CAF301

your all in one

AMF Controller

Last updated
2015-05-12

1 General

1.1 Application

This set of operating instruction is valid for the CAF301 (Automatic Mains Failure) controller only.
Non-compliance with the operating instructions – in particular with the safety instructions – as well as non-manufacturer modification or use of non original spare parts will result in loss of warranty coverage. The manufacturer accepts no liability for damage or injury resulting from incorrect use, installation or malfunction.
Instructions can change without notice.

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1.2 Queries and ordering

For queries and orders please contact the manufacturer during office hours 6:00 to 15:00 GMT (8:00 to 17:00 South African time GMT + 2)

1.3 Technical data

Input Voltage	12V to 32V
Minimum Current	1mA
Maximum Current	2A
Size	160mm x 100mm x 20mm
Weight	0.13Kg

1.4 Areas of Application

This product is used to convert any Genset independent of its size, make, model, Petrol or Diesel, that can be electrically started and electrically shutdown into a fully automatic standby Genset. It can also be used to replace manufacturer proprietary AMF controllers. This module is suitable for use on 110V to 380V gensets.

 WARNING!
This controller can NOT be used with contactors that mechanically lock the contacts in position after switching occurred. It can ONLY be used with contactors requiring constant power to remain in a switched position.

1.5 Features

Most of the functionality is onboard selectable allowing customizing the module according to site requirements.

1.5.1 Selectable features

- Single or 3 Phase.
- Un-interrupted/No Break switch back when power is restored
- Generator frequency warning
- Keep engine warm while on standby
- Standby charging failure warning and Charger on/off control
- Engine charging failure warning
- Use glow plugs/pre heat during startup
- Over heat protection
- Low fuel level warning and shutdown.

1.5.2 Fixed features

- Low oil pressure protection
- Over/Under start voltage protection
- Phase rotation/sequence and phase failure protection on Utility and Genset power (3 Phase)

1.5.3 Operational modes

- Manual (Base load)
- Automatic
- Calibrate

2 Safety

These instructions for use and installation contains general information, which should be noted and adhere too when setting up and using this equipment. These instructions must therefore be read and understood by all personnel involved in setting up and using this equipment. Furthermore these instructions should always be available for consultation at the site where equipment is used. Special care should be taken to avoid electrical shock while performing installation, maintenance or operation of equipment.

 WARNING!

A clearly visible warning sign must be affixed to the Genset warning any bystanders that the machine can start without warning.

2.1 Marking of information in the instructions for use

Safety instructions which must be followed if danger to personnel or damage to equipment is to be avoided are marked with a general danger symbol:

 WARNING!

Information labels which are mounted directly on equipment, e.g.:

Arrows indicating direction of turning

Markings indicating moving parts must be maintained in readable condition on equipment.

2.2 Personnel qualification and training

Personnel operating, maintaining, inspecting or fitting the equipment must be qualified for the duty they are performing. The owner of the equipment is responsible for ensuring the supervision of qualified personnel. If the personnel are not qualified in the use of the equipment, then it is the responsibility of the owner to ensure that they are trained in its use. If necessary, the owner may request assistance with training from the manufacturer of the equipment.

2.3 Dangers if the safety instructions are ignored

Ignoring of safety instructions can be dangerous to personnel and to the environment as well as causing possible damage to the equipment. Non-compliance with safety instructions will lead to loss of all damage claim rights.

Non-compliance with safety instructions can lead to:

- Loss of important or all functions of the equipment
- Danger of injury from electrical, mechanical or chemical sources.
- Environmental damage resulting from leaks of environmentally dangerous substances.

2.4 Safe operation

These safety instructions, as well as all national safety requirements and extra internal company precautions or such laid down by the owner of the equipment must be observed.

2.5 Safety for the owner / operator

- Any parts of the machine which could be a possible source of hot or cold burns should be covered.
- Guards covering moving parts should not be removed while machine is in use.
- Leakage of dangerous or flammable substances have to be handled in such a way that no danger to persons or the environment may occur. Legal requirements must be observed.
- Danger resulting from electrical current must be prevented.

2.6 Non-manufacturer modifications and spare part production

Modifications or changes to the product are only allowed after consulting the manufacturer. Original spare parts and accessories authorized by the manufacturer should be used to ensure safe and reliable operation.

2.7 Unauthorized usage

The safety of the product is only guaranteed when used for the purpose specified in section 1 – General of the instructions. The listed maximum specifications should under no circumstances be exceeded.

3 Operational instructions

3.1 Version

To display the current version of the software, remove all power to the module, press and hold the start button and reinstate power to the module. The version will be displayed via the LEDs. Once the LEDs begin to flash the start button can be released.

3.2 Manual (Base Load)

3.2.1 Behavior

If the Genset is wired to the Utility Power lines and there is no power failure the load will be connected to the utility power supply.

If no power failure exists and the standby charging is enabled the battery voltage will be monitored and warnings issued if it is overcharging or charging is insufficient. If the charger control is used it will switch ON the standby charger if the battery voltage is too low and switch it OFF if it is fully charged.

If the standby heater is enabled it will control the heating device by switching it ON if the engine temperature falls below the set value and switch it OFF if the set value is reached. This will only function as intended if a heat sender is used to detect temperature changes. A thermal switch will cause undesired results.

In case of 3 Phase the utility power lines are constantly monitored for phase rotational correctness and phase failure, any such failing condition will be treated as a power failure.
Incase of a power failure the load will be disconnected from the utility power lines and an appropriate error code will be displayed.

If the Genset has started and no failure condition exists the load will be removed from the Utility Power supply and connected to the Genset's generator supply. This behavior is quite useful where the supply is single phase and the generator is 3 phase, thus the generator can be used to drive any 3 phase equipment whenever the need arises with out having to simulate a power failure.
If there is no power failure or power is restored while the machine is in operation the alarm will be sounded for a short burst and a code indicating the power is restored will be displayed.
The Genset lines are constantly monitored for phase rotational correctness and phase failure, any such failing condition will result in the Genset being disconnected and shutdown and the error condition being displayed

With the engine alternator charging system warning enabled a warning will be issued if it is overcharging or not charging sufficiently. If the frequency checking is enabled a warning will be issued if it is not maintained within the set thresholds.

Most warning messages will be preceded by the alarm being sounded before the error/warning code is displayed via the LEDs.

3.2.2 Start procedure

If so desired the operator can engage the glow plugs by pressing the Glow Plug button.
Press the Start/Stop button holding it down the Ignition relay will engage immediately, after ±3 seconds the Starter relay will engage.
If the Start/Stop button is released before the Start relay is engaged or the engine had time to activate the oil pressure switch the start procedure will be aborted.
Release the Stop/Start and Glow plug buttons once the engine has started.
The engine will shut down after ±10 seconds if any failing condition is detected and the relevant error condition will be displayed via the LEDs
The load will be connected to the Genset's generator supply if no error is detected.

3.2.3 Stop procedure

The engine must be running.
Press the Start/Stop button and hold it down until the engine shuts down.
Release the Start/Stop button.
During shutdown the load will be disconnected from the Genset supply. The load will be connected to the Utility Power supply if no power failure exists.

3.3 Automatic

 WARNING! Be aware that the machine can start without warning.

3.3.1 Behavior

In this mode startup and shutdown of the Genset occurs automatically.
In case of 3 Phase the utility power lines are constantly monitored for phase rotational correctness and phase failure, any such failing condition will be treated as a power failure.
If a power failure is detected the module will attempt to start the engine. If it is unable to accomplish a successful start after 5 attempts the relevant error condition will be displayed and no further attempts will be made until the condition is cleared via a module reset or manual startup by an operator. If a successful start is made and no failure condition exists the load will be transferred to the Genset's supply. If the Utility Power is restored the load will be transferred back to the Utility Power supply and the Genset will shutdown.
The Genset lines are constantly monitored for phase rotational correctness and phase failure, any such failing condition will result in the Genset being disconnected and shutdown and the error condition being displayed

At any stage while in standby and no power failure exist the operator can do an engine Test run as part of the scheduled maintenance procedure.
A Test run is when the engine is started and allowed to run freely until the operator shuts it down by pressing the Start/Stop button again.
If a power failure should occur during a Test run the load will be transferred to the Genset's supply and continue servicing the load until power is restored or a failing condition occurs in which case it will automatically shutdown. In this situation the operator can no longer terminate the test run by pressing the Start/Stop button.
In the case of power being restored the load will be transferred to the Utility Power supply before the shutdown is executed.

How the load is transferred back to the Utility Power supply is governed by the Un-interrupted switch back selection.
If interrupted switch back is selected the load will be disconnected from the Genset's supply before the load is connected to the Utility Power supply.
If un-interrupted switch back is selected the module will try and accomplish synchronization between the Genset and Utility Power supplies. If synchronized an un-interrupted switch back will be made.
If no synchronization could be established an interrupted switch back will be made.

The Test run startup and shutdown procedure is the same as for Manual operation.

If no power failure exists and the standby charging is enabled the battery voltage will be monitored and warnings issued if it is overcharging or charging is insufficient. If the charger control is used it will switch ON the standby charger if the battery voltage is too low and switch it OFF if it is fully charged.

If the standby heater is enabled it will control the heating device by switching it ON if the engine temperature falls below the set value and switch it OFF if the set value is reached. This will only function as intended if a heat sender is used to detect temperature changes. A thermal switch will cause undesired results.

If the genset is in operation and the Engine charging system is enabled the battery voltage will be monitored and warnings issued if it is overcharging or charging is insufficient. If the frequency checking is enabled a warning will be issued if it is not maintained within the set thresholds.

Any warning messages will be preceded by the alarm being sounded before the error/warning code is displayed via the LEDs.


WARNING!
A clearly visible warning sign must be affixed to the Genset warning any bystanders that the machine can start without warning.

4 Explanation of selectable features

4.1 Single or 3 Phase

This module is equipped to handle Single or 3 Phase Gensets. The proper selection must be made according to installation requirements by means of switch J1.
For a 3 Phase selection, phase rotation checking is done by default on the Utility Power and Genset supplies.

4.2 Un-interrupted/No Break switch back

 WARNING!

Only to be used on single to single phase or 3 Phase to 3 Phase installations. Failing to adhere to this warning will result in irreparable damage to switching gear and or Genset and or Utility Power equipment. The manufacturer can and will not be held liable for damages or injuries incurred due to incorrect use of this feature. When in doubt don't use it.

This will allow for an un-interrupted switch back to the Utility Power supply when power is restored. This will ONLY happen if the module was able to accomplish synchronization between the Utility Power and Genset supplies. If no synchronization could be established in the set time an interrupted switch back will be made. See SW2-1

 WARNING!
This feature can not be used with switchgear that is mechanically interlocked to prevent simultaneous engagement.

4.3 Generator frequency warning

This will monitor the Genset generator output frequency and if it reaches a 5 Hz deviation from the norm it will sound the alarm and display the condition via the LEDs. This feature can serve as a warning that the Genset is unable to cope with the current workload forcing it to fall below the rated frequency. See SW2-2

4.4 Keep engine warm

This feature can only be used if the engine is fitted with a heating device and a heat sender is installed. This will keep the engine at an adjusted temperature as set by the installer to allow fast startup in all conditions. This feature uses the same heat sender for the overheating protection feature. If over heat protection is accomplished by means of a thermal switch you are advised **NOT** to enable this feature. See SW2-3

4.5 Standby charging failure warning & Charger On/Off Control

If the Genset is fitted with an accompanying standby charging system to charge the batteries while not in operation it is advisable to enable this feature. If the charging system should fail either by over charging or charging insufficiently it will sound the alarm and display the condition via the LEDs. The module operates from the genset's battery, thus to prevent battery rundown a charging system of some sort needs to be installed. The switch charger On/Off facility will enable you to make use of a low end charger and eliminate the need of special regulating and overload circuitry since the module will regulate the battery state. It will switch off the charger if the engine is about to be started preventing damage to the charger. See SW2-4

4.6 Engine charging failure warning

If the engine is fitted with a charging system (Alternator/Generator) to charge the batteries during engine operation it is advisable to enable this feature. If the charging system should fail either by over charging or not charging at all it will sound the alarm and display the condition via the LEDs.

If the Standby Charging System is ENABLED and this feature is DISABLED the module will use the standby charger to charge the batteries during engine operation. This configuration can be used if the engine is not fitted with a charging system or to supplement a failed engine charging system. It is not advised to use this configuration with a functional engine charging system for the module will NOT be able to detect if it should fail. See SW3-1

4.7 Use glow plugs/pre heat during startup

If enabled the startup procedure in automatic mode will allow for the heating of the glow plugs before engaging the starter motor. Mostly to be used on diesel engines not fitted with a standby heating system. The drawback of using this feature is that it will delay the startup of the Genset with an additional ± 20 seconds for every start attempt made. See SW3-2

4.8 Over heat protection

You are advised to enable this selection when ever possible. This will allow the shutting down of the engine if the set over heat temperature is reached. This condition can be cleared by a manual startup. Over heat protection can be accomplished by means of a thermal switch or a heat sender. When using a thermal switch you are advised **NOT** to enable the keep engine warm feature. See SW3-3

4.9 Low fuel level warning & shutdown

When the fuel level reaches a critical low level it will shutdown the engine and report the condition. It is better to shutdown the engine than to go through the effort of priming the fuel system. This condition can be cleared by a manual startup.

Tank Unit:
A warning will be sounded and displayed via the LEDs when the set warning level is reached. Ignoring this warning will result in the inevitable.
See SW3-4

It is possible to adjust the levels in such a fashion that the engine will shut down without giving a warning or allow the engine to shutdown due to fuel starvation. See calibration instructions.

Float Level Switch:
When using a float level switch to signal a low fuel level you lose the ability to issue a low fuel warning.

5 Explanation of Fixed features

5.1 Low oil pressure protection

The automatic startup routine relies on the oil pressure switch to determine if the engine has started or not. If during operation the oil pressure should fall below the operational pressure of the fitted switch it will shutdown the engine. This error can be cleared by a reset or manual startup. The oil pressure switch can be substituted by a relay on the generator output lines, but is only advised for Genset's not fitted with oil pressure pumps. See diagram Single To Single Phase – No Oil Pressure. Engines that require a lot of cranking might buildup sufficient oil pressure before the engine actually started and might terminate the startup sequence prematurely. A relay can be coupled in parallel with the oil pressure switch to also detect if the generator is producing output, to allow for the maximum cranking time allowed. See diagram Single To Single Phase – No Oil Pressure on how to connect the relay

 WARNING!
For this configuration the relay must always be able to detect generator output to prevent damage to the starter motor.

 WARNING!
Some air cooled engines are fitted with a belt break trip switch. The manufacturer strongly encourages that it be hooked up with the low oil pressure protection circuit for the sole reason it can not be disabled and the load being disconnected from the generator before the engine is shut down. Or it must be wired in such a fashion that it will force the engine to shut down if a belt break should occur, with this method the load will remain connected to the generator till near stand still.

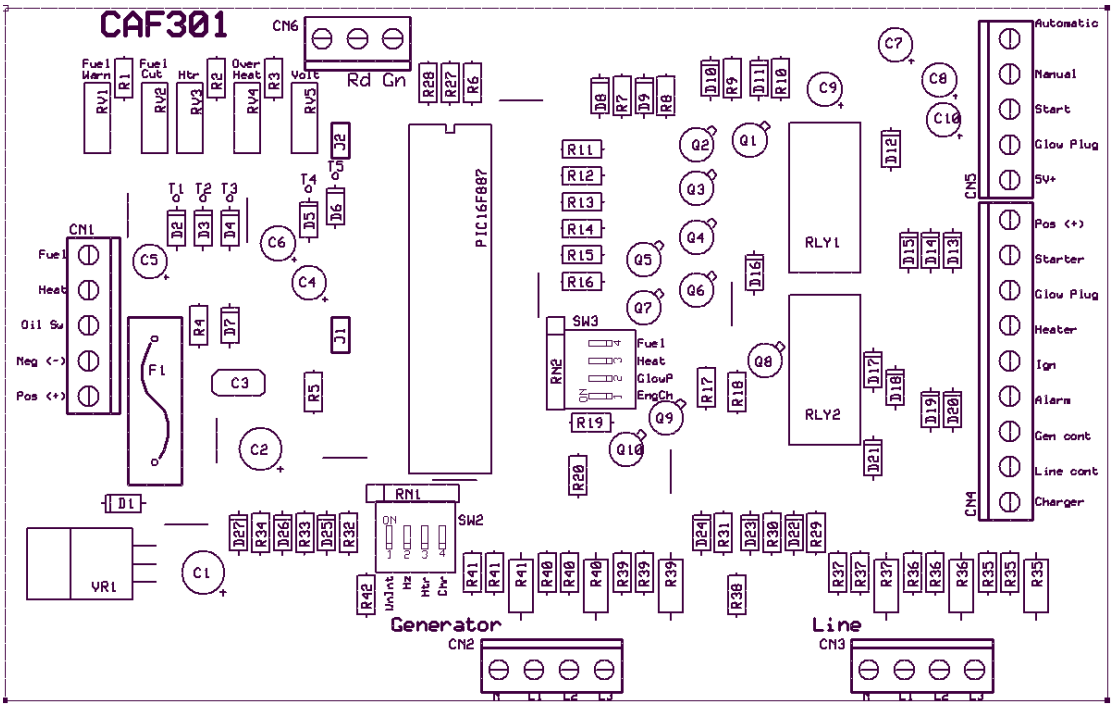
5.2 Over/Under start voltage protection

If the battery voltage falls below an acceptable start voltage the start procedure will be aborted and the error displayed via the LEDs the same goes for over voltage. This is done to prevent damage to the starter motor as a result of incorrect starting voltage applied.

5.3 Phase rotation/sequence protection

For 3 Phase installations a clock wise phase rotational sequence must be observed. Phase rotation and phase checks are performed **constantly** on Utility Power and Genset power to ensure the correct rotational sequence exists and early detects if any phase should fail / fall away. To prevent damage to electrical equipment and switch gear the load will be disconnected from the faulty supply and the condition reported. In the case of the Genset being at fault the engine will be shutdown.

6 Board Layout



6.1 CN1

This connector hosts the connections to the engine's senders and DC power supply to the module.

- (Fuel) Fuel level sender – This pin needs to be connected to the fuel level sender or float level switch (Make contact when empty) situated in the fuel reservoir.
- (Heat) Heat sender – This pin needs to be connected to the heat sender or thermal switch (Normal Open) of the engine. In water cooled models it is normally situated near the outlet to the radiator. Air cooled models are mostly situated near the combustion chambers.
- (Oil Sw) Oil switch – This pin needs to be connected to a pressure switch sensing the oil pressure of the engine. It must be of a normal closed configuration.
- (Neg) Battery Negative – This pin must be connected to the battery's negative pole.
- (Pos) Battery Positive – This pin must be connected to the battery's positive pole, preferably via an Emergency stop switch.

6.2 CN2 (Generator line connections)

6.2.1 Single Phase:

N Neutral wire of the generator output
L1 Live wire of the generator output
L2 Not connected
L3 Not connected

6.2.2 3 Phase

N Neutral wire of the generator output. Can be left not connected for it has no effect on the operation of the module.
L1 First phase of the generator output
L2 Second phase of the generator output
L3 Third phase of the generator output

6.3 CN3 (Utility Power line connections)

6.3.1 Single Phase

N Neutral wire of utility power
L1 Live wire of the utility power
L2 Not connected
L3 Not connected

6.3.2 3 Phase

N Neutral wire of the utility power. Can be left not connected for it has no effect on the operation of the module.
L1 First phase of utility power
L2 Second phase of utility power
L3 Third phase of utility power

6.4 CN4 (To Relays)

Relays used must match the voltage rating of the Genset e.g. 6V, 12V or 24V. The relay coils must not consume more than 250mA.

- (+) Positive – This pin supplies positive power to the relays. This is the same pin as the positive pin on CN1.
- (ST) Starter – Operates the relay that will engage the starter solenoid.
- (GP) Glow Plug – Operates the relay that will engage the glow plugs.
- (Htr) Heater – Operates the engine standby heater relay.
- (Ign) Ignition – Operates the Ignition relay.
- (BZ) Alarm – Operates the Alarm/Hooter/Siren relay.
- (GC) Generator Contactor – Operates the relay that will engage the contactor/magnetic switch connected to the generator's power lines.
- (LC) Line Contactor – Operates the relay that will engage the contactor/magnetic switch connected to the utility power lines.
- (CHR) Charger – Operates the relay that will control power to the standby charger.


WARNING! Some contactors induce RFI (Radio Frequency Interference) signals when disengaged causing the CPU to reset. This phenomenon can be addressed by connecting a MOV (Metal Oxide Varistor) or a Transorb of sufficient voltage across the contactor coil.

6.5 CN5 (Control panel switches)

- (AUTO) Automatic – Connected to the switch that will indicate that automatic mode is selected.
- (MAN) Manual – Connected to the switch that will indicate that manual mode is selected. (Base load)
- (ST) Start – Connected to the Start/Stop button.
- (GP) Glow Plug – Connected to the Glow plug button. Can be omitted if plant is not equipped with glow plugs.
- (5V+) Positive – Use this pin to supply power to any of the installed switches to be connected to this connector.


WARNING! Do not make use of any other power source to power the switches or use this supply to power any other requirements.

6.5 CN6 (To LED's)

Connector where the LED's are to be connected to enable the display of error codes and calibration modes.

7 Switch settings

7.1 J1 (Single/3 Phase select)

With the jumper installed/connected the module will operate in Single Phase mode. If the jumper is removed the module will operate in 3 Phase mode.

7.2 J2 (Fuel sender select)

This setting is only of value if low fuel shutdown is enabled/to be used.
If a tank unit is to be used in sensing the fuel level the jumper must be installed.
If a float level switch is to be used to indicate a low fuel level the connection must be left open

7.3 SW1

Emergency Stop (Not fitted on the module).
An on/off witch to allow for immediate removal of all power to the controller forcing a shutdown in case of an emergency.
See the diagrams for wiring details.

7.4 SW2

1. Un-interrupted/No Break switch back to Utility Power.

   
   WARNING! Only to be used with Single to Single Phase or 3 Phase to 3Phase installations. If used incorrectly damage to equipment is unavoidable and injuries might be incurred.
2. Generator Frequency. A warning alarm will be sounded if frequency falls below/above thresholds.
3. Standby Heater. If the engine is equipped with heater elements it will keep the engine temperature with in a preset range.
4. Standby Charging. Will monitor the standby charging system and sound the alarm if the charging level falls below/above thresholds. The charger on/off is also controlled via this setting. If the battery voltage falls below/above thresholds the charger will be switched on/off

7.5 SW3

1. Engine charging. Will monitor the engine's alternator charging system and sound the alarm it the charging level falls below/above thresholds.
2. Use Glow plugs during startup. Will heat up the glow plugs before the engine is started. Generally used in Genset models not equipped with standby heaters.
3. Engine Over heat: Will monitor the engine operating temperature and shutdown the engine if the configured level is reached.
4. Monitor Fuel level. Will monitor the Fuel level and sound the alarm if the warning level is reached and shutdown the engine if the preset shutdown level is reached.

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8 Installation Procedures

 WARNING! Installation must be done by a qualified and authorized technician.

No procedures can be provided merely guidelines to follow due to the diversity of Gensets and installation sites.

8.1 Pre requisites

1. The Genset power output must be adequately rated to carry the intended load.
2. Magnetic switches (Contactors) must be correctly rated for the expected voltage and current rating.
3. Adequate tools to complete the installation.
4. The technician must be able to read and interpret schematic diagrams correctly.

8.2 Procedure

Select an installation diagram closely resembling your planed installation.
Features not applicable to your installation can be omitted.

1. Remove power on power lines to be worked on.
2. Disconnect the battery power from the Genset to prevent accidental startup.
3. Remove any hazardous material in / on and around the work area.
4. Do not commence work if any environmental hazard exists.
5. Mount the module board in a water proof enclosure as close as possible to the Genset and switching gear.
6. Mount the adequate number of relays, as required for your installation.
7. Fit the Start/Stop, Glow plug, Emergency Stop and Mode switches on a suitable accessible panel.
8. Wire the switches to the module as indicated on selected diagram
9. Wire the relay's to the module as indicated on selected diagram
10. Wire the remaining pins of the relays according to the selected diagram.
11. Wire the oil pressure switch, heat sender, fuel level sender and power feeds to the module.
12. Ensure Mode select is set to OFF.
13. Reconnect Genset's battery.
14. Execute the calibration procedure on enabled features.
15. Perform a manual start up. Check for any errors, and correct if required.
16. Restore Power.

9 Calibration

All voltage measurements are made with the negative test probe connected to the negative pin on connector CN1. The positive probe must be connected to the test point as indicated in the table below.

1. Select Calibration mode by switching the mode selector to OFF. (The Manual and Automatic connections are not energized)
2. Press and hold down the Start/Stop button until the calibrate mode is displayed via the LEDs.
3. After the calibrate mode display the feature to be calibrated will be displayed 3 times.
4. The various calibrate codes are listed in the table below.
5. For the specific feature to calibrate turn the POT left or right until the Green LED lights up brightly. If the Green LED is on it confirms that the desired set value is correct.
6. If you press the Start/Stop button again it will proceed to the next value to calibrate. Once the last value is reached and the Start/Stop button is pressed again it will wrap and enter calibration for the first item.
7. You can exit calibration mode by selecting Automatic or Manual mode.
8. To successfully calibrate the voltage you will need an adjustable power supply to reach the required voltage.
9. Alternatively the voltage can be calibrated by making use of the voltage table and a digital multi tester (for better accuracy). Adjust the voltage on T5 to the corresponding value for the input voltage applied.

Hints:
Standby heater: Allow the standby heater to heat the engine to the desired temperature and calibrate accordingly.

Over heat: Disable over heat protection. Allow the engine to operate under full load until engine reaches operating temperature. Adjust RV4 till the voltage reading at T4 reads 0.2V or above. Re-enable over heat protection. Slowly adjust RV4 so that the voltage reading goes down until the engine shutdown due to overheat. Take the voltage reading and add 0.05V to it this will be your new reference voltage. Adjust RV4 till the voltage reading reflects your new reference voltage. This will allow for a ± 5°C temperature increase depending on the temperature sender used. Restart the engine. If the engine still shuts down adjust RV4 to read a higher voltage at T4 until the engine no longer shutdown. It is a good idea to verify the shut down temperature by allowing the engine to heat up sufficiently, take corrective action if needed.

Fuel level (Tank Unit): Calibrating the fuel level is easier when starting of with an empty reservoir. Fill it to the level you want the engine to be shutdown, calibrate the shutdown level.
Now fill it to the level you want the fuel low warning to be issued, calibrate the warning level.

Calibrate	Input Criteria	Selection Display		Adjust	Voltage at test point
		Red	Green		
Charging Voltage	12V models: 12.6V on main supply pins 24V models: 25.2V on main supply pins	1	1	RV5	T5 3.94V (@12.6V/25.2V) Preset during manufacturing.
Standby Heater	Engine must be at maximum preheat temperature.	1	2	RV3	T3 0.1V
Over Heat	**Heat Sender** Engine must be at shutdown temperature. **Thermal switch** See notes	1	3	RV4	T4 0.1V
Fuel shutdown level	**Tank Unit** Adjust tank unit to the level it must shut the engine down **Float Level Switch** Switch must be in an open condition	1	4	RV2	T2 0.2V T2 4.0V
Fuel Warning level	**Tank Unit** Adjust tank unit to the level it must issue a warning. **Float Level Switch** Feature not available	1	5	RV1	T1 0.2V

Notes:
If a **Thermal switch** is used to signal an overheat condition, it can not be calibrated. The following procedure must be exercised.

1. Adjust RV4 until the value at T4 reaches a value of approximately 1V.

10 Voltage Table

12V Models	24V Models	Voltage at test pin T5
12.0V	24.0V	3.75V
	24.1V	3.76V
12.1V	24.2V	3.78V
	24.3V	3.80V
12.2V	24.4V	3.81V
	24.5V	3.83V
12.3V	24.6V	3.84V
	24.7V	3.86V
12.4V	24.8V	3.87V
	24.9V	3.89V
12.5V	25.0V	3.90V
	25.1V	3.92V
12.6V	25.2V	3.94V
	25.3V	3.95V
12.7V	25.4V	3.97V
	25.5V	3.98V
12.8V	25.6V	4.00V
	25.7V	4.01V
12.9V	25.8V	4.03V
	25.9V	40.5V
13.0V	26.0V	4.06V
	26.1V	4.08V
13.1V	26.2V	4.09V
	26.3V	4.11V
13.2V	26.4V	4.12V
	26.5V	4.14V
13.3V	26.6V	4.16V
	26.7V	4.17V
13.4V	26.8V	4.19V
	26.9V	4.20V
13.5V	27.0V	4.22V
	27.1V	4.23V
13.6V	27.2V	4.25V
	27.3V	4.26V
13.7V	27.4V	4.28V
	27.5V	4.30V
13.8V	27.6V	4.31V
	27.7V	4.33V
13.9V	27.8V	4.34V
	27.9V	4.35V
14.0V	28.0V	4.37V
	28.1V	4.39V
14.1V	28.2V	4.41V
	28.3V	4.42V

14.2V	28.4V	4.44V
	28.5V	4.45V
14.3V	28.6V	4.47V
	28.7V	4.48V
14.4V	28.8V	4.50V
	28.9V	4.51V
14.5V	29.0V	4.53V
	29.1V	4.55V
14.6V	29.2V	4.56V
	29.3V	4.58V
14.7V	29.4V	4.59V
	29.5V	4.61V
14.8V	29.6V	4.62V
	29.7V	4.64V
14.9V	29.8V	4.66V
	29.9V	4.67V
15.0V	30.0V	4.69V
	30.1V	4.70V
15.1V	30.2V	4.72V
	30.3V	4.73V
15.2V	30.4V	4.75V
	30.5V	4.76V
15.3V	30.6V	4.78V
	30.7V	4.80V
15.4V	30.8V	4.81V
	30.9V	4.83V
15.5V	31.0V	4.84V
	31.1V	4.86V
15.6V	31.2V	4.87V
	31.3V	4.89V
15.7V	31.4V	4.90V
	31.5V	4.92V
15.8V	31.6V	4.94V
	31.7V	4.95V
15.9V	31.8V	4.97V
	31.9V	4.98V
16.0V	32.0V	5.00V

11 Error Codes

Error Code – number of flashes per LED		
Red	Green	Description
0	1	No error
0	2	Oil pressure low
0	3	Reserved for future use
0	4	Engine overheat
0	5	Engine failed to start
0	6	Engine is already running
0	7	Generator failed to establish synchronization with line power for an un-interrupted switch back.
0	8	Fuel level low – warning
0	9	Fuel level low – Shutdown level
1	0	Reserved for future use
1	1	Fatal error condition – reason error code to follow
1	2	Analog to Digital conversion failed – CPU failure
1	5	Engine Alternator is overcharging
1	6	Engine Alternator is not charging
1	7	Standby charging system is overcharging
1	8	Standby charging system is not charging
1	9	Reserved for future use
2	0	Reserved for future use
2	1	Reserved for future use
2	2	Generator Frequency error – unable to determine frequency
2	3	Generator Frequency to high – generator turning to fast
2	4	Generator Frequency to low – generator turning to slow
2	5	Engine Oil pressure switch failure
2	6	Engine start voltage to low – insufficient battery power
2	7	Engine start voltage to high – battery voltage exceeds model threshold
2	8	Power is restored.
2	9	Reserved for future use
3	0	Reserved for future use

3	1	No power detected on generator line(s)
3	2	Phase rotation error on Generator lines (3 Phase)
3	3	No power activity detected on Generator line1
3	4	No power activity detected on Generator line2 (3 Phase)
3	5	No power activity detected on Generator line3 (3 Phase)
3	6	No power activity detected on Utility Power line(s)
3	7	Phase rotation error on Utility Power lines
3	8	No power activity detected on Utility Power line1
3	9	No power activity detected on Utility Power line2 (3 Phase)
3	10	No power activity detected on Utility Power line3 (3 Phase)
4	3	Calibration Mode
4	4	Invalid operating mode signals detected
4	5	CPU – timeout situation – contact manufacturer
4	6	Phase selection not correctly set for line signals detected
15	14	Write to EEPROM failed – CPU failure – contact manufacturer
15	15	Demonstration/Trail period expired

12 Total module failure bypass

Unforeseen situations might arise where the module becomes non-functional, for whatever reason, but Utility Power has been restored/is available. Firstly you would be advised to acquire a replacement module.
A Mains/Off/Generator selection switch can be wired into any of the listed diagrams to facilitate a quick fallback to utility power should it be available.

 WARNING! This procedure will render the Genset non-operational.

 WARNING! No phase rotational and or phase failure protection will be available when switched to the “Mains” selection.

See diagram Mains/Off/Generator Selection for wiring detail.

13 Trouble shooting

Q	The module is not operating at all.
A	Check that all connections are made correctly. Check if the power switch is switched on. Check that the battery is connected and have sufficient power. Check if the fuse is still OK, replace it with the same rating fuse if fused.
Q	I get an error code 2 shortly after an attempted start.
A	Check if the machine has a sufficient oil level. Check if the oil pressure switch is operating correctly. Check if there is sufficient oil pressure when the engine turns. This condition can also be triggered due to fuel starvation and/or failing electrical fuel control system or any other condition preventing the engine from operating normally and causing it to shutdown unexpectedly.
Q	I get an error code 5.
A	The engine has failed to start after 5 attempts. Try to start the Genset manually. Apply corrective action as needed.
Q	I get an error code 31 after the engine has shutdown.
A	The generator is not functioning at all or the generator wires to the module are not wired correctly.
Q	I get an error code 32 after Genset shuts down.
A	The generators phase rotation is incorrect or the module is wired incorrectly. If the connections are correct the generator is at fault, correct generator line outputs.
Q	I get an error code 36.
A	There is a power failure or the module's utility power connection is not wired correctly.
Q	Line contactors fail to engage and I get an error code 37.
A	The utility power lines have power but the phase rotation is incorrect. Correct the phase rotation problem.
Q	I get an error code 44.
A	The mode selection connections are not wired correctly and or an incorrect mode select switch is fitted.
Q	I get an error code 46 after switch on.
A	The Phase selection is incorrect. Module is set to single phase but is connected to a 3 Phase supply or is set to 3 Phase and is connected to a Single phase supply or phase select is set to single phase and all 3 input lines L1, L2, L3 is bridged when connected to a single phase supply.
Q	I get an error code 25.
A	The oil pressure switch might be faulty and/or an oil pressure problem exists on the engine and is unable to maintain sufficient pressure to operate the oil pressure switch correctly.
Q	I get an error code 26 when the engine tries to start.
A	Your battery is faulty and is unable to maintain sufficient power to complete the start procedure or the voltage detection circuit is not calibrated correctly.
Q	I get an error code 27.
A	The battery input voltage exceeds the maximum threshold the module is calibrated for or the voltage detection circuit is not calibrated correctly e.g., a module calibrated for a 12V is fitted to a 24V Genset. Calibrate the module for the input voltage applied (12V/24V) See Calibration

Q	I get an error code 28.
A	You are operating in manual mode but the power has been restored in the meantime while the Genset is in use. A Manual shutdown is required, after shutdown switch back to the Utility Power supply will commence.
Q	The Genset operated correctly but suddenly shutdown.
A	Check the error code and take corrective action or restart the engine manually if it fails again check the error code and take corrective action.
Q	I selected un-interrupted switch back but the module performs an interrupted switch back to utility power and gives an error code 7.
A	The Genset power and the utility power did not remain in synchronization long enough to safely perform an un-interrupted switch back. The common cause of this condition is the Genset's output frequency is too high/low to effectively remain synchronized with the utility power.
Q	I get a phase rotation error where the correct error would be line1, line2 or line3 missing.
A	This is not wrong it is a side effect of power being returned via the load to the module. Remove the load and the correct error will display. This can also happen if one of the lines is disconnected on the primary side of the utility power transformer.
Q	I get a battery over/not charging error but the engine it is not equipped with a charging system.
A	You have a standby charger connected to the battery and standby charging monitoring is enabled and Engine charging monitoring is disabled but you did not make use of the Charger On/Off facility to control the charger and the charger is not charging or is over charging.
Q	The module disengages the line contactor only to re-engage after a short wait, it appears to be random of nature or when a contactor is disengaging.
A	Connect a Varistor or Transorb of sufficient voltage across the coil(s) of the contactor(s) emitting the RFI signals causing the CPU to reset.
Q	The controller indicates no error but fails to engage the line contactor, but if I switch to manual mode and start up the Genset the generator contactor engages and an error code 28 (power restored) is displayed. If I switch the Genset off again it still fails to engage the line contactor and no error code is displayed.
A	The contactor or the relay driving the contactor might be at fault or This situation might arise when utility power voltage is high enough for the controller to detect power signals but is still too low to energize the line contactor. The Alarm might also be sounded intermittently due to inconsistent utility power voltage. Contact the Utility Power provider to rectify the power problem. If urgent power is required switch to manual mode and start the Genset.

Q	Once the engine has started it fails to shutdown.
A	Especially on Diesel engines shutdown is accomplished by closing a fuel valve or shutdown solenoid. Once the engine has started and the engine alternator kicks in, it can provide sufficient power via the warning light (D+/WL) circuitry to keep it operational/engaged. There are various ways to solve this phenomenon. 1. By isolating the shutdown circuitry from the engine charging circuitry by means of a relay. 2. By installing a diode in series with the wire feeding the warning light/exciter point on the alternator. See diagrams for details.
Q	We need to service/do maintenance on the machine but are wary that it might start due to an unforeseen power failure.
A	It depends on your site requirements. The safest would be to remove power to the controller resulting in a total site power failure until maintenance is complete and power to the controller is restored. The next best option is to switch to Manual mode for the duration of the maintenance. Beware that switching between modes can result in a short power interruption (± 5 Seconds) if switching is not done under 1 second. Or If the installation has a Main/Off/Generator selection switch wired in, you could select the "Mains" option. Beware that this option will result in a power interruption and you will lose phase failure and phase rotation protection as long as this option is exercised.
Q	The Engine requires a lot of cranking but the controller stops the start procedure before the maximum cranking time is reached.
A	Due to the extended cranking the engine builds up sufficient oil pressure to activate the oil pressure switch, which the controller uses to determine if the engine has started. The cranking can be extended to the maximum cranking time by using a relay to sense the generator output as well. The normal closed contacts are coupled in parallel with the oil pressure switch. See diagram Single To Single Phase – No Oil Pressure on how to connect the relay.
Q	When I try to start the engine manually it engages the starter momentarily and at times it displays a code that does not seem to be a valid error code.
A	This problem is caused by a faulty battery. When the starter engages the battery voltage drops below a sustainable voltage to energize the controller and forces it to reset. The code being displayed is in fact the version of the software and not an error code. See section Version
Q	I get an error code 15 14.
A	You are fitted with a Demonstration/Trial controller and the CPU encountered difficulty writing to its internal permanent storage area. You have a CPU failure and would require a replacement CPU.
Q	I get an error code 15 15.
A	You are fitted with a Demonstration/Trial controller and the trial period has expired. Acquire a new Demonstration/Trial or non expiring controller.

14 Abbreviations

LED	-	light emitting diode
CPU	-	Central Processing Unit
POT	-	Potentiometer
Genset	-	Also known as Standby Plant, Power Plant, Generator
MOV	-	Metal Oxide Varistor
RFI	-	Radio Frequency Interference
AMF	-	Automatic Mains Failure

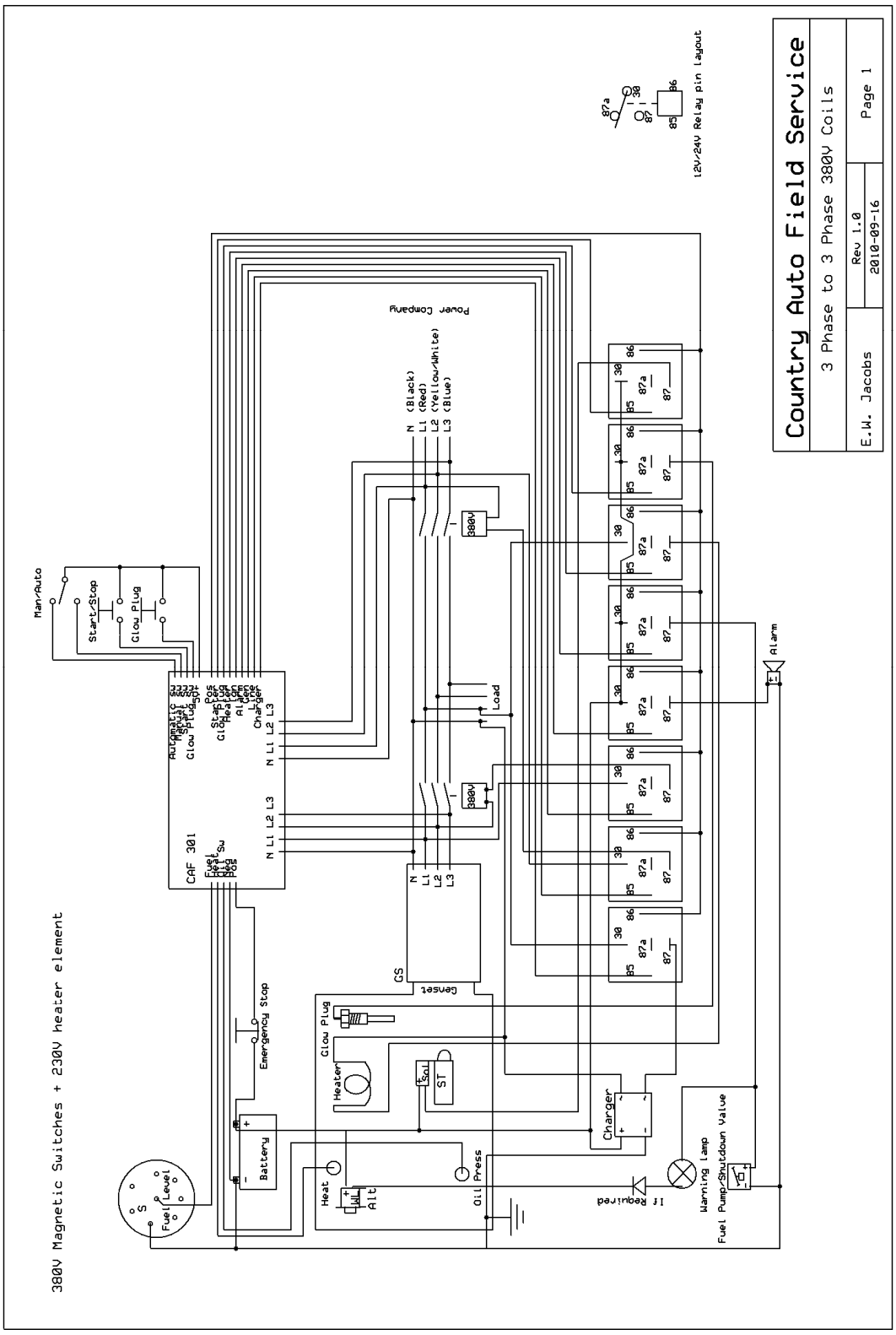
15 Guarantee

We as manufacturer guarantee the product for 12 months from the date of purchase. Your receipt serves as valid proof of purchase. Within the guarantee period we will repair or replace (as we consider appropriate) the product should any problems arise resulting from material defects or manufacturing error. Excluded from this guarantee are any defects caused by incorrect use, incorrect installation, wear and tear of moving parts e.g. mechanical switches, lighting strikes or power surges of what ever cause. The manufactures will not be held liable for any injuries, damage incurred to equipment or infrastructure as a result of a faulty or damaged product or incorrect use of the product.

16 Diagrams

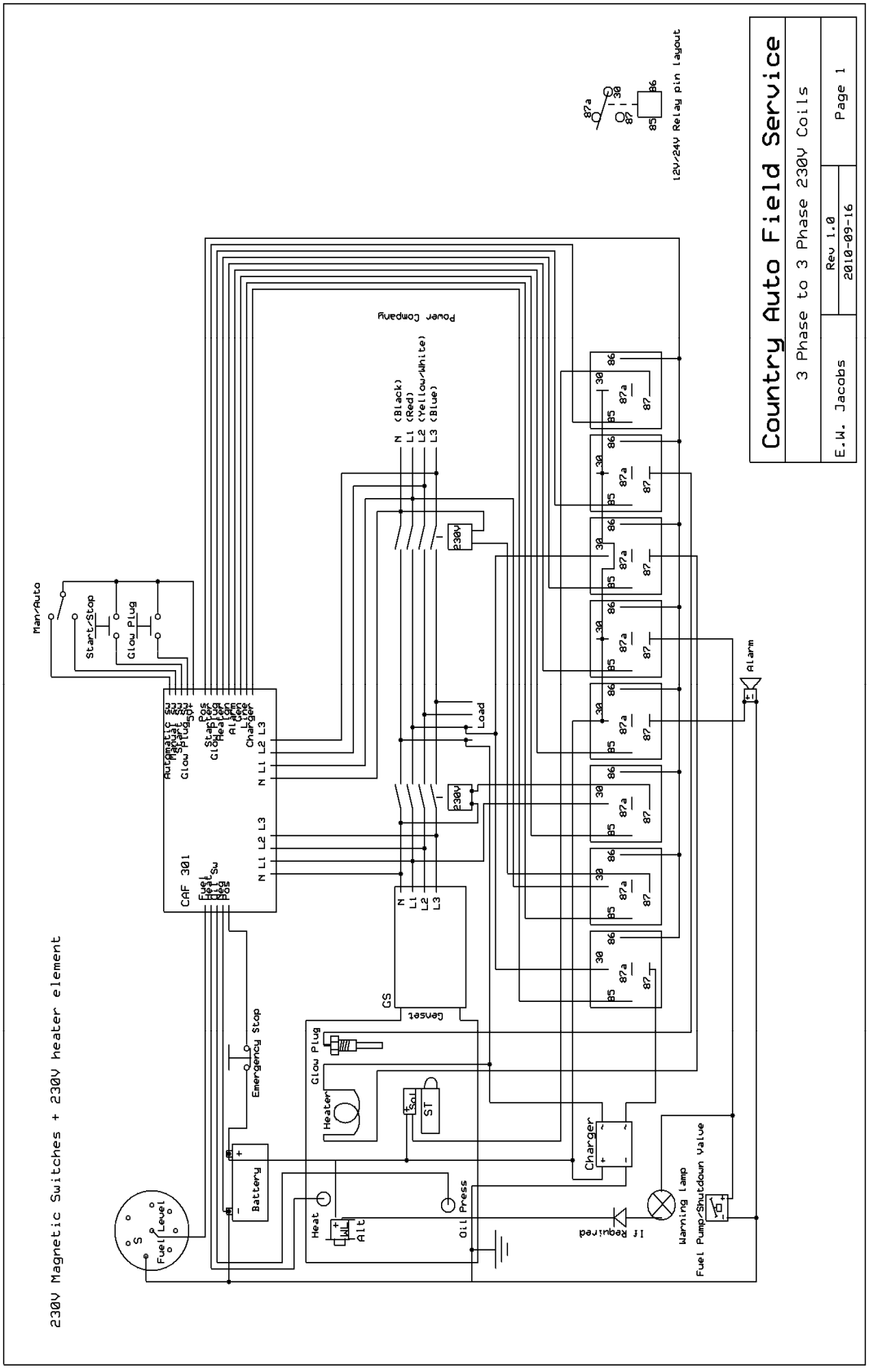
16.1 3 Phase to 3 Phase 380V

3 Phase utilizing 380V contactor coils and 230V engine heater element.



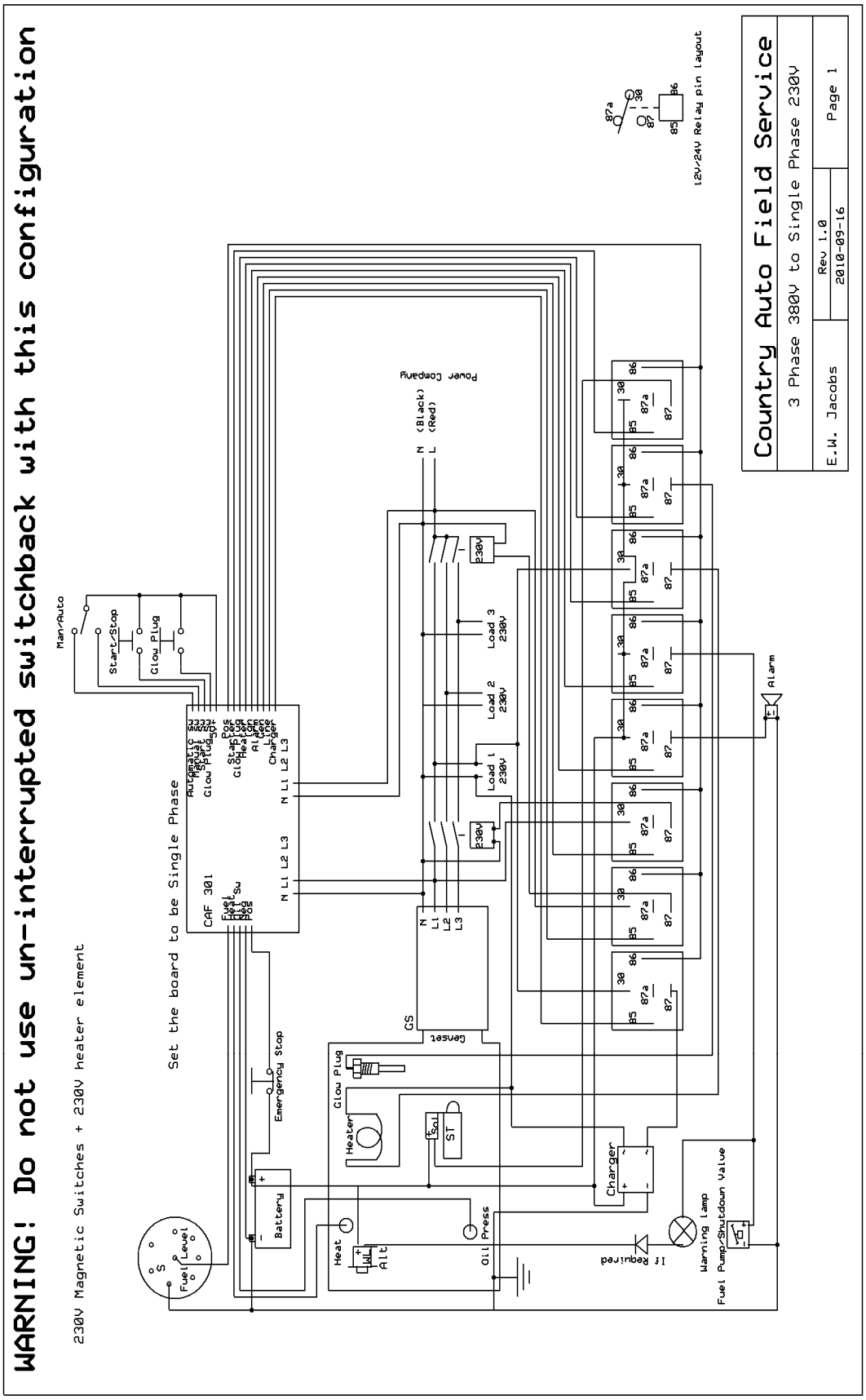
16.2 3 Phase to 3 Phase 230V

3 Phase utilizing 230V contactor coils and 230V engine heater element.



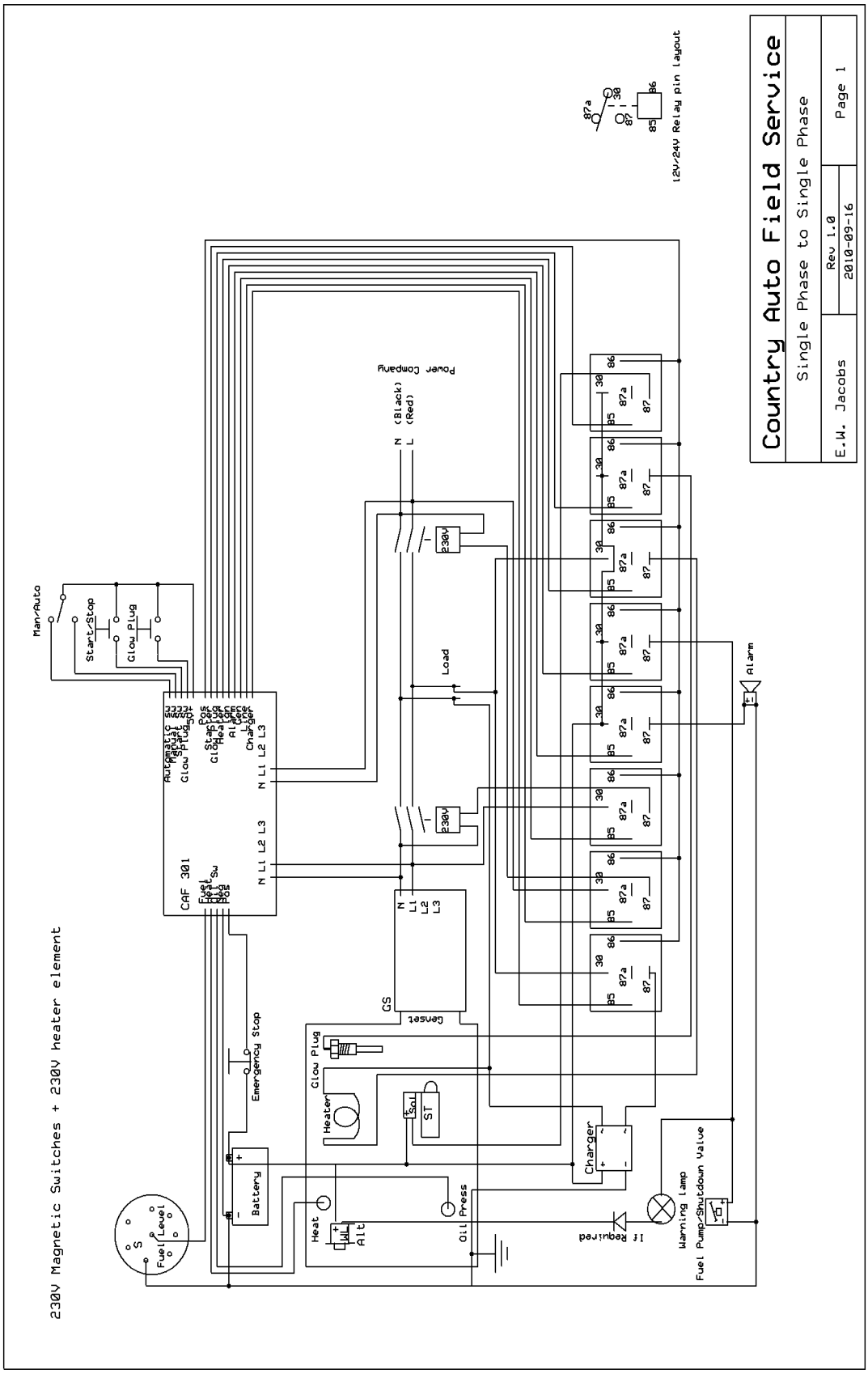
16.3 3 Phase to Single Phase

3 Phase Genset used to drive various Single Phase loads



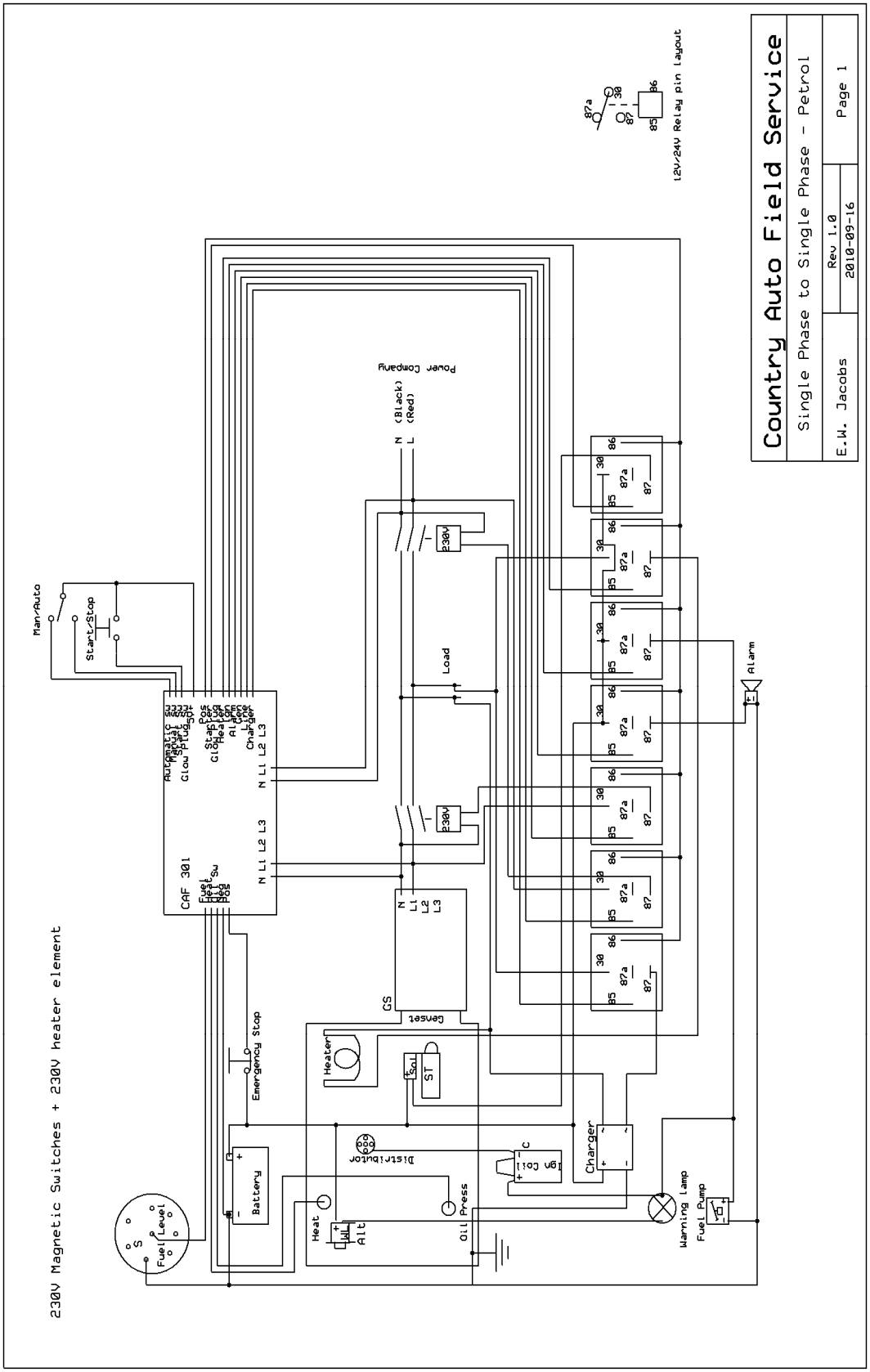
16.4 Single Phase to Single Phase

General Single Phase Genset connected to a Single Phase supply



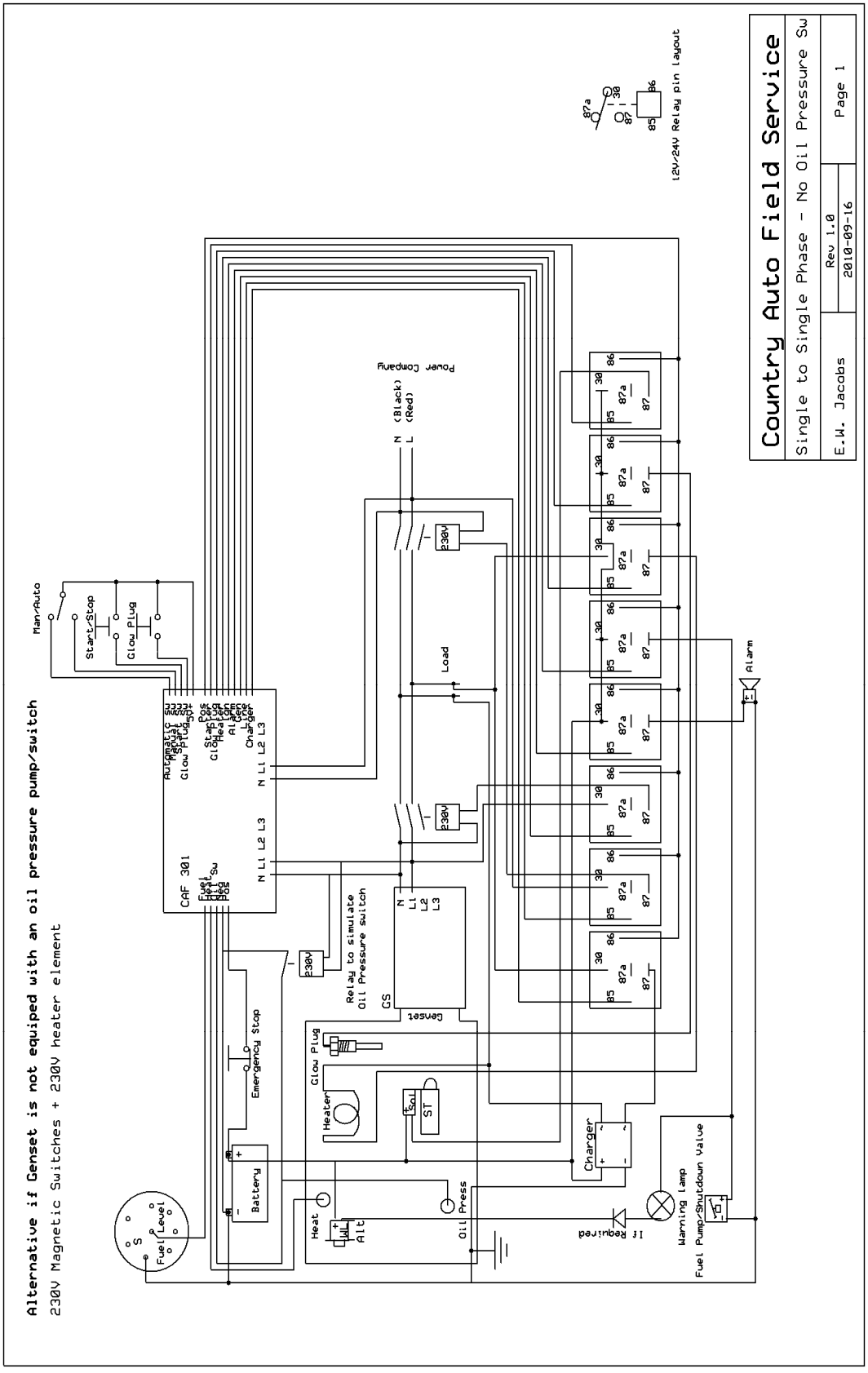
16.5 Single Phase to Single Phase – Petrol

For smaller petrol driven Gensets



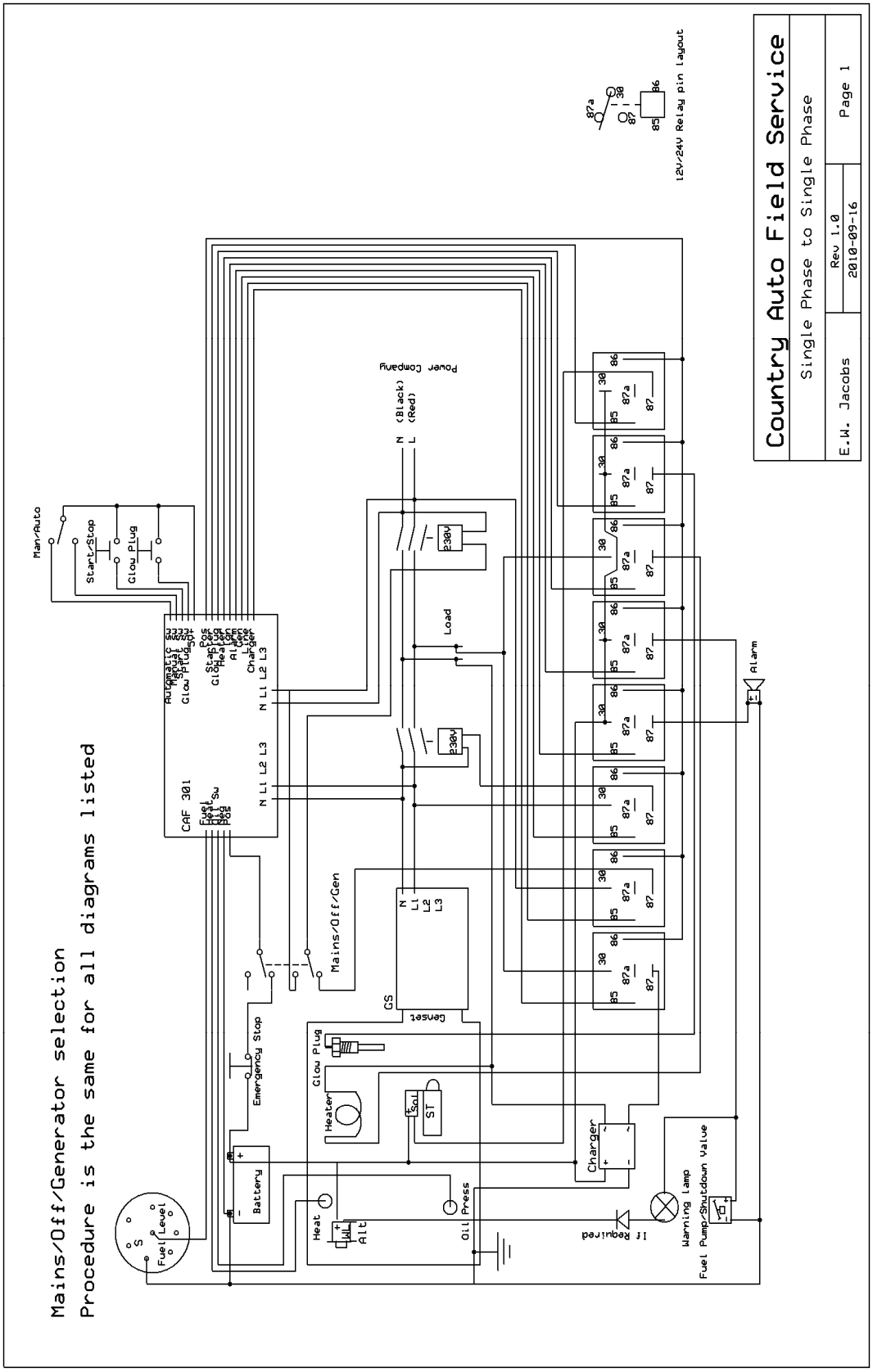
16.6 Single Phase to Single Phase – No Oil Pressure Switch

For smaller models not equipped with oil pressure pump or switch



16.7 Mains/Off/Generator Selection

For a quick switchover in cases of a module failure



16.8 Schematic

Schematic diagram