 mm^2
PN	Plant Neutral	10 way Block	1	Input	1 mm^2
PL1	Plant Live	10 way Block	1	Input	1 mm^2
PC	Plant Contactor	10 way Block	1	Output	1 mm^2
N	Mains Neutral	10 way Block	2	Input	1 mm^2
L1	Mains L1	10 way Block	1	Input	1 mm^2
L2	Mains L2	10 way Block	1	Input	1 mm^2
L3	Mains L3	10 way Block	1	Input	1 mm^2
MC	Mains Contactor	10 way Block	1	Output	1 mm^2

1.5 Input Terminal connections

1.5.1 Power Supply (DC voltage)

Important – There are no internal fuses within the module; therefore external fuses must be fitted to protect the module.

It is important to observe the correct DC voltage when connecting the module to the supply voltage. Permanent damage will be caused connecting a 12Vdc module to a 24Vdc supply.

Supply Current:- <= 150mA

Transient immunity:- Will withstand a voltage dip of <=5Vdc during cranking without the fuel or Pre-heat relay de-energising.

The AMF module is available as either 12 or 24Vdc. Connections are as follows.

Battery Negative Input - Terminal ID = BATT-
Battery Positive Input – Terminal ID = BATT +

1.5.2 Plant Input Voltage & Frequency (AC)

Important – There are no internal fuses within the module, therefore external fuses must be fitted to protect the module

Isolation is provided with in the controller for the ac input circuitry. This is achieved through the use of opto-couplers.

The plant ac input has a dual function; this input provides measured data for both plant ac voltage and frequency.

Plant Under Voltage Protection

Rise of voltage above 160Vac, for 230Vac line to neutral voltage (75Vac For 115Vac line to neural systems), is used to lockout the starter motor.

Under voltage:- This must exist continuously for 500ms for the module to trip. The under voltage trip levels are set as below.

230Vac operation under voltage = 160Vac
115Vac operation under voltage = 75Vac

The under voltage LED illuminates when the module fails due to under voltage, All relay driven outputs will be de-energised.

Maximum working voltage:- 257Vac line to neutral

Plant Over Frequency Protection

Plant frequency data is acquired from the plant ac input. An Overspeed condition must exist continuously for four seconds in order to trip the module to a failure state.

Plant Neutral Input - Terminal ID = PN
Plant Live Input - Terminal ID = PL1

1.5.3 Mains input Voltage (AC)

Important – There are no internal fuses within the module; therefore external fuses must be fitted to protect the module.

The AC circuitry within the module is isolated from the DC battery through an opto-coupler.

The controller continuously monitors the status of the three-phase mains supply and operates with a hysteresis loop as shown in Figure 3, and is described below.

With all 3 phases above the Mains healthy threshold; the mains available and mains on load LED's will illuminate. Any individual phase falling below the mains failed threshold will cause the mains available and mains on load LED's to switch off and the mains failed LED to illuminate. The mains available and mains on load LED's will illuminate when all 3 phases return to a voltage equal to or above the healthy threshold.

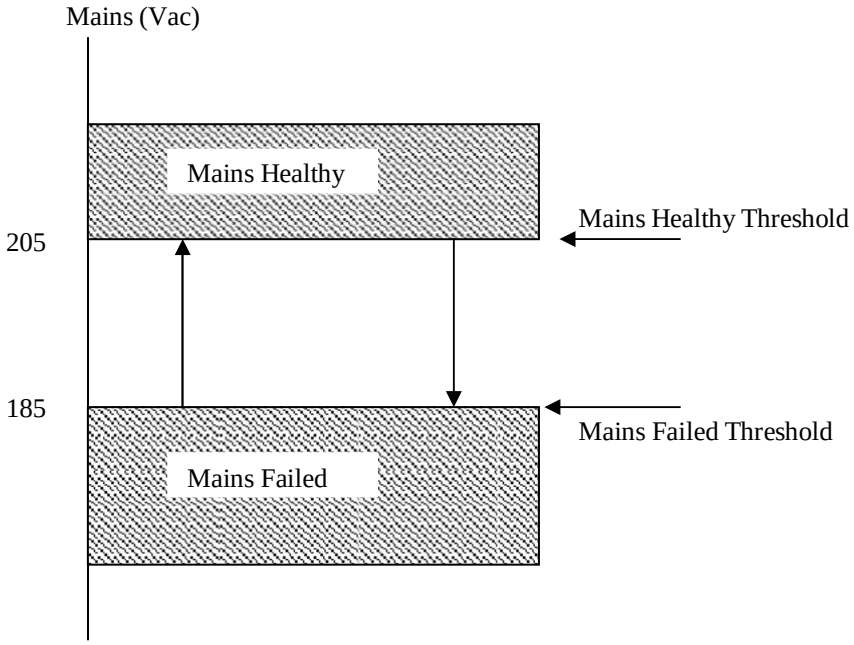

Figure 3 Hysteresis for Mains voltage thresholds.

1.5.4 Contact Switches

Three dedicated shutdown inputs are available, high coolant temperature, low oil pressure and static charger. These inputs are configurable as either Normally open (N/O) or Normally closed (N/C), through dipswitches at the rear of the controller. All contact inputs are designed to work with switches making to or breaking from battery negative on a failure.

Operation of the failure inputs is on a “first up” latched basis, giving a positive indication for the reason of plant shutdown and inhibiting further alarms from registering.

Low oil Pressure Shutdown (Terminal ID – OIL)

The low oil pressure shutdown is a dedicated input, it may be configured to work with a (N/O) or (N/C) contact. An error signal from the low oil pressure switch must be present for 1 second to trip the module. On tripping the low oil pressure LED illuminates, the relay driven outputs will be de-energised. This input is inhibited for 15 seconds after rise of the ac voltage to allow the oil pressure to build up. Selecting OFF clears the indicated fault condition. The plant fail relay will operate when this state is entered.

High Coolant Temperature Shutdown (Terminal ID – TEMP)

The high coolant temperature shutdown is a dedicated input, it may be configured to work with a (N/O) or (N/C) contact. An error signal from the high coolant temperature switch must be present for 3 seconds to trip the module. On tripping the high coolant LED illuminates, the relay driven outputs will be de-energised. This input is active from the ignition state. Selecting OFF clears the indicated fault condition. The plant fail relay will operate when this state is entered.

Static Charger Input (Terminal ID – CHGE)

The Static charger input is a user configurable input; it may be configured to either

- Indicates the failure of the Static charger due to the CHGE input, grounding to battery negative or
- Indicates the failure of the Static charger due to the CHGE input, being open circuit.

The above is configured through dipswitches at the rear of the module.

1.5.5 Charge fail W/L (Terminal - WL)

The charge fail LED will illuminate should this line go low, thus indicating a failure of the charging alternator system. The WL input is a user configurable input; it may be configured to either:

- Indicate the failure of the charging alternator or
- Indicate the failure of the charging alternator and stop the generator.

The above is configured through dipswitches at the rear of the module.

On tripping the charging fail LED illuminates; and the relay driven outputs will be de-energised. This input is inhibited for 15 seconds after rise of the ac voltage. Selecting OFF clears the indicated fault condition. The plant fail relay will operate when this state is entered.

The WL terminal should be connected directly to WL terminal of the alternator. This line provides the necessary excitation current to excite the alternator. Before start the WL potential will be at zero causing the charge fail LED to illuminate. After start the WL line will rise to the alternator charging potential, causing the charge fail indication to extinguish. The LED will illuminate again should the WL line go low.

1.6 Output Terminal Connections

All outputs are relay driven specifications as below.

It is recommended to use slave relays for outputs, in order to pro-long the life of the internal relays.

Fuel Control

The fuel control output is via the Fuel Control Relay (FCR) fitted within the module. When energised this relay will switch a battery positive signal to operate the fuel system on the engine.

Terminal I.D = FCS
Maximum switching = 16 Amps

Pre-Heat Control

The pre-heat control output is via the Pre-Heat Relay (PHR) fitted within the module. When energised this relay will switch a battery positive signal to operate the pre-heat system on the engine.

Terminal I.D = PH
Maximum switching = 16 Amps

Starter Motor Control

The starter motor control output is via the Starter Motor Control relay (SMS) fitted within the module. When energised this relay will switch a battery positive signal to operate the starter motor system on the engine.

Terminal I.D = SMS
Maximum switching = 16 Amps

Plant Contactor Control

Plant contactor control is via the Plant Contactor Relay (PCR) fitted within the module. This relay switches a feed from Plant line 1 to terminal 23, when energised. The output operates when the plant settle timer reaches zero. (Note the plant settle timer is set through S10)

Terminal I.D = PC
Maximum switching = 10 Amps

Mains Contactor Control

Mains contactor control is via the Mains Contactor Relay (MCR) fitted within the module. This relay switches a feed from Mains line 1 to terminal 28, when energised.

Terminal I.D = MC
Maximum switching = 10 Amps

Sequence of Operation

1.7 Inhibit Mode

1. Switching the rotary switch to the INHIBIT position enables the mains sensing circuits with in the module

2. The three phases of the local supply are monitored. If all phases are healthy the mains available and mains on load LED's will illuminate, the mains contactor control relay within the module will be energised.

3. Should any phase of the local mains supply fail the mains fail led will illuminate and the mains contactor control relay de-energise. The engine will be inhibited from starting

4. On return of all three phases of the mains supply to a healthy state, the mains contactor control relay will close.

1.8 Automatic

1. This position switches the module into AMF mode. (The load transfer circuits in the module are enabled). The unit may be left unattended in this mode and all operations are automatic. The 3 phases of the local supply are monitored.

2. If mains is healthy the mains contactor control relay within the module will be energised. Should one of the incoming mains phases fail the mains contactor control relay will de-energise. The ignition circuits of the module are enabled.

3. The Fuel relay energises, thus enabling the engine fuel system, also the automatic timed pre-heat is activated. The pre-heat time will be dependent upon the setting of S9. An excitation current is provided to the battery-charging alternator via the WL line.

4. After the pre-heat timer reaches zero, the start control circuit is enabled, thus enabling the start system on the engine. Should the engine fail to start, three more cycles of pre-heating and starting will be attempted.

5. If the engine fails to start on the fourth attempt, the start fail LED will illuminate.

6. As the generator starts, the engine oil pressure builds up to its normal operating pressure, causing a change in state of the oil pressure switch. The alternator produces ac voltage, and the battery charging alternator produces an output. (Which switches out the charge fail led.) Either of these two actions will cause the starter motor to be locked out to prevent engine / starter motor damage due to over cranking / accidental use.

7. The generator is now running in a healthy condition. The plant settle timer will activate (Controlled with switch S10), and start counting down, on reaching zero, the plant contactor control relay will energise.

8. Should a shutdown error occur the fuel relay is de-energised, thus stopping the engine, the appropriate fail LED is illuminated. The plant contactor relay will open and the plant fail relay will close.

9. On return of all three phases of the mains supply to a healthy state, the mains available LED will illuminate and the mains restoration timer will be initialised; on reaching zero the plant contactor control relay will open followed by the mains contactor control relay closing, thus transferring load from the generator to mains supply.

10. The generator will carry on running in a cool down period, as set through switch S12. Should the mains fail during this period load will be transferred back to the generator.

11. Switching the rotary switch to the OFF position removes the power to the fuel relay, thus disabling the fuel control system. All alarm indications will be reset.

1.9 Test /Remote Mode

1. Switching the rotary switch to the TEST/REMOTE[1] position enables the Fuel relay, thus enabling the engine fuel system, also the automatic timed pre-heat is activated. An excitation current is provided to the battery-charging alternator via the WL line. The pre-heat time will be dependent upon the setting of S9

2. After the pre-heat timer reaches zero, the start control circuit is enabled, thus enabling the start system on the engine. Should the engine fail to start, three more cycles of pre-heating and starting will be attempted.

3. If the engine fails to start on the fourth attempt, the start fail LED will be illuminated.

4. As the generator starts the engine oil pressure builds up to its normal operating pressure, causing a change in state of the oil pressure switch. The alternator produces ac voltage, and the battery charging alternator produces an output, which switches out the charge fail led. Either of these 2 actions will cause the starter motor to be locked out to prevent engine/starter motor damage due to over cranking/ accidental use.

5. The generator is now running in a healthy condition.

6. With mains available at this time the mains contactor will remain energised (there will be no load transfer). Mains failing whilst the generator is running in this mode, will cause load to be transferred to the generator. The generator may be stopped by switching to the OFF position

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[1] Note, for the controller to operate in Remote:

- The external remote switch must be connected and closed between terminals AUTO and TEST.
- Remote mode to be selected from the fascia switch.

Typical Installation

Figure 4 shows an example of a typical installation.

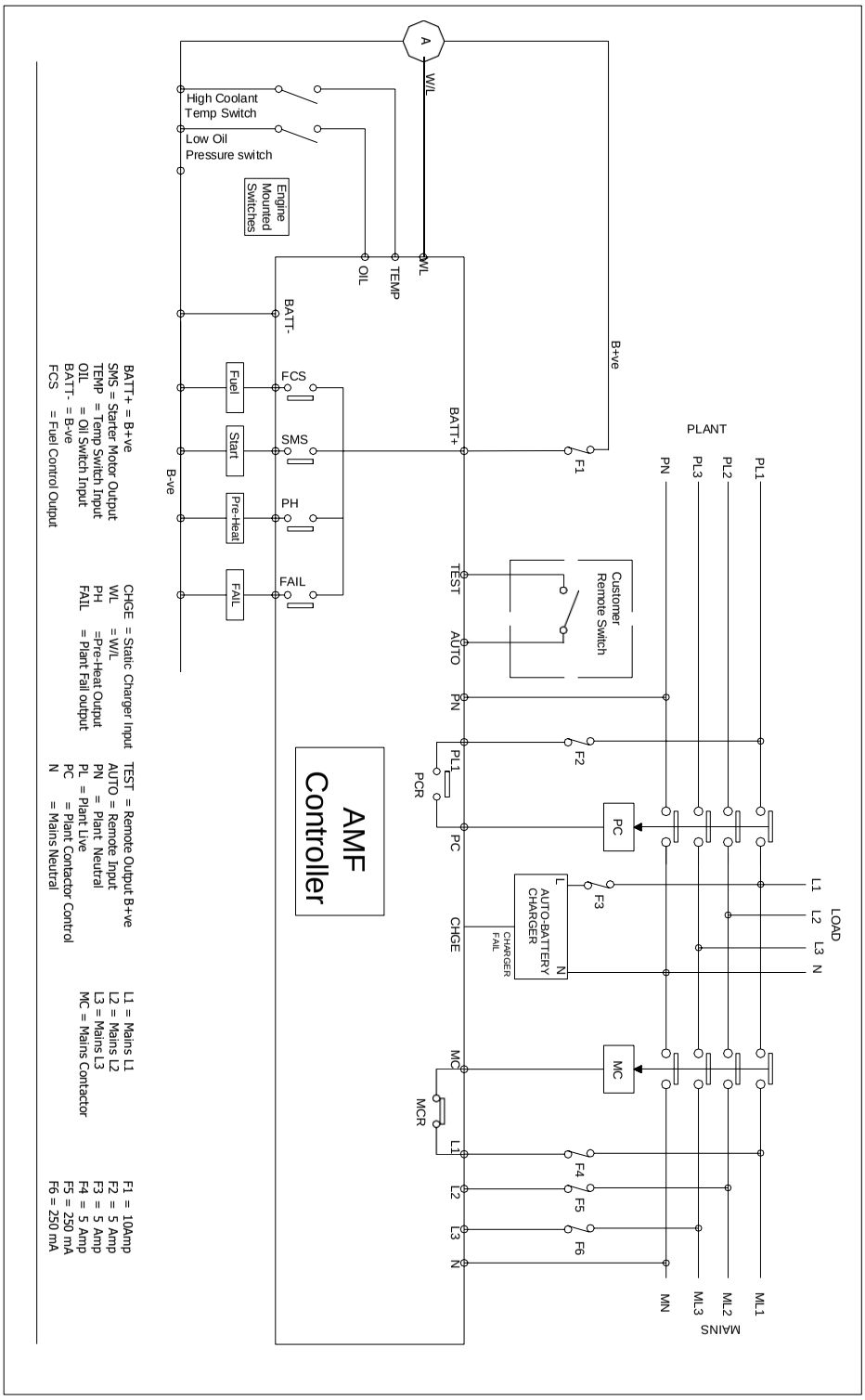

Figure 4 Typical AMF Installation

Maintenance

1.10 Maintenance

The controller contains no user serviceable parts. Maintenance is limited to preventive actions only.

- Excess dust should not be allowed to build up around the controller.
- Terminals to be periodically checked to ensure there is no corrosion build up and all terminal screws are tight.

Fault Diagnosis

The following is intended as a guide to aid in identifying possible defective operation and solving installation problems.

Fault	Cause	Action
No LED indication	No DC voltage power to module.	Check battery is connected & in serviceable condition Check correct module type 12Vdc\24Vdc Check DC fuse & battery voltage Measure voltage across terminals BATT- & BATT+ of module. (should = battery voltage)
Engine cranks, but does not start	No fuel	Check fuel level, fill as required
	Fuel solenoid not operating	Check voltage across fuel solenoid & fuel solenoid slave relay terminals,(both engine mounted). (Should = battery voltage) Measure voltage across terminals BATT- & FCS of module. (should = battery voltage) Above to be carried out in the TEST position
Engine does not crank	No start signal to starter motor	Check voltage across starter motor and starter motor slave relay (should = battery voltage) Measure voltage across terminals BATT- & SMS of module (should = battery voltage) above to be carried out with module in start mode. Check terminal WL is connected, and at battery negative potential
Charge warning light continuously lit	No output from charging alternator (dc)	Check drive belts Measure battery volts, when stationary and running, volts, should be higher when running Check W/L wire connected.
Generator shuts down on charge fail	Charge alternator fail	Check switch S5 Check drive belts
Generator shuts down showing low oil pressure.	Low engine oil pressure	Check oil level, fill as required
	Wrong operating mode of Oil Pressure Switch (OPS)	Check OPS configuration corresponds to dipswitch S2. I.e. N/O or N/C
	Faulty OPS switch	Replace switch
Generator shuts- down showing high Coolant temperature	High engine Coolant temperature.	Check radiator coolant level, fill as required
	Wrong operating mode of Coolant Temperature Switch (CTS)	Check CTS configuration corresponds to dipswitch S3. I.e. N/O or N/C
	Faulty CTS switch	Replace switch
Generator shuts down showing Over Frequency.	Generator Frequency above allowable threshold	Check setting of dipswitch S8
Generator shuts down showing Alternator fail	Alternator Ac voltage dropped below allowable threshold (165Vac for Nominal 230Vac & 75Vac for nominal 115Vac)	Check AVR output Check fuse for line 1 (250m Amp)
Mains Returns, but does not indicate available	Any 1 Phase below threshold value	Check 3 phase supply neutral to live, should = 205Vac or higher on all three phases
Charge fail indication when mains on load	Automatic battery Charger failure	Check Dipswitch S4 Check fuse of the battery charger