



**DEEP SEA ELECTRONICS PLC**

## **Guide to Synchronising and Load Sharing**

### **PART 1 – Usage of the 5510/5520/5560 in synchronisation / load sharing systems.**

*(Also covers 550/555/556)*

**Author:- Anthony Manton  
Revisions :- Miles Revell, John Ruddock**



Deep Sea Electronics Plc  
Highfield House  
Hunmanby  
North Yorkshire  
YO14 0PH  
ENGLAND

Sales Tel: +44 (0) 1723 890099  
Sales Fax: +44 (0) 1723 893303

E-mail: [Sales@Deepseapl.com](mailto:Sales@Deepseapl.com)

*Deep Sea Electronics Guide to Synchronising and Load Sharing*

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2. On-Site Power Generation. EGSA Education Committee. ISBN 0-9625949-3-8

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## 2 INTRODUCTION

A general overview of generator uses is given including synchronising. This is only to be treated as a guide to newcomers to this particular subject, and should not be treated as a total learning package.

Part 2 of this manual details the interfacing the 55xx and 55x controllers with many of the most common AVR's and Governors in use on generating sets.

## 3 STEP BY STEP GUIDE

This section details the main steps that need to be taken in producing a synchronising / load sharing system. This is intended as a guide only and is not a substitute for in depth knowledge of synchronising and load sharing.

- Identify your base application. Applications supported by the DSE controllers are detailed in the section headed 'Synchronising and load sharing solutions'.
- Identify your governor and AVR interface methods. Details of this are contained in the sections headed 'Interfacing to governors' and 'interfacing to Automatic voltage regulators'.
- Design your panel and system wiring. DSE can assist with your specific questions on this but cannot design the panel for you. If you want a panel designing, please contact DSE Technical Support Department who may be able to recommend a third party panel designer / builder capable of producing a synchronising / load sharing system.
- Check / adjust the module's configuration using the PC configuration software. If it is a MultiSet system, ensure that the settings for the MultiSet Communications Link are correctly configured and the MultiSet communications cable is of the correct specification.
- Commission each set in the system as a single standalone set. Before doing this, ensure the governor/AVR interface is disabled as detailed in the section entitled 'On site commissioning'.
- Set up the governor and AVR as detailed in their respective manufacturers' handbooks.
- Before synchronising sets for the first time, double check that all the Bus wiring is correct and that the controllers initial settings are suitable. This may include lowering the settings for 'gain' and 'stability' in the synchronising, voltage matching and load control sections.

**Further detailed information on this subject is contained in the DSE Load Share Commissioning Guide.**

Should you have any queries arising from this manual please contact our Technical Department:

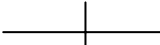
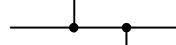
**INTERNATIONAL TEL: +44 (0) 1723 890099**

**INTERNATIONAL FAX: +44 (0) 1723 893303**

**E-mail: [support@deepseapl.com](mailto:support@deepseapl.com)**

**Web: <http://www.deepseapl.com>**

### 3.1 CLARIFICATION OF NOTATION AND TERMINOLOGY USED WITHIN THIS PUBLICATION.

|                                                                                                   |                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <b>NOTE:</b>    | Highlights an essential element of a procedure to ensure correctness.                                                                                                                                                                            |
|  <b>CAUTION!</b> | Indicates a procedure or practice which, if not strictly observed, could result in damage or destruction of equipment.                                                                                                                           |
|  <b>WARNING!</b> | Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.                                                                                                                          |
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|                  | Compliant with BS EN 60950 Low Voltage Directive<br>Compliant with BS EN 50081-2 EMC Directive<br>Compliant with BS EN 50082-2 EMC Directive                                                                                                     |
|                  | Two crossing wires with no interconnection between the two.                                                                                                                                                                                      |
|                  | Three wires, all connected together                                                                                                                                                                                                              |
|                  | Connections to the 55x controller's battery supply negative terminal, usually the earthed battery –ve terminal.                                                                                                                                  |
| A.V.R.                                                                                            | Automatic Voltage Regulator. Fitted to the alternator to regulate the output of the generator.                                                                                                                                                   |
| Governor                                                                                          | Engine Speed Governor. Fitted to the engine to electronically control the speed of the engine.                                                                                                                                                   |
| Droop                                                                                             | When load is applied to a generator fitted with a droop governor / AVR, the speed/voltage will drop. This is called droop. It is common for a droop set to drop between 3% and 10% in speed / voltage from no load applied to full load applied. |
| Isochronous                                                                                       | A governor with no speed droop, or where speed droop is disabled is known as an isochronous governor. The engine speed remains constant so long as the load levels are within the set's capability.                                              |
| Synchronise                                                                                       | To get the supplies identically matched, ready for paralleling.                                                                                                                                                                                  |
| Parallel                                                                                          | Connect two or more supplies together. These supplies must be in synchronism before this can occur.                                                                                                                                              |
| Datum                                                                                             | 'centre' point of an electronic pot, digital resistance or AVR/Governor.                                                                                                                                                                         |
| Nominal                                                                                           | The nominal voltage or frequency of the system i.e. 230V 50Hz. This is not necessarily the same as the Datum.<br>(i.e. when droop governors/AVRs are used, the datum will be higher than the nominal )                                           |
| Mains supply                                                                                      | The AC distributed power supply of a power generation company. Often also called the 'grid', or 'utility' supply.                                                                                                                                |

## 4 GENERATOR USES

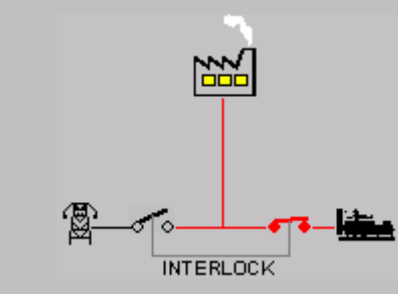
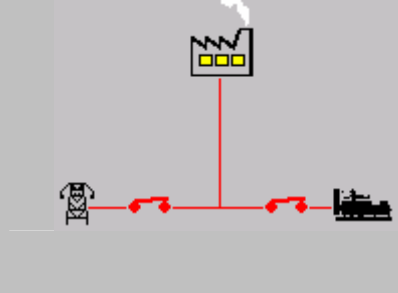
AC Power Generators are widely used to supply power to a load at “mains” voltage levels. Most people first encounter a generating set when used as the primary power source. An example of this is the small trailer mounted generators often seen in use supplying power to highway maintenance equipment.

Other terms used to describe a generator as the sole supply are ‘Primary power’ or ‘Prime power’. Knowledge of prime power generation in this way is assumed and is not covered within this manual.

### 4.1 STANDBY GENERATORS

Generators are commonly used as a backup to the mains supply. Due to their nature, backup supply generators are rarely seen by the public! Should the mains supply fail, the generator will be started and used to provide power until it returns. Applications include factories, offices, schools, emergency services (including hospitals), airports, telecommunications providers etc.

Backup generators fall into two main categories:

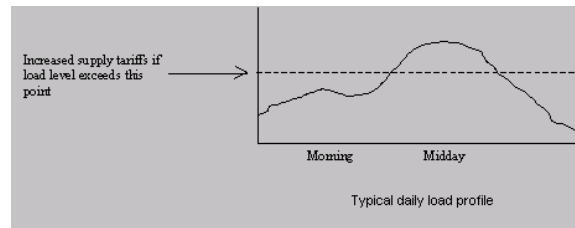
| Illustration                                                                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>4.1.1 TRANSFER SWITCH</b><br>    | The most common form of backup generator to the mains supply is a single generator in “standby” mode. When the mains supply fails, the load is left without power until the generator is started. Once the set is “available”, the transfer switch changes over so that the load is supplied by the generator.<br>Typically, the “down time” will be around 15 seconds, but may be longer depending upon the time taken to run the engine to nominal speed and other application dependent factors. When the mains supply returns, the load-switching device (contactors/breakers) will momentarily remove power from the load (typically 1 second) before transferring the load back to mains supply power.                                                                                                           |
| <b>4.1.2 NO BREAK TRANSFER</b><br> | The break in supply when transferring back to the mains can be eradicated by synchronising the generator supply to the returned mains supply, and closing the supplies in parallel with each other for a short period of time. Then, the generator load switch is opened, returning the mains to supply power to the load. There has been no break in supply to the load during this return transfer process. Terms often used for this procedure are “bumpless transfer”, “no break return” and “no break transfer”. Additionally, the same procedure can be used to transfer from mains supply to generator supply enabling, for instance, “on load” testing of the genset with no break in supply to the load. This can also be performed if the supply authority informs customers of a scheduled break in supply. |

## 4.2 CONTINUOUS PARALLEL OPERATION

Electricity supply boards have many tariffs based upon the customer's load demand. In some cases, the tariffs can treble or more during certain times of the day if a specific load level is exceeded.

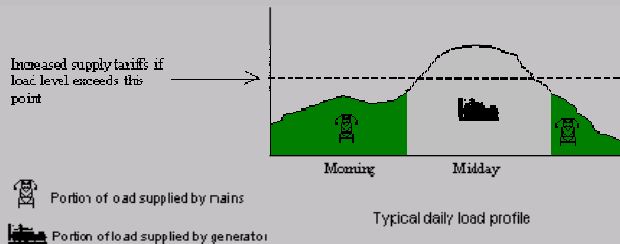
In this example, the customer is charged more for his electricity in the hours around midday, as his load level places his power usage into the next charging tariff.

In some cases, it can be more cost effective for the customer to provide an alternative power supply during this time of high tariff. There are a number of possibilities open to him:



### Illustration

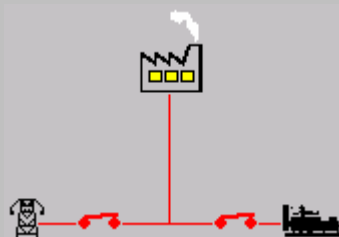
#### GENSET SUPPLY.



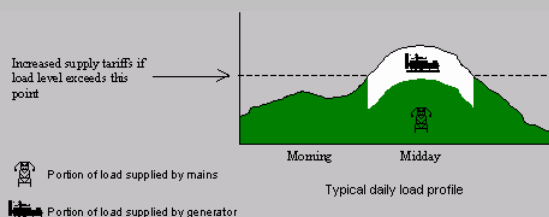
### Description

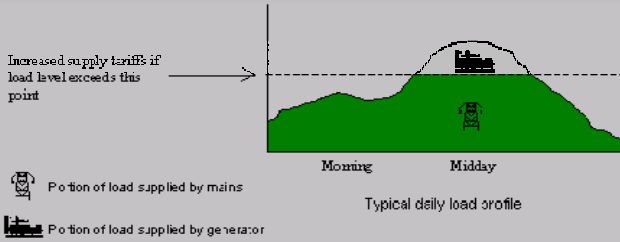
During the time of high load level a single (or multiple) generator(s) could be started, and then used to power the load using a 'no break' transfer. This genset supply must be capable of supplying the entire load during this time of high usage.

## 4.3 BASE LOAD WITH 5520/555/557 CONTROLLER



In this example, a 5520 or 555, 557 controller is being used in a base load peak lopping system. The controller has been configured to start the generating set at 10am, synchronise with the mains and parallel the supplies. It will then export a fixed amount of power (kW) to the load and maintain a specified power factor (both configurable).

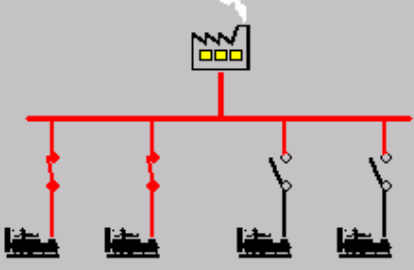


| Illustration                                                                                                                                                                                                                                                                                                                                                     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>4.3.1 TRUE PEAK LOPPING AND IMPORT/EXPORT CONTROL</b></p>  <p>Increased supply tariffs if load level exceeds this point</p> <p>Portion of load supplied by mains</p> <p>Portion of load supplied by generator</p> <p>Typical daily load profile</p> <p>Morning Midday</p> | <p>A more advanced variation of the peak lopping system described above is to use a 5520 (for single set) or 5510/5560 (up to 16 sets). In this situation variable Peak Lopping or true import/export can be achieved.</p> <p>The 5560 or 5520 will monitor the site load levels and vary the generator(s) power production. This can be used to ensure the set is used at its economic load level, and prevents the system exporting power. It can also be used to hold the mains usage to a certain level, helping to avoid higher electricity board tariffs or supplementing the mains supply on a site with limited supply available.</p> |

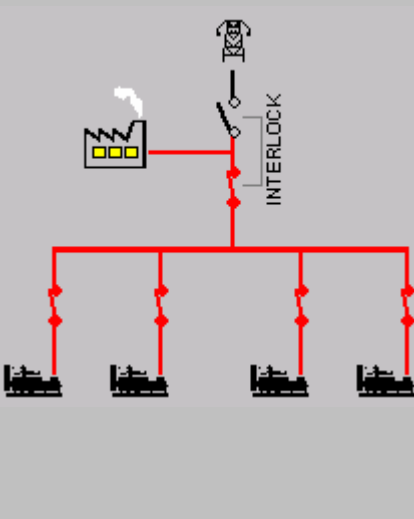
**NOTE:** - It is recommended that ROCOF (Rate of change of frequency) or vector shift detection components are fitted when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. If in doubt, you should refer to your local Electricity Supply Company for advice.

## 4.4 MULTIPLE GENERATORS

There are many reasons for requiring more than one generator on the same site.  
The most common reasons are described below:

| Illustration                                                                                                                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>4.4.1 MULTIPLE SET PRIME POWER</b></p>  | <p>In this example, the site has four generating sets, used as the primary power source.</p> <p>One genset will be running all the time, to provide power to the site. If the load demand of the site increases, one or more generators will be automatically called to start. They will then synchronise onto the bus, and provide power in parallel with the other set(s). At this point, the sets connected to the bus will share the load, normally utilising load sharing equipment.</p> <p>Using multiple generating sets rather than one large set allows for maintenance to be performed on one of the sets while the other set(s) are still available for duty.</p> <p>Additionally, if load demands are low, individual generators can be started as required, rather than one large generator being used at (for instance) only 25% of its full load rating.</p> <p>If the overall size of the load increases, for instance due to factory expansion another set can be added to increase capacity with minimal disruption to the rest of the system.</p> <p>Using this system, “redundancy” can be built in by utilising a larger number of gensets than is required to supply the load. This way, the load can still be supplied if one or more sets are unavailable due to engine failure or maintenance.</p> <p>The 5510/550 controllers have “no master” ensuring a seamless transition when one or more sets are removed from the system.</p> |

#### 4.4.2 MULTIPLE SETS PROVIDING STANDBY TO THE MAINS SUPPLY

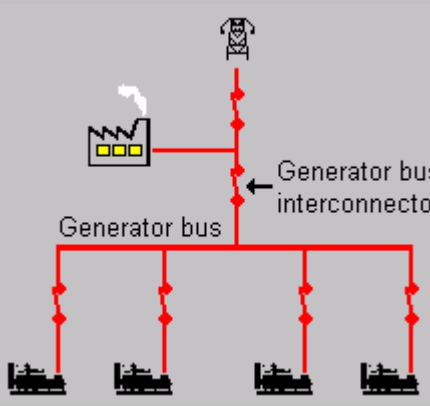
| Illustration                                                                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>If multiple gensets in parallel are used to backup the mains supply, care should be taken when designing the system. In the example above for instance, should the mains supply fail, two possibilities exist. Firstly, if only two generating sets are providing power to the bus, they must be capable of supplying the currently active load. Secondly, if none of the sets are available, they will all start up simultaneously. The first set will close onto the dead bus, and supply power to the load. Again, the set must be capable of supplying this power to the currently active load.</p> <p>Two solutions exist :</p> <ol style="list-style-type: none"> <li>Ensure each generating set is capable of supplying the entire load so that the above situations will not occur.</li> <li>Ensure before closing the load switch and powering the load with the generating sets, that all of the generating sets are available and synchronised onto the generator bus. While running in this manner, not in parallel with the mains supply, this is called 'islanded mode'.</li> </ol> |

#### 4.4.3 LOAD-SWITCHING USING 530 ATS

The DSE 530 automatic transfer switch can be used to monitor the mains supply to ensure it is within limits. Should the mains supply fail, the 530 can be used to 'remote start on load demand' the 550/5510 controllers used in the example shown. All sets in the system will start together. The first available set will close onto the dead bus, also closing its load switch auxiliary contact. The other generating sets will synchronise onto the generator bus, and then close in parallel with it. Connect all of the generating set load switch auxiliary contacts in series and connecting into the *auxiliary generator ready* input (terminal 10) of the DSE 530 automatic transfer switch in conjunction with further external relay logic to latch this signal. (Further details of this can be found in Appendix 1 of this publication).

The DSE 530 module will sense the generator bus voltage and frequency, and once within limits will 'wait' for the presence of the *auxiliary generator ready* input. This signifies the correct closure of all sets in the system onto the generator bus. The mains – generator load transfer is then performed by the 530 automatic transfer switch controller.

#### 4.4.4 MULTIPLE SETS (STANDBY) – NO BREAK TRANSFER

| Illustration                                                                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>In the example above, it was not possible to perform no break transfers to/from the mains supply.</p> <p>If a 5560/556 'mains controller' is fitted, to monitor the mains supply and power supplied by the mains to the load, additional possibilities exist, the most important of which are :</p> <ol style="list-style-type: none"> <li>1) Should the mains supply fail, 5560/556 can call for the generating sets, which will synchronise and close onto the generator bus. When the sets are available on the generator bus 5560/556 can close the generator bus interconnecting load switch. When the mains supply returns, the generator bus can be synchronised and closed in parallel with it, to allow a no break return to the mains supply.</li> <li>2) As the power being supplied by the mains is also being monitored, the 5560/556 can pass this information to the generator controllers, allowing load sharing between the generator bus and the mains supply.</li> <li>3) No-break on load testing is possible, by calling for generators to start. The first to become available will close onto the dead generator bus, the remaining generators synchronising with the now live generator bus and closing in parallel with it. The 5560/556 will then communicate with the generating set controllers to effect synchronism of the generator bus with the mains supply. When synchronism has been achieved, the 5560/556 can close the supplies in parallel.</li> </ol> |

#### 4.4.5 MULTIPLE MAINS SUPPLIES

Due to local electrical supply conditions or historical growth of the load, it is possible for the load to be fed by more than one incoming AC mains supply. Normally each mains supply will feed a separate part of the load. The 5560 module allows the standby generators to parallel with any one of the mains supplies at a time and will transfer the loads accordingly. Peak lopping is also possible on any one 5560 module in the system, in the event of a mains failure condition peak lopping can be automatically terminated to ensure the gen-sets are available for standby operation.

**NOTE:** - It is recommended that ROCOF (Rate of change of frequency) or vector shift detection components are fitted when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. If in doubt, you should refer to your local Electricity Supply Company for advice.

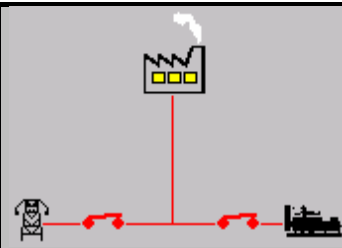
## 5 SYNCHRONISING AND LOAD SHARING SOLUTIONS

As the DSE synchronising and load sharing controllers can be used in many varying configurations, this chapter explains how the controllers are utilised and what controller options must be fitted. Where droop governors or AVR's are required, this is also mentioned. A more detailed description on synchronising and load sharing follows this section.

### 5.1 SINGLE SETS

#### 5.1.1 SINGLE SET NO BREAK RETURN WITH MAINS ("HARD TRANSFER")

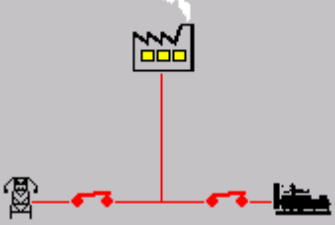
A single set primarily used to provide backup to the mains supply should it fail. When the mains supply returns, the generator is synchronised to the mains supply and momentarily closed in parallel with it before opening the generator load switching device. This is often called 'no break back synching'. No control over governor/AVR is made when in parallel so load ramping is not possible.

|                                                                                   |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                  |
|-----------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
|  | Controller :         | 5520, 557, 555 auto sync (Load share version not necessary)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                  |
|                                                                                   | Governor :           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                                                |
|                                                                                   |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 5520 analogue output, 5xxx Raise/lower relays, P120 governor interface (555/557) |
|                                                                                   | AVR :                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                                                |
|                                                                                   |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 55xx analogue output, 5xxx Raise/lower relays, P121 governor interface (555/557) |
|                                                                                   | Load Share options : | <ul style="list-style-type: none"> <li>Fixed export</li> <li>Import / Export control (5520 only)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                  |
| Description                                                                       |                      | <p>As no load sharing capability exists in the 555 autosync module, no control is made over the reactive / active load share. In applications of this type, this is not normally a requirement. However, if load sharing is required during this short-term parallel, a load sharing 555, 557 or 5520 module can be used. This will provide the additional function of load ramping (soft transfer) during "mains available" transfers. (see 'base load peak lopping' example below for details of this)</p> <p>Using the 5520 over the other controllers gives true peak lopping functionality by providing mains power measurement. This allows for genset start/stop based upon mains load.</p> |                                                                                  |

**NOTE:** - It is recommended that ROCOF (Rate of change of frequency) or vector shift detection components are fitted when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. However, in applications of this type, where parallel time is kept to a minimum, this is usually not a requirement. If in doubt, you should refer to your local Electricity Supply Company for advice.

### 5.1.2 SINGLE SET NO BREAK RETURN WITH MAINS (“SOFT TRANSFER”)

A single set primarily used to provide backup to the mains supply should it fail. When the mains supply returns, the generator is synchronised to the mains supply and momentarily closed in parallel with it before opening the generator load-switching device. This is often called ‘no break back synching’.

|                                                                                   |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                           |
|-----------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
|  | Controller :         | <ol style="list-style-type: none"> <li>1) 5520 controller. (To provide single set true peak lopping with mains failure protection). Back sync with mains is possible.</li> <li>2) 555 load controller (to provide single set ‘fixed output’ parallel with mains failure protection). Back sync with mains is possible.</li> <li>3) 557 load controller (to provide single set ‘fixed output’ parallel with mains failure protection). Back sync with mains is possible.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                           |
|                                                                                   | Governor :           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✗                                                         |
|                                                                                   |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5520 analogue output<br>P120 governor interface (555/557) |
|                                                                                   | AVR :                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓                                                         |
|                                                                                   |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5520 analogue output<br>P121 governor interface (555/557) |
|                                                                                   | Load Share options : | <ul style="list-style-type: none"> <li>• kW control</li> <li>• kVAr control</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                           |
|                                                                                   | Description          | <p>5520 - The set can either produce a fixed amount of power or can be configured to control the generator power or mains power to maintain a specified level (i.e. import/export control and peak lopping)</p> <p>555/557 - The set will produce a fixed amount of power and will therefore export power to the mains supply (utility) if the load falls below the configured load control level.</p> <div style="border: 1px solid black; padding: 5px;"> <p><b>⚠ CAUTION!:- External ROCOF/Vector shift detection equipment MUST be fitted to the incoming mains supply to detect loss of mains when in parallel.</b></p> <p><b>This external relay MUST be used to provide a signal into one of the digital inputs configured to “Auxiliary mains failure”.</b></p> <p><b>This is used to ensure termination of the power export function upon loss of the mains supply during paralleling.</b></p> </div> |                                                           |

### 5.1.3 BASE LOAD PEAK LOPPING / PEAK SHAVING

One or more sets are used for multiple purposes. These can be:

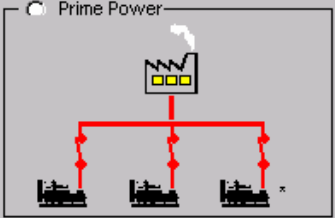
- Backup to the mains supply in case of mains failure and 'no break return' back to mains.
- Supplement to the mains supply to reduce mains supply load and hence reduce supply costs.

|  |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                  |
|--|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
|  | Controller :         | Either :<br>1) 5520 load controller (to provide single set true peak lopping / import export control with mains failure protection). Back sync with mains is possible.<br>2) 5510 / 550 load controller to parallel with mains and produce fixed amount of power. Multiple engines can be used to increase the amount of power taken by the sets. Mains failure protection is not integrally provided and if the mains breaker is opened, active back sync with the mains is not possible.<br>3) 5510 / 5560 or 550 / 556. Multiple engines can be used to increase the amount of power taken by the sets. Mains failure protection is provided by the 5560 / 556 controller which will also allow back-synch with the mains supply and true peak lopping / import export control.<br>4) 555/557 load controller (to provide single set fixed power with mains failure protection). Back sync with mains is possible.                                                                                   |                                                                  |
|  | Governor :           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✗                                                                |
|  |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5520 analogue output<br>P120 governor interface (555/557)        |
|  | AVR :                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                                                                |
|  |                      | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5510 / 5520 analogue output<br>P121 governor interface (555/557) |
|  | Load Share options : | <ul style="list-style-type: none"> <li>• kW control.</li> <li>• Var/pf control</li> <li>• Import / export control (with 5560 / 556)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                  |
|  | Description          | <p>If a 5560 / 556 controller is not present, the set will produce a fixed amount of power and will therefore export power to the mains supply (utility) if the load falls below the configured load control level.</p> <p>The 5560 / 556 controller will enable the mains current to be monitored and will maintain mains or generator usage (configurable) to a pre-set level.</p> <p>The 5560 will also allow standby to multiple mains supplies while operating in a peak lopping mode.</p> <div style="border: 1px solid black; padding: 5px;"> <p><b>! CAUTION!:- External ROCOF/Vector shift detection equipment MUST be fitted to the incoming mains supply to detect loss of mains when in parallel.</b></p> <p><b>This external relay MUST be used to provide a signal into one of the digital inputs configured to "Auxiliary mains failure".</b></p> <p><b>This is used to ensure termination of the power export function upon loss of the mains supply during paralleling.</b></p> </div> |                                                                  |

## 5.2 MULTIPLE SETS

### 5.2.1 MULTIPLE SET PRIME POWER

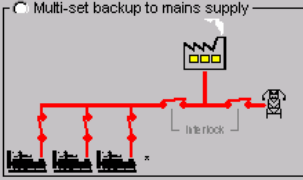
Two or more sets are used to provide power to the load, sharing power equally as a percentage of the sets full load rating. Sets are automatically started and stopped depending upon load levels allowing economic use of the available generators.

|                                                                                   |                                                                                 |                                                                                                                                                        |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <b>Controller :</b> 5510 Load sharing controller<br>550 Load sharing controller |                                                                                                                                                        |
|                                                                                   | <b>Governor :</b>                                                               | Droop <b>✗</b>                                                                                                                                         |
|                                                                                   |                                                                                 | Interface method 5510 analogue output<br>P120 governor interface (550)                                                                                 |
|                                                                                   | <b>AVR :</b>                                                                    | Droop <b>✓</b>                                                                                                                                         |
|                                                                                   |                                                                                 | Interface method 5510 analogue output<br>P121 governor interface (550)                                                                                 |
|                                                                                   | <b>Load Share options :</b>                                                     | • Load share kW                                                                                                                                        |
| <b>Description</b>                                                                |                                                                                 | Full control of the kW/KVAr load share is possible, the sets equally sharing the kW load between them pro rata (i.e. same percentage of their rating). |

**⚠ NOTE:** - It is recommended that ROCOF (Rate of change of frequency) or vector shift detection components are fitted when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. However, in applications of this type, where parallel time is kept to a minimum, this is usually not a requirement.  
If in doubt, you should refer to your local Electricity Supply Company for advice.

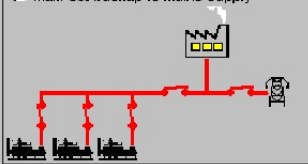
### 5.2.2 MULTIPLE SET STANDBY TO MAINS SUPPLY (BREAK RETURN)

Two or more sets are used to provide backup to the mains supply. When the mains supply fails, the sets are started, synchronised and paralleled together. The generators bus is then closed to feed the load, the sets sharing power equally as a percentage of their full load rating. Sets are automatically started and stopped depending upon load levels allowing economic use of the available generators. When the mains supply returns, there will be a break in supply to the load while the transfer takes place.

|                                                                                   |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                       |
|-----------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
|  | <b>Controller :</b>         | 5510 load sharing controller.<br>550 load sharing controller.<br>530 Transfer switch control module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                       |
|                                                                                   | <b>Governor :</b>           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ✗                                                     |
|                                                                                   |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 5510 analogue output<br>P120 governor interface (550) |
|                                                                                   | <b>AVR :</b>                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ✓                                                     |
|                                                                                   |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 5510 analogue output<br>P121 governor interface (550) |
|                                                                                   | <b>Load Share options :</b> | <ul style="list-style-type: none"> <li>• Load share kW</li> <li>• Load share kVAr</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                       |
| <b>Description</b>                                                                |                             | <p>A DSE 530 controller will monitor the mains supply and signal the sets to start should the supply fail. All available sets will start and after successfully paralleling with each other will signal their availability to the 530 transfer switch controller. The 530 will then transfer the load to the generator bus. The generators will then share power using their load sharing communications link, sets being stopped / started depending upon load demands. Upon mains restoration, the 530 controller will change the load back to the mains supply, then instruct the generating sets that they are no longer required.</p> <p>See Appendix 1 for further details of this application.</p> |                                                       |

### 5.2.3 MULTIPLE SET STANDBY TO MAINS SUPPLY (NO BREAK RETURN)

Two or more sets are used to provide backup to the mains supply. When the mains supply fails, the sets are started, synchronised and paralleled together. The generators bus is then closed to feed the load, the sets sharing power equally as a percentage of their full load rating. Sets are automatically started and stopped depending upon load levels allowing economic use of the available generators. When the mains supply returns, there will be **NO** break in supply to the load while a ramped transfer takes place.

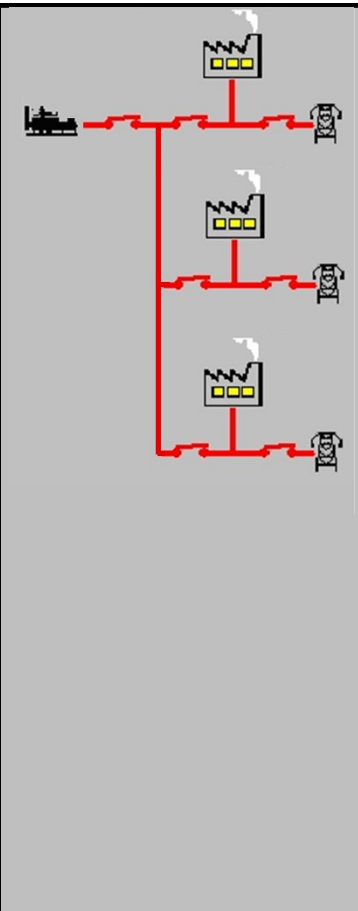
|                                                                                   |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                       |
|-----------------------------------------------------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
|  | <b>Controller :</b>         | 5510 load sharing controller / 5560 Mains controller<br>550 load sharing controller / 556 Mains controller                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                       |
|                                                                                   | <b>Governor :</b>           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✗                                                     |
|                                                                                   |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5510 analogue output<br>P120 governor interface (550) |
|                                                                                   | <b>AVR :</b>                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                     |
|                                                                                   |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5510 analogue output<br>P120 governor interface (550) |
|                                                                                   | <b>Load Share options :</b> | <ul style="list-style-type: none"> <li>• Load share kW.</li> <li>• Load share kVAr</li> <li>• Import / Export control</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                       |
|                                                                                   | <b>Description</b>          | <p>A DSE 5560/556 controller is connected to the load share controllers via the <b>Multi Set Communications</b> (up to 16 load share controllers can be connected together and up to 16 mains controllers can be connected together. The maximum number of controllers on a system must not exceed 20)</p> <p>A DSE 5560/556 controller will monitor the mains supply and signal all available sets to start should the supply fail. Additionally the 5560 will start the sets if the mains load reaches a configurable level to provide peak lopping and import/export control. All available sets will start and after the minimum number of sets have successfully paralleled with each other, the 5560 will transfer the load to the generator bus.</p> <p>The generators will then share the load using their load sharing communications link, sets being stopped / started depending upon load demands (if enabled)</p> <p>Upon mains restoration, the 5560 controller will synchronise the generator bus to the mains and ramp the load back to the mains. The sets are then instructed to cool down and stop.</p> |                                                       |

## 5.3 MULTIPLE MAINS SUPPLIES

### 5.3.1 SINGLE SET STANDBY TO MULTIPLE MAINS SUPPLY (NO BREAK RETURN)

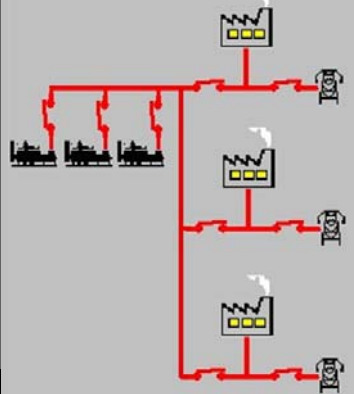
One set is used to provide backup to multiple mains supplies. Should one of the mains supplies fail, the set is started, and the appropriate load is transferred to the generator set. Should further mains supplies fail, the appropriate loads will also be transferred to the generator.

Should one of the mains supplies return, there will be **NO** break in supply to the load while a ramped transfer takes place. This will be repeated for each returning mains supply until the generator set is transferred off load and finally stopped.

|                                                                                    |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                      |
|------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|  | <b>Controller :</b>         | 5510 load sharing controller / 5560 Mains controller                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                      |
|                                                                                    | <b>Governor :</b>           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✗                    |
|                                                                                    |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5510 analogue output |
|                                                                                    | <b>AVR :</b>                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓                    |
|                                                                                    |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 5510 analogue output |
|                                                                                    | <b>Load Share options :</b> | <ul style="list-style-type: none"> <li>• Load share kW.</li> <li>• Load share kVAr</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |
|                                                                                    | <b>Description</b>          | <p>A DSE 5560 controller is connected to the load share controllers via the <b>Multi Set Communications</b> link (up to 16 load share controllers can be connected together and up to 16 mains controllers can be connected together. The maximum number of controllers on a system must not exceed 20)</p> <p>A DSE 5560 controller will monitor the mains supply and signal all available sets to start should the supply fail. Additionally the 5560 will start the sets if the mains load reaches a configurable level to provide peak lopping and import/export control. The set will start and the 5560 will transfer the load to the generator.</p> <p>Upon mains restoration, the 5560 controller will synchronise the generator to the mains and ramp the load back to the mains.</p> |                      |

### 5.3.2 MULTIPLE SET STANDBY TO MULTIPLE MAINS SUPPLY (NO BREAK RETURN)

Two or more sets are used to provide backup to multiple mains supplies. When a mains supply fails, the sets are started, synchronised and paralleled together. The generators bus is then closed to feed the load, the sets sharing power equally as a percentage of their full load rating. Sets are automatically started and stopped depending upon load levels allowing economic use of the available generators. Should more than one mains supply fail, their appropriate loads are also transferred to the gen-sets. When a mains supply returns, there will be **NO** break in supply to the load while a ramped transfer takes place. If all mains supplies return together then the mains priority is used to determine which mains transfer first, each mains supply is paralleled with the gen-sets and the appropriate load is ramped onto the mains supply, until all mains supplies are back on load.

|                                                                                    |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                      |
|------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|  | <b>Controller :</b>         | 5510 load sharing controller / 5560 Mains controller                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                      |
|                                                                                    | <b>Governor :</b>           | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✗                    |
|                                                                                    |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5510 analogue output |
|                                                                                    | <b>AVR :</b>                | Droop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                    |
|                                                                                    |                             | Interface method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5510 analogue output |
|                                                                                    | <b>Load Share options :</b> | <ul style="list-style-type: none"> <li>• Load share kW.</li> <li>• Load share kVAr</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                      |
|                                                                                    | <b>Description</b>          | <p>A DSE 5560 controller is connected to the load share controllers via the <b>Multi Set Communications</b> link (up to 16 load share controllers can be connected together and up to 16 mains controllers can be connected together. The maximum number of controllers on a system must not exceed 20)</p> <p>A DSE 5560 controller will monitor the mains supply and signal all available sets to start should the supply fail. Additionally the 5560 will start the sets if the mains load reaches a configurable level to provide peak lopping and import/export control. All available sets will start and after the minimum number of sets have successfully paralleled with each other, the 5560 will transfer the load to the generator bus.</p> <p>The generators will then share the load using their load sharing communications link, sets being stopped / started depending upon load demands (if enabled)</p> <p>Upon mains restoration, the 5560 controller will synchronise the generator bus to the mains and ramp the load back to the mains. The sets are then instructed to cool down and stop.</p> |                      |

## 6 LOAD SHARING

### 6.1 ACTIVE POWER SHARING

We have discussed the synchronising of one or more supplies to the mains or bus supply. Once these supplies are closed in parallel with each other, the power will be shared between the supplies depending upon the generating set characteristics.

Consider firstly, two generators operating in droop, closed together in parallel. Providing that the governors are set correctly, the ratios of the power supplied to the load by each generator will be proportional to the ratio of governor droop in each system.

For instance for a load of 100kW, and two generators with 3% speed droop, the generators will equally share the load, each one supplying 50kW.

Consider now one generator operating in droop, connected in parallel with the mains supply, with the governor adjusted so that the mains and the generator are sharing the load between them. "Backing off" the governor, decreasing the engine's fuel supply, will result in the mains 'motoring' the alternator. The generator is being "reverse powered", absorbing power from the mains supply and not supplying any power to the load.

Instructing the governor to increase fuel to the engine will also have no effect on engine speed because the generator is "tied" to the mains. Instead, the generator will begin to supply power to the load. Further increasing the fuel supply increases the amount of power supplied by the generator. This in turn decreases the amount of power supplied by the mains. This is known as Kilowatt (kW) export.

This can be taken a step further, by paralleling multiple generating sets, all operating isochronously (zero droop). Utilising an active load-sharing controller such as the **DSE 55xx or 55x** range, precise changes can be made to the amount of power supplied to the load by each generating set. This is achieved by altering the amount of fuel supplied to the engine, and monitoring the amount of power supplied by the set.

Each controller can communicate with the others, passing information regarding load levels. This can also be used to bring in or drop off other generating sets as load demands change.

### 6.2 REACTIVE POWER SHARING

Again, consider two identical generating sets closed together in parallel. Each generator has a 'droop kit' fitted to the AVR and the field current of each generator is the same. In this situation, they will both supply equal reactive power (kVAr) to the load.

Adjusting the amount of field excitation in one of the generators has the effect of that generator supplying more or less of the reactive power to the load, matched by an equal drop in the reactive power supplied by the other generator.

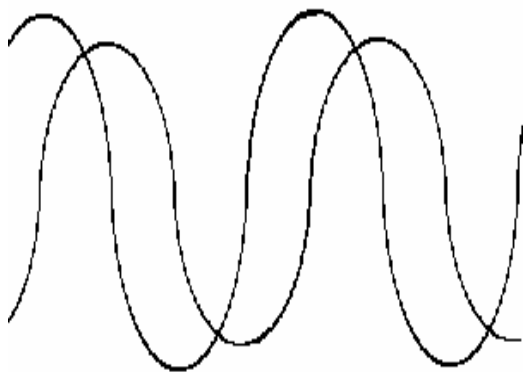
Uses of reactive power control include:

- 1) Where multiple generators are used in parallel with each other, the AVRs droop kits will ensure that the reactive power is equalised between the sets, removing circulating currents caused by imbalance in the reactive power (VAr) supplied by the paralleled generating sets. This circulating current generates heat in the alternator windings, which has the effect of limiting active power (kW) output, reducing the efficiency of the generating set. If left unchecked, excess circulating current can also damage the alternator windings.
- 2) Power factor control or VAr control. This feature maintains a specific power factor where one generating set is used in parallel with the mains supply. This is normally used so that the generator maintains its VARs to keep its output at the site load's average power factor level, to minimise demands on the mains supply.

## 7 THE NEED FOR SYNCHRONISING

Before two or more A.C. supplies can be 'closed' together in parallel, the frequency, voltage and phase of the supplies must be matched as closely together as possible. Collectively, frequency and voltage matching are known as synchronisation, although voltage matching may not be required in all applications.

Additionally, the phase rotation of the supplies must be the same, i.e. L1, L2, L3 (Anticlockwise rotation) or L3, L2, L1 (Clockwise rotation). The DSE synchronising and load sharing modules will check the phase rotation. If this is wrong, the controller can not act, apart from notifying the operator with an alarm condition. The fault must be corrected before synchronising of the supplies can be attempted.



Synchronisation is achieved firstly by adjusting the engine speed and generator voltage to get the frequency and voltage of the generator closely matched to that of the bus / mains supply.

Then the phase angle of the supplies is monitored until it is within an acceptable 'window' before the supplies can be closed together in parallel.

In the example to the left, the two supplies (shown by the two sine waves) have very similar frequencies (seen as the distance between the "peaks" of the waves). However, they have very different voltages (overall heights of the waves) and the supplies are not in phase (the two supply waves are not "on top" of each other).

Typically, a frequency difference (called slip frequency) of 0.2Hz, a voltage difference of 5% and a phase angle of 5° will allow for satisfactory paralleling of the supplies.

Once the supplies are closed in parallel, the phase of the supplies will not alter, they are 'locked' in parallel together.



**WARNING! Attempting to close the supplies in parallel when they are not in synchronism can result in damage to the generating set system.**

**For example: If synchronising (using two gensets) is effected 120° out of phase, the coupling torque can be as high as 12 times full load torque, depending on the ratio of engine and generator inertias (Source: Diesel Generator Handbook L.L.J. Mahon).**

The actual synchronising process can be achieved through various methods. Put simply, each method involves manipulating the engine governor to increase/decrease engine speed (which has a direct relationship with generator frequency) and the Automatic Voltage Regulator (which controls the alternator excitation field to produce voltage).

The engine governor determines engine speed, by sensing the speed of rotation of the flywheel (normally using a magnetic pickup probe). The governor can then control the actuator to adjust the amount of fuel into the engine, which changes engine speed (similar to the accelerator in a car). Most governors are also fitted with a 'remote speed adjust' input to allow an external device to increase or decrease the set speed of the engine.

The Automatic Voltage Regulator effects change in the generator output voltage by controlling the alternator's exciter field. The AVR adjusts the voltage output to the required set voltage. Most AVRs are also fitted with a 'remote volts adjust' input to allow an external device to increase or decrease the set voltage of the alternator.

Automatic synchronisers act upon the 'remote speed adjust' and 'remote volts adjust' inputs of the governor and AVR to affect synchronism and voltage matching.

The method of interface between the automatic synchroniser and the governor/AVR depends upon the type of governor and AVR being used, and are described in the section entitled "Methods of Adjusting Voltage and Frequency".

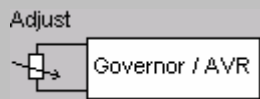
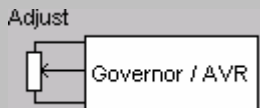
## 8 METHODS OF ADJUSTING VOLTAGE & FREQUENCY

### 8.1 REMOTE SPEED / VOLTAGE POTENTIOMETERS

The most common way to remotely adjust engine speed/generator voltage is by speed/voltage potentiometers. These are fitted to the control panel to allow the operator to adjust the supply to the parameters required and connect directly to most AVRs/Governors, which are fitted with terminals designed for the purpose.

A simple way to replace this manual operation with an automatic one is by utilising a motor driven potentiometer, which is adjusted automatically by the synchronising controller.

Two popular methods of interfacing with potentiometers have been adopted by AVR/Governor manufacturers and are commonly shown on their 'connection diagrams' as shown in the following examples:

| Illustration                                                                                                 | Description                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Variable resistance</p>  | <p>This diagram shows a two terminal connection to the governor/AVR. The value of the variable resistor (rheostat) depends upon the requirements of the governor/AVR being used.</p> <p>This type of interface is suitable for connection direct to the analogue governor output of the 55xx controllers or connection to the DSE <b>P120</b> governor interface module for 55x controllers.</p> |
| <p>Potentiometer</p>       | <p>This diagram shows a three terminal arrangement, for connection to a potentiometer. The value of the potentiometer depends upon the requirements of the governor/AVR being used.</p> <p>This type of interface is suitable for connection direct to the analogue governor output of the 55xx controllers or to the DSE <b>P120</b> governor interface module for 55x controllers.</p>         |

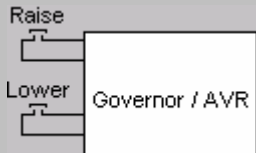
### 8.2 DC VOLTAGE INPUT

Another analogue interface often used by governor manufacturers utilises a DC voltage, the level of which is proportional to the engine speed required. An example of this is the G.A.C.ESD5500E that accepts a DC signal from 2V to 8V to represent adjustment away from the set speed point. When the DC level is at 5V, the engine speed is the governors' set speed.

This type of interface is suitable for connection direct to the analogue governor output of the 55xx controllers or connection to the DSE **P120** governor interface module for 55x controllers.

### 8.3 RAISE / LOWER PUSH BUTTONS

Push buttons to raise/lower the engine speed / alternator output voltage can also be used. The push buttons are fitted to the control panel and allow step changes in voltage / frequency with a single press of the button.

| Illustration                                                                                                          | Description                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>RAISE / LOWER PUSH BUTTONS</p>  | <p>This diagram shows switched inputs to the governor/AVR to raise/lower speed/voltage.</p> <p>This type of interface is suitable for direct connection to the 5xxx controller, though it is usual to fit interposing slave relays between the controller and the governor/AVR to provide isolation between the devices.</p> |

**NOTE:- Governor and AVR connections are covered in detail (including typical connection for commonly used governors and AVRs) in the DSE Guide to Synchronising and Load Sharing Part 2.**

## 8.4 CAN / ELECTRONIC ENGINE SPEED CONTROL

Some electronic engine ECUs support speed control via the CAN data interface negating the requirement to connect additional speed control signals to the speed controller.

This feature is supported only by the 5510 and 5520 controllers.



**NOTE:-** Connections to electronic engine ECUs are detailed in the DSE publication *Electronic Engines and DSE wiring* and the *Guide to Synchronising and Load Sharing Part 2*.

## 9 REQUIREMENTS FOR SYNCHRONISATION AND LOAD SHARING

### 9.1 AUTOMATIC SYNCHRONISING

Automatic synchronising is the control over engine speed and generator output volts prior to the actual paralleling of the supplies. All 5510/5520 controllers perform automatic synchronising using either the inbuilt analogue governor output or the inbuilt relays.

All 'auto-sync' and 'load-share' versions of the 55x controller can perform this function, although some governors/AVRs will require an external interface device (See sections entitled P120/P121 analogue voltage module and P122 Digital resistance module).

### 9.2 ISOCHRONOUS LOAD SHARING

Isochronous load sharing is the use of isochronous (zero droop) governors, with full automatic control over load sharing (i.e. the amount of power supplied by each set). When either off load, or on load, the generators output frequency will remain the same (i.e. 50Hz).

The DSE modules (when used in a MultiSet system) communicate to establish total system load. This data is then used (when the controllers are suitably configured) to decide whether it is necessary to call more sets for duty as the load levels increase. Additionally sets are automatically unloaded and removed from the bus if the load level falls low enough to allow this. This allows the generating sets to be used at a more economical level by ensuring the available (gensets currently running) capacity is close to the actual demand. This reduces the amount of unloaded engines that are running, hence improving efficiency and lowering fuel costs.

For isochronous load sharing, the governor must be controlled by the inbuilt analogue governor output on 5510 based systems or the P120 analogue governor interface module for 550 based systems.

 **NOTE: - It is recommended that ROCOF (Rate of change of frequency) or vector shift detection components are fitted when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. If in doubt, you should refer to your local Electricity Supply Company for advice.**

## 9.3 GOVERNOR AND GOVERNOR INTERFACE

### 9.3.1 ISOCHRONOUS LOAD SHARING

For synchronising purposes where active load sharing is employed, isochronous governors with sync/load share DC analogue inputs should be used.

Isochronous active load sharing demands a fast response to variations in the measured parameters. For this reason, we recommend the use of the connection direct to the analogue governor output of the 5510/5520 controllers or P120 analogue governor interface module in 550/555/557 applications of this type

Isochronous active load sharing is typically employed in mains peak lopping or multiple set prime power applications.

## 9.4 GENERATOR AND AVR INTERFACE

### 9.4.1 REACTIVE LOAD SHARE

Automatic reactive load control is used in multiset load sharing applications to minimise the circulating currents between sets. AVR droop kits go some way to providing this function but the addition of automatic control provided by the 55xx or 55x can reduce the circulating current even further.

The generator must be fitted with a remotely adjustable AVR (automatic voltage regulator).

The DSE Load sharing controller can take full control over the reactive power supplied by the generating set.



**WARNING: - Care should be taken with respect to the grounding methodology of the generator neutrals, particularly where alternators with differing winding pitches are to be paralleled.**



**NOTE:- As the kVAr control input on many AVRs is 'slugged' (time delayed) it is important that the alternator has droop fitted and configured. Using an alternator without droop and relying on the load sharing controller may appear to operate correctly under test and commissioning, but fast changing load levels can make the system unstable if alternator droop is not used correctly.**

**For further details, you are referred to your AVR/Alternator manufacturer.**

### 9.4.2 REACTIVE LOAD CONTROL

Automatic reactive load control is typically used in peak lopping / peak shaving applications to minimise the kVAr demands on the mains supply.

For voltage matching with the mains/utility supply, the generator must be fitted with a remotely adjustable AVR (automatic voltage regulator).

The 5xxx Load sharing controller can take full control over the reactive power supplied by the generating set. This can be used for exporting a fixed amount of power (VAr control).

 **NOTE:-** As the kVAr control input on many AVRs is 'slugged' (time delayed) it is important that the alternator has droop fitted and configured. Using an alternator without droop and relying on the load sharing controller may appear to operate correctly under test and commissioning, but fast changing load levels can make the system unstable if alternator droop is not used correctly.  
For further details, you are referred to your AVR/Alternator manufacturer.

 **WARNING:-** Care should be taken with respect to the grounding methodology of the generator neutrals, particularly where alternators with differing winding pitches are to be paralleled.

## 9.5 FUNCTION COMPARISON CHART

|                                                      | 5510 load share                                                                  | 5520 load control                                                                | 5560 mains controller                                                            | 550/555 non sync                                    | 555 auto sync                                       | 550 load share                                      | 555 load control                                    | 557 load control                                    | 556 mains controller                                |
|------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Power measurement instrumentation                    | ✓                                                                                | ✓                                                                                | ✓                                                                                | Only 'enhanced' (power measurement) controllers.    | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   |
| Auto synchronising                                   | ✓                                                                                | ✓                                                                                | ✓                                                                                | ✗                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   |
| Isochronous load sharing / control                   | ✓                                                                                | ✓                                                                                | ✓                                                                                | ✗                                                   | ✗                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   |
| MultiSet communications                              | ✓                                                                                | ✗                                                                                | ✓                                                                                | ✗                                                   | ✓                                                   | ✓                                                   | ✗                                                   | ✓                                                   | ✓                                                   |
| Starts sets on rising mains load                     | ✗                                                                                | ✓                                                                                | ✓                                                                                | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   |
| Automatic first set on the bus determination         | ✓                                                                                | N/A                                                                              | ✓                                                                                | ✗                                                   | ✗                                                   | ✓                                                   | N/A                                                 | N/A                                                 | ✓                                                   |
| Calls for more or less sets on changing load demands | ✓                                                                                | N/A                                                                              | ✓                                                                                | ✗                                                   | N/A                                                 | ✓                                                   | N/A                                                 | N/A                                                 | ✗                                                   |
| Mains power monitoring                               | N/A                                                                              | ✓                                                                                | ✓                                                                                | ✗                                                   | ✗                                                   | N/A                                                 | ✗                                                   | ✗                                                   | ✓                                                   |
| Adjustable priority                                  | ✓                                                                                | N/A                                                                              | ✓                                                                                | ✗                                                   | N/A                                                 | ✓                                                   | N/A                                                 | N/A                                                 | ✓                                                   |
| Automatically balances run hours (multiset system)   | ✓                                                                                | N/A                                                                              | ✓                                                                                | ✗                                                   | ✗                                                   | ✗                                                   | N/A                                                 | ✗                                                   | ✗                                                   |
| RS232 option available?                              | ✓                                                                                | ✓                                                                                | ✓                                                                                | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✗                                                   | ✓                                                   |
| RS485 option available?                              | ✓                                                                                | ✓                                                                                | ✓                                                                                | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✗                                                   | ✓                                                   |
| Configurable LEDs?                                   | ✓                                                                                | ✓                                                                                | ✓                                                                                | ✓                                                   | ✓                                                   | ✓                                                   | ✓                                                   | ✗                                                   | ✓                                                   |
| Interface to governor/AVR                            | Inbuilt analogue output                                                          | Inbuilt analogue output                                                          | N/A                                                                              | ✗                                                   | P120 / P121                                         | P120 / P121                                         | P120 / P121                                         | P120 / P121                                         | N/A                                                 |
| Load switch push buttons?                            | Inbuilt fascia buttons, also available using digital inputs and external buttons | Inbuilt fascia buttons, also available using digital inputs and external buttons | Inbuilt fascia buttons, also available using digital inputs and external buttons | Available using digital inputs and external buttons | Available using digital inputs and external buttons | Available using digital inputs and external buttons | Available using digital inputs and external buttons | Available using digital inputs and external buttons | Available using digital inputs and external buttons |
| Support for P130 input expansion?                    | ✓                                                                                | ✓                                                                                | ✓<br>(digital inputs only)                                                       | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   | ✗                                                   |
| PC configuration software                            | 5xxx for Windows                                                                 | 5xxx for Windows                                                                 | 5xxx for Windows                                                                 | P810 for Windows                                    | P810 for Windows                                    | P810 for Windows                                    | P810 for Windows                                    | P810 for Windows                                    | P810 for Windows                                    |
| Remote Comms software                                | Link5000Plus                                                                     | Link5000Plus                                                                     | Link5000Plus                                                                     | Link500Plus                                         | Link500Plus                                         | Link500Plus                                         | Link500Plus                                         | Link500Plus                                         | Link500Plus                                         |

## 9.6 SYNC / LOAD SHARE PROTECTION COMPARISON CHART

|                                    | 5510 load share | 5520 load control | 5560 mains controller | 550/555 non sync                                 | 555 auto sync | 550 load share | 555 load control | 557 load control | 556 mains controller |
|------------------------------------|-----------------|-------------------|-----------------------|--------------------------------------------------|---------------|----------------|------------------|------------------|----------------------|
| Phase rotation protection          | ✓               | ✓                 | ✓                     | ✓                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Dead bus relay                     | ✓               | ✓                 | ✓                     | ✗                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Frequency check                    | ✓               | ✓                 | ✓                     | ✗                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Voltage check                      | ✓               | ✓                 | ✓                     | ✗                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Phase angle check                  | ✓               | ✓                 | ✓                     | ✗                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Fail to synchronise alarm          | ✓               | ✓                 | ✓                     | ✗                                                | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Generator reverse power            | ✓               | ✓                 | ✓                     | Only 'enhanced' (power measurement) controllers. | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Mains reverse power                | ✗               | ✓                 | ✓                     | ✗                                                | ✗             | ✗              | ✗                | ✗                | ✗                    |
| Loss of excitation protection      | ✓               | ✓                 | ✗                     | ✗                                                | ✗             | ✗              | ✗                | ✗                | ✗                    |
| Earth fault protection             | ✓               | ✓                 | ✓                     | Only 'enhanced' (power measurement) controllers. | ✓             | ✓              | ✓                | ✓                | ✓                    |
| Negative phase sequence protection | ✓               | ✓                 | ✗                     | ✗                                                | ✗             | ✗              | ✗                | ✗                | ✗                    |

 **NOTE:- Model 5560 must be used in conjunction with one or more 5510 controllers. It is not a stand alone module.**

 **NOTE:- Model 556 must be used in conjunction with one or more 550 controllers. It is not a stand alone module.**



## 10 LOAD SWITCHING DEVICES

The paralleling of two or more supplies requires that the switching of the supplies be performed as close to zero phase as possible. The check sync feature of the DSE synchronising and load sharing controller can accurately measure the phase, and when within the 'check sync' window can issue the load switching closure signal within a few milliseconds. However, there will be a delay in the actual operation and physical movement of the switching device that must be minimised and taken into account when designing and commissioning any paralleling system.

### 10.1 CHOOSING A LOAD SWITCHING DEVICE

It is typically considered that load switching for parallel supplies be performed within 5 supply cycles of the close signal being given to ensure the phase of the supplies has not changed too greatly after the closing signal has been given.

|             | Cycle time | Max load switch closing time |
|-------------|------------|------------------------------|
| 50Hz system | 20.0 ms    | <b>100 ms</b>                |
| 60Hz system | 16.7 ms    | <b>83 ms</b>                 |

 **NOTE:** - The closing time of any load switching device slave relays should also be taken into account. For instance, plug in relays typically used in generating set control panels have an operation time of 10mS-20mS.

 **NOTE:** - If fitting a mains (utility) 'Breaker' with a trip position, it is recommended to fit one equipped with auxiliary contacts to indicate the "tripped" position. This can be fed into an input configured to "auxiliary mains failure" so that the module is 'informed' of mains (utility) supply breaker tripping should this occur. This is particularly important when the module is operating in parallel with the mains (utility) supply.

 **WARNING!** Manually operated breakers CANNOT be used as they cannot be operated within the required closing time.

#### 10.1.1 CONTACTORS

Contactors normally operate fast enough for paralleling applications but care should be taken to choose a contactor that the manufacturer specifies be fast enough for use in paralleling applications. (See above).

#### 10.1.2 CHARGED SPRING BREAKERS

In general, charged spring breakers will operate much faster than contactors.

Charged spring breakers 'pre charge' a large spring device within the breaker, so that when breaker operation is required, the spring is 'released' which operates the closing action of the device.

Typically, the spring is charged when the undervolts input is energised, normally when the set is first started. Once charged, the breaker is ready for the closing signal.

#### 10.1.3 AIR CIRCUIT BREAKERS (ACBS)

A.C.B.'s normally operate fast enough for paralleling applications but care should be taken to choose an A.C.B. that the manufacturer specifies be fast enough for use in paralleling applications. (See above).

#### 10.1.4 MOTOR OPERATED BREAKERS

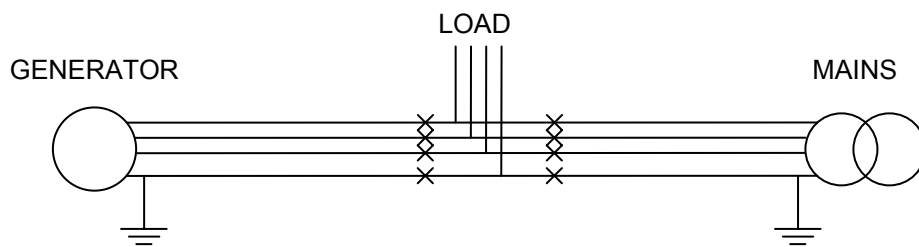
Some types of motor operated breakers are not suitable for paralleling operations due to the excessive amount of time that the breaker takes to motor into position before the closing process can be completed. Care should be taken to choose a motor operated breaker that the manufacturer specifies be fast enough for use in paralleling applications. (See above).

#### 10.1.5 MANUALLY OPERATED BREAKERS

As these cannot be closed within the required time, manually operated breakers cannot be used.

### 10.2 NEUTRAL EARTHING

Where the generator star point (Neutral conductor) is connected to earth, care must be taken to avoid *earth loops*. This is of particular importance when paralleling a generator with other sets or with the mains supply.



This diagram shows a typical situation where the generator neutral conductor is earthed. The mains neutral conductor is earthed by the supply company. If the generator is placed in parallel with the mains supply, the neutral will be earthed at two points, creating an earth loop, which in turn generates current flow in the loop. To prevent this situation, the generator neutral earth link can be broken when the supplies are in parallel using a neutral earthing contactor in the neutral to earth link.

Similarly, when two or more sets are in parallel with each other, it is important to ensure that only one neutral to earth link exist in the system at any one time.

Control over the neutral earthing is not made by the dse controller. Provision for this function must be made by external switching, often utilising auxiliary contacts of the load switching devices.

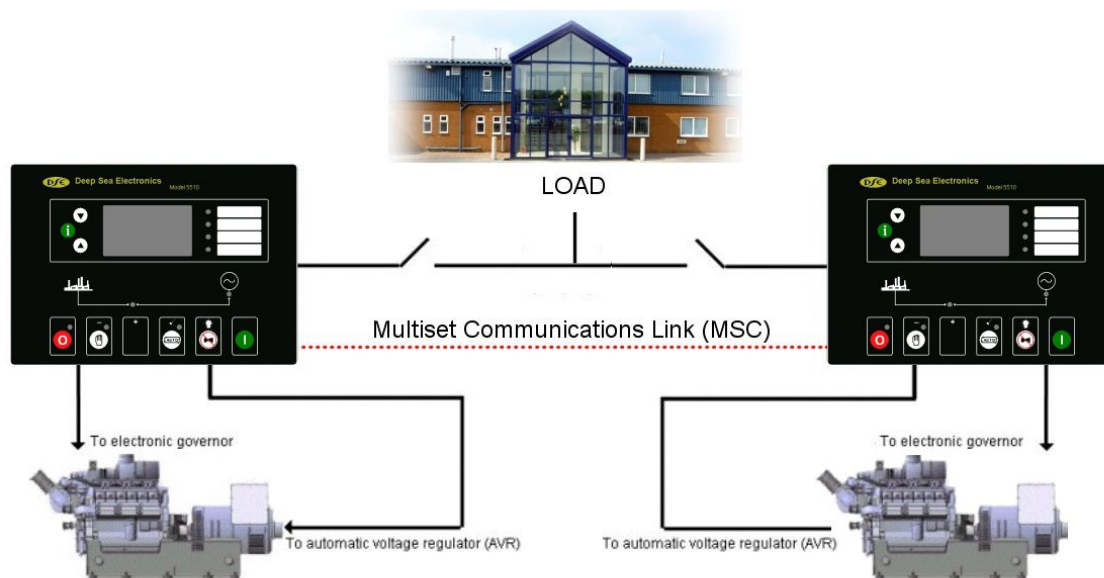
## 11 MULTISSET COMMUNICATIONS (MSC) LINK

The 5510 / 5560 / 550 / 556 / module is fitted with a data communications link known as the *MultiSet Communications Link* (MSC Link). This should only be connected to other DSE controllers as shown below and must not be connected to any other device.

The MSC Link is used by the controllers advanced load share functions. Some examples of this are:

- Determining which set is to be the first to close onto a dead bus, eliminating the need for complex external relay logic as traditionally used to perform this function.
- Determining the level of the total system load for use in load sharing applications. This is the digital equivalent of analogue load sharing lines.
- Identifying whether the set should start / stop based upon load levels when used in *running on load demand* mode.
- Starting and stopping the sets based on the accumulation of running hours. (5510 only)

### 11.1 MSC DETAILS



**NOTE:** - The MultiSet Communications link terminals (Mh, MI & SCR) are only to be connected to other DSE controllers as shown (5510/5560 controllers), and must not be connected to any other device.

**NOTE:** - Do not connect the MSC cable screen (SCR) to earth at any point. Protection from interference is provided within the module and may be compromised by earthing the MSC cable screen.

**NOTE:** - The maximum total length of the MSC link is 250 meters.

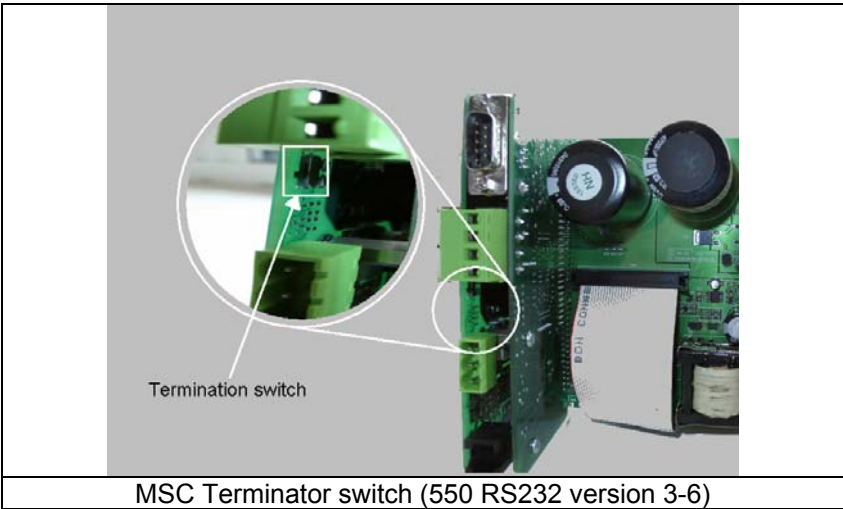
11.2 SETTINGS (ONLY ON 550 MODULES)

The MSC link is a data transmission line, requiring that a 120Ω termination resistor is present at the ends of the cable on the Mh and MI lines.

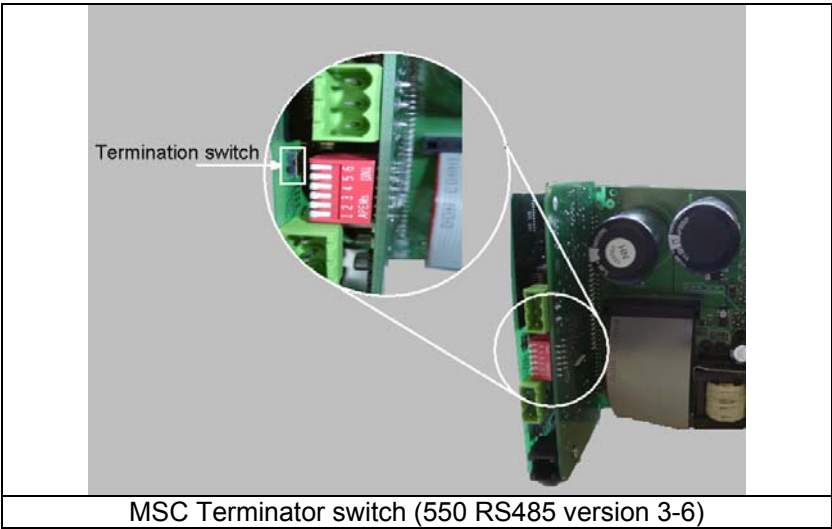
On version 7 and later 550 modules and on the 5510 / 5560 / 560 controllers, the resistor is supplied with the controller and must be fitted to the two ends of the cable on the Mh and MI lines.

On pre version 7 550 modules, this termination resistor is provided within the 550 module and is enabled / disabled via a switch, located behind the module's rear fascia plate. To access the switch, remove the six small screws from the rear of the module and gently remove the back plate. The switch is located above the MSC connection socket.

|             |                           |
|-------------|---------------------------|
| Switch up   | 120Ω termination resistor |
| Switch down | No termination resistor   |



MSC Terminator switch (550 RS232 version 3-6)



MSC Terminator switch (550 RS485 version 3-6)

**NOTE:** - Only the “end” modules in the MSC link must have the 120Ω termination resistor enabled (switch up). All other controllers must have the termination resistors disabled (switch down).

### 11.3 SPECIFICATIONS

| Parameter                                            | Value                                                                                                   |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Connection type                                      | Twin conductors with screen. Ensure screen is connected to SCR terminal of every controller on the bus. |
| Cable impedance                                      | 120Ω                                                                                                    |
| Maximum cable resistance                             | 0.050Ω/m                                                                                                |
| Maximum cable capacitance (between conductors)       | 75pF/m                                                                                                  |
| Maximum cable capacitance (conductor to shield)      | 110pF/m                                                                                                 |
| Termination resistors (one at each end of cable run) | 120Ω 4W (supplied loose/switchable)                                                                     |
| Max number of 5510 controllers per bus               | 16 (only 3 shown above for clarity)                                                                     |
| Max number of 5560 controllers per bus               | 16                                                                                                      |
| Max number of 5510 and 5560 controllers per bus      | 20                                                                                                      |
| Max number of 550 controllers per bus                | 16                                                                                                      |
| Max number of 556 controllers per bus                | 1                                                                                                       |
| Max cable length                                     | 250m                                                                                                    |
| Max Spur length (see note 2 below)                   | 1m                                                                                                      |
| Recommended cable                                    | * BELDEN 9841 120Ω cable.                                                                               |

 **NOTE :- \* Deep Sea Electronics part number. 016-030**

 **WARNING! 120Ω impedance cable must be used for the MultiSet Communications Link.**  
**Use of any other impedance cable may cause intermittent failures in communications, indicated by MSC alarms although the system may function normally during engine / panel testing.**

 **NOTE 1: - The 120Ω terminator must be enabled on the first and last devices on the communications bus. See section header MSC Settings for further details.**

 **NOTE 2: - It is important that the MultiSet Communications Link cable is run from one module to the next in a 'bus' fashion. 'Spurs' off this bus should be avoided where possible, but where a spur is unavoidable; its length should be kept less than 1m from the bus cable.**

## 11.4 ALARMS

Several alarms are provided to warn the operator of possible problems with the communication link between the gensets.

### 11.4.1 MSC ID ALARM

Each genset must have a unique MSC ID so that they can properly communicate. Should two or more sets have the same ID then one or more of the affected sets will declare “MSC ID ERROR” this will cause an electrical trip on the affected set. The correct ID must be set using the PC configuration software.

 **NOTE: - To avoid possible problems with spare modules it is suggested that units are commissioned in the system starting with ID 1 and then 2,3... etc. Any modules used as spares should be configured as number 16,15... etc. These can then be added to the system without causing any conflicts with existing modules. Alternatively, use the PC configuration software to reconfigure the module to suit.**

 **NOTE:- 5510 controllers version 5 and later will “auto negotiate” their MSC ID alarms to ensure that conflicts will never occur.**

### 11.4.2 MSC DATA ERROR

When the sets are communicating on the MultiSet Communications link, should the data be corrupted the affected modules will display ‘MSC DATA ERROR’. This will cause an electrical trip on the affected set.

 **CAUTION! - Care should be taken to ensure that correct wiring is used between the modules, the MSC terminator is correctly enabled on only end units on the link and that maximum cable run distances are not exceeded. Should data error alarms be apparent, operation of the MultiSet system may not be possible.**

### 11.4.3 MSC FAILURE

If the number of modules communicating on the Multiset communications link should fall, then an MSC failure alarm will occur. This can be configured to a ‘warning’ or ‘electrical trip’ type alarm. Should the number of modules on the communications link fall below the “Minimum modules on Multiset comms link” configurable setting, an additional alarm is triggered. This alarm can be disabled, or configured to generate a warning or electrical trip alarm.

If the number of modules communicating on the Multiset communications link should rise, then any existing ‘MSC failure’ warning alarm is cleared, and all communicating modules are automatically reconfigured to ‘expect’ the increased number of sets on the bus.

Additionally, one of the module’s digital inputs can be configured so that the MSC failure alarm is disabled when the input is active. The module can be configured to alert / remind the user of this via an indication or warning alarm if required via the “Multiset comms alarm disabled action” setting.

 **NOTE:- For details on the MSC failure alarm settings, you are referred to the section entitled “5xxx controller configuration for load sharing” elsewhere in this manual.**

### 11.4.4 MSC TOO FEW SETS

This alarm activates if the number of sets on the MSC link is less than minimum number configured in the module.

## 12 LOAD SHARE LINES

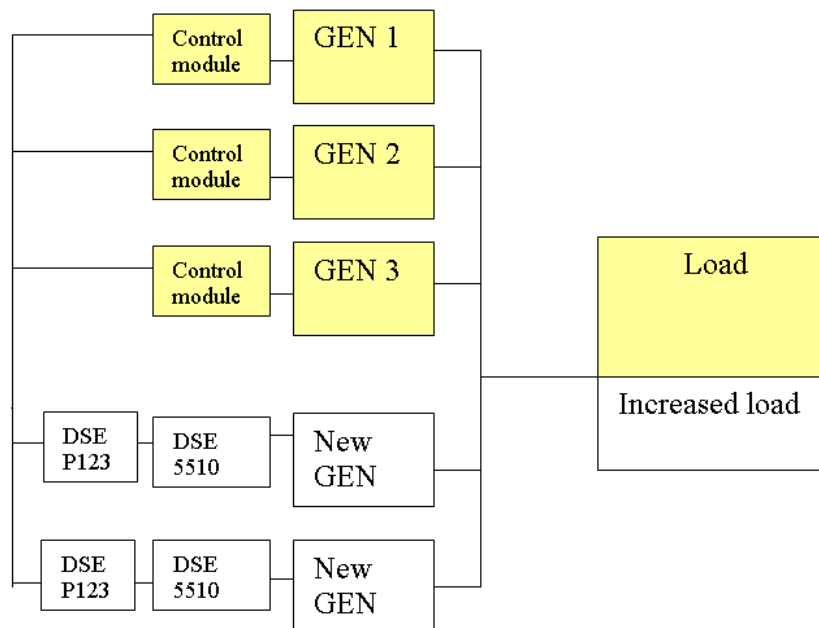
While the MSC link provides functions far in excess of what is possible using conventional load share line technology, occasions arise when it may be necessary to interface to an existing installation.

The DSE P123 module provides a method of connecting the 5510 modules into the load share line based system. This mimics an additional set on the load share line system and will operate in both kW share and Kvar share modes (if supported by the installation).

The P123 is compatible with a range of different load share lines commonly found in the field; selection is via switches on the P123.



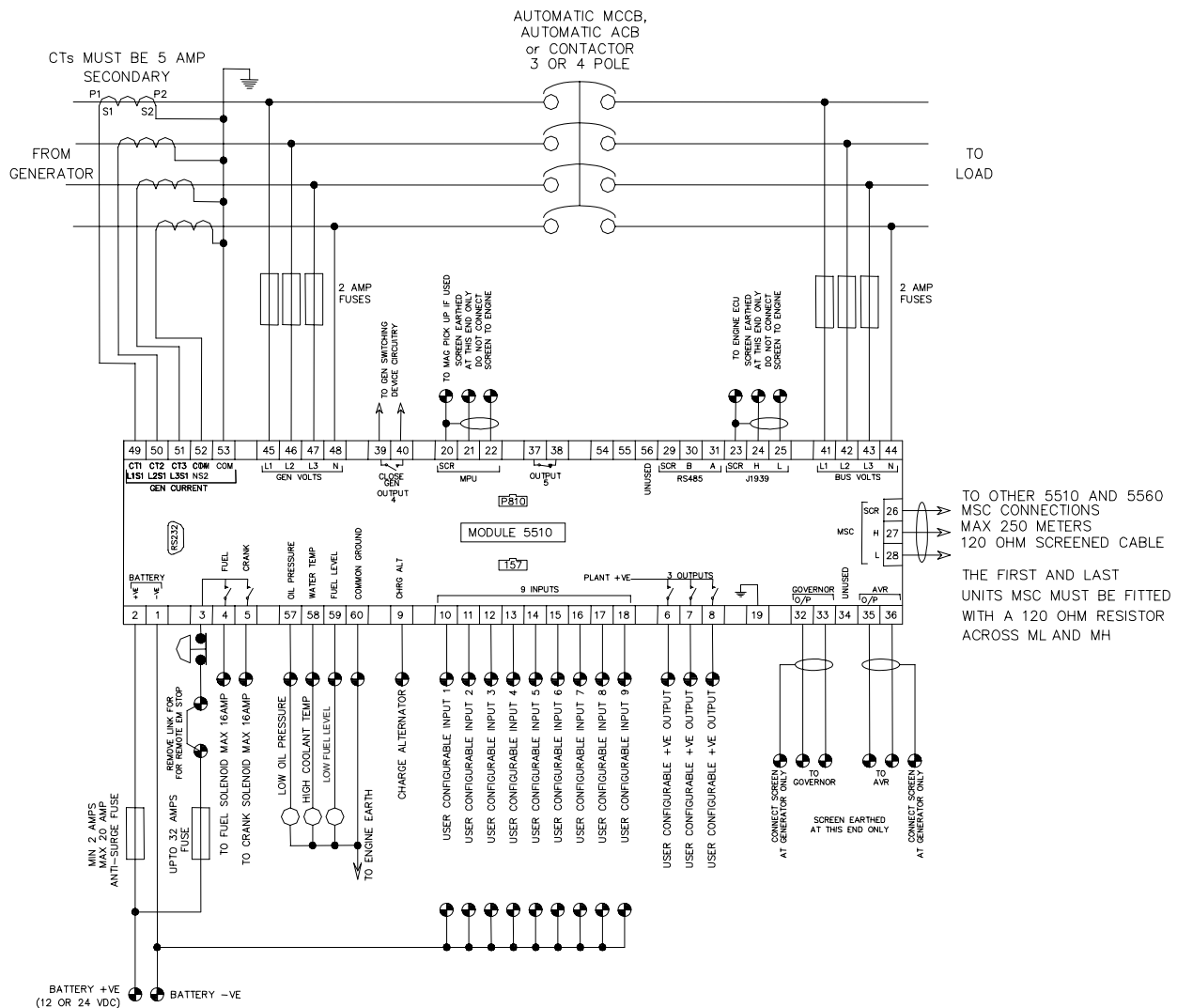
### 12.1 TYPICAL P123 INSTALLATION



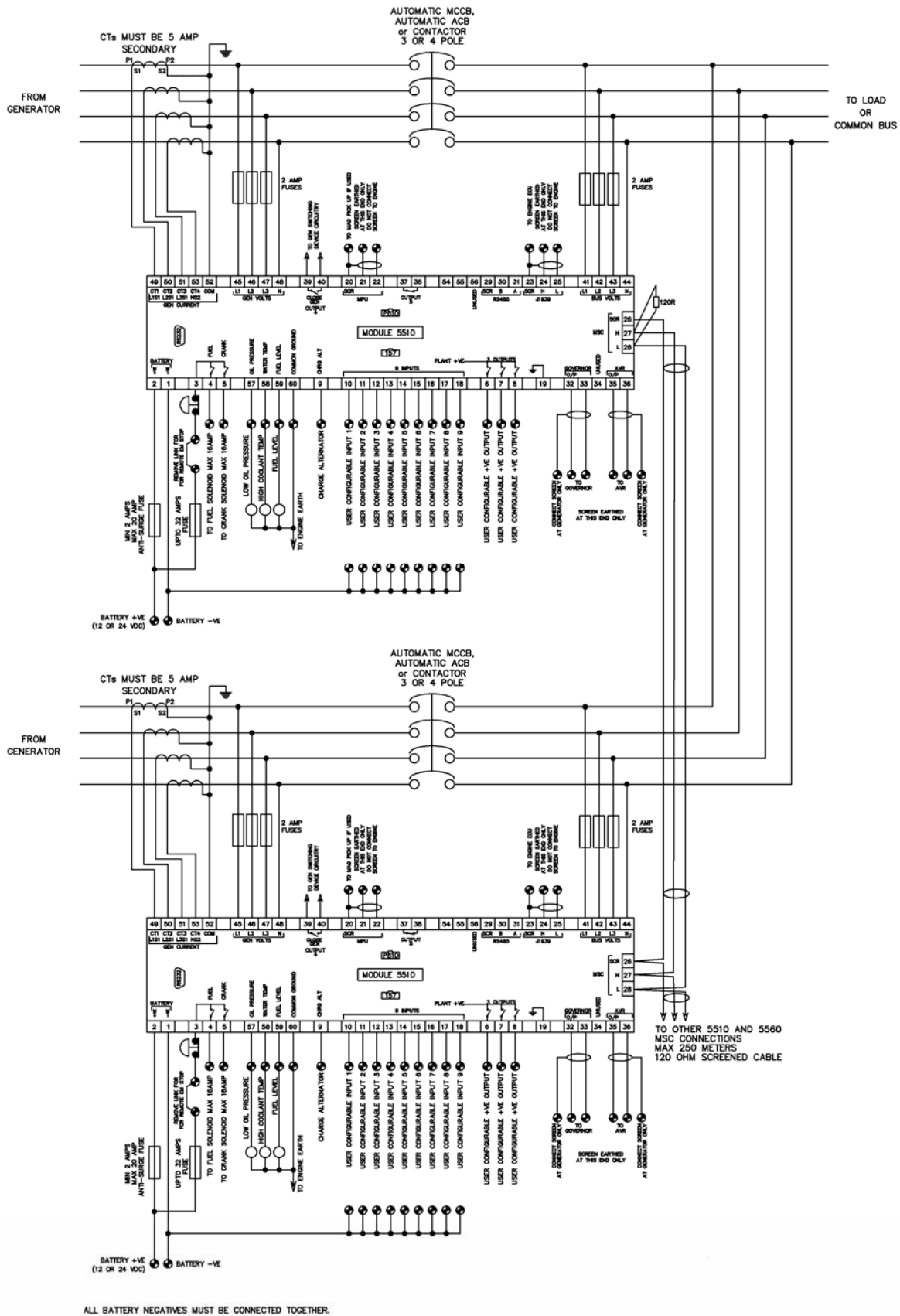
## 13 TYPICAL CONNECTIONS

### 13.1 5510/5520/5560 CONTROLLERS

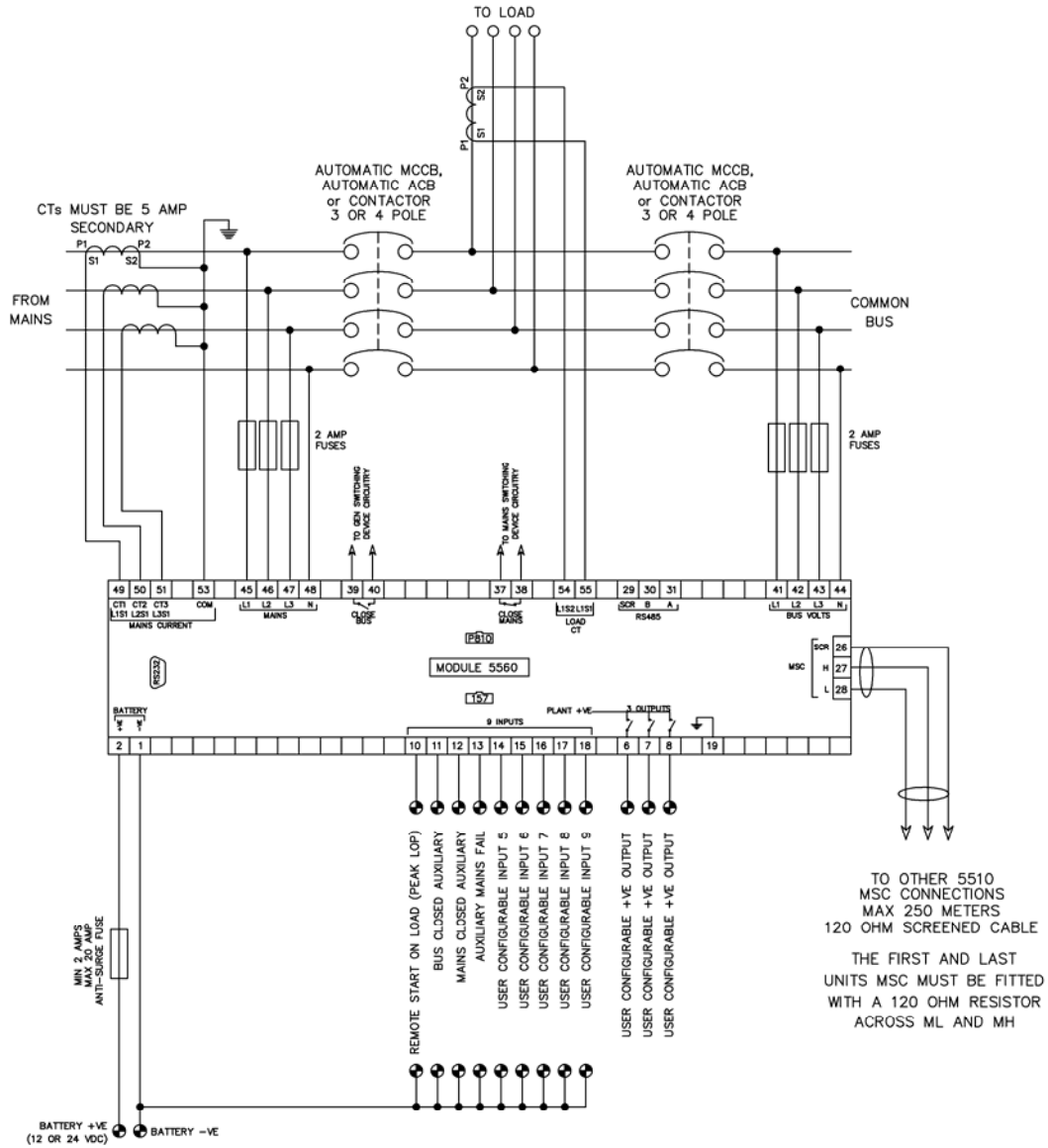
#### 13.1.1 TYPICAL CONNECTIONS FOR A SINGLE 5510 LOAD SHARE UNIT.



## 13.1.2 TYPICAL CONNECTIONS FOR TWO 5510 LOAD SHARE MODULES IN PARALLEL



### 13.1.3 TYPICAL CONNECTIONS FOR A 5560

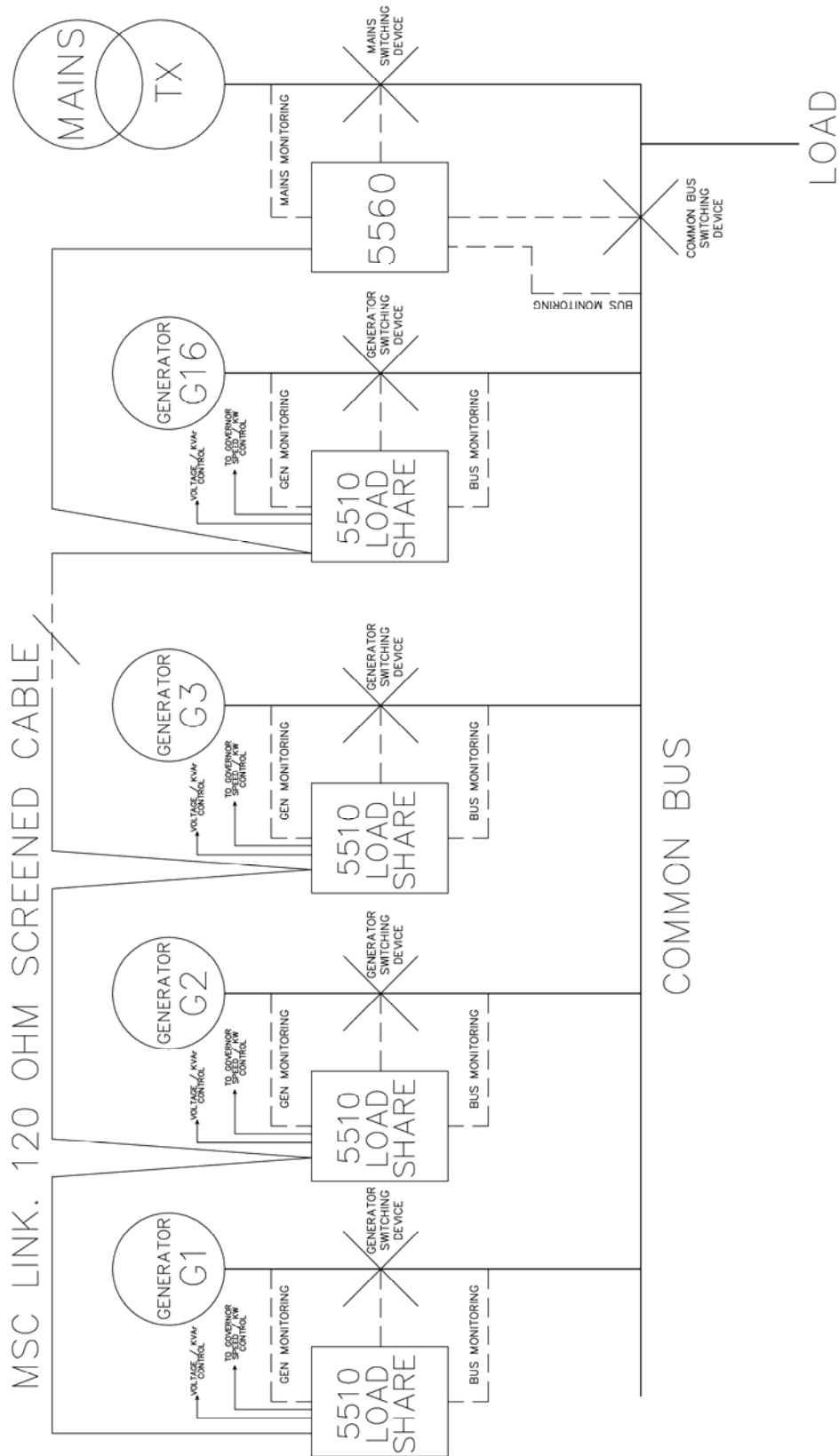


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### 13.1.5 TYPICAL SINGLE LINE DIAGRAM OF MULTI SET MAINS FAIL (5510/5560)

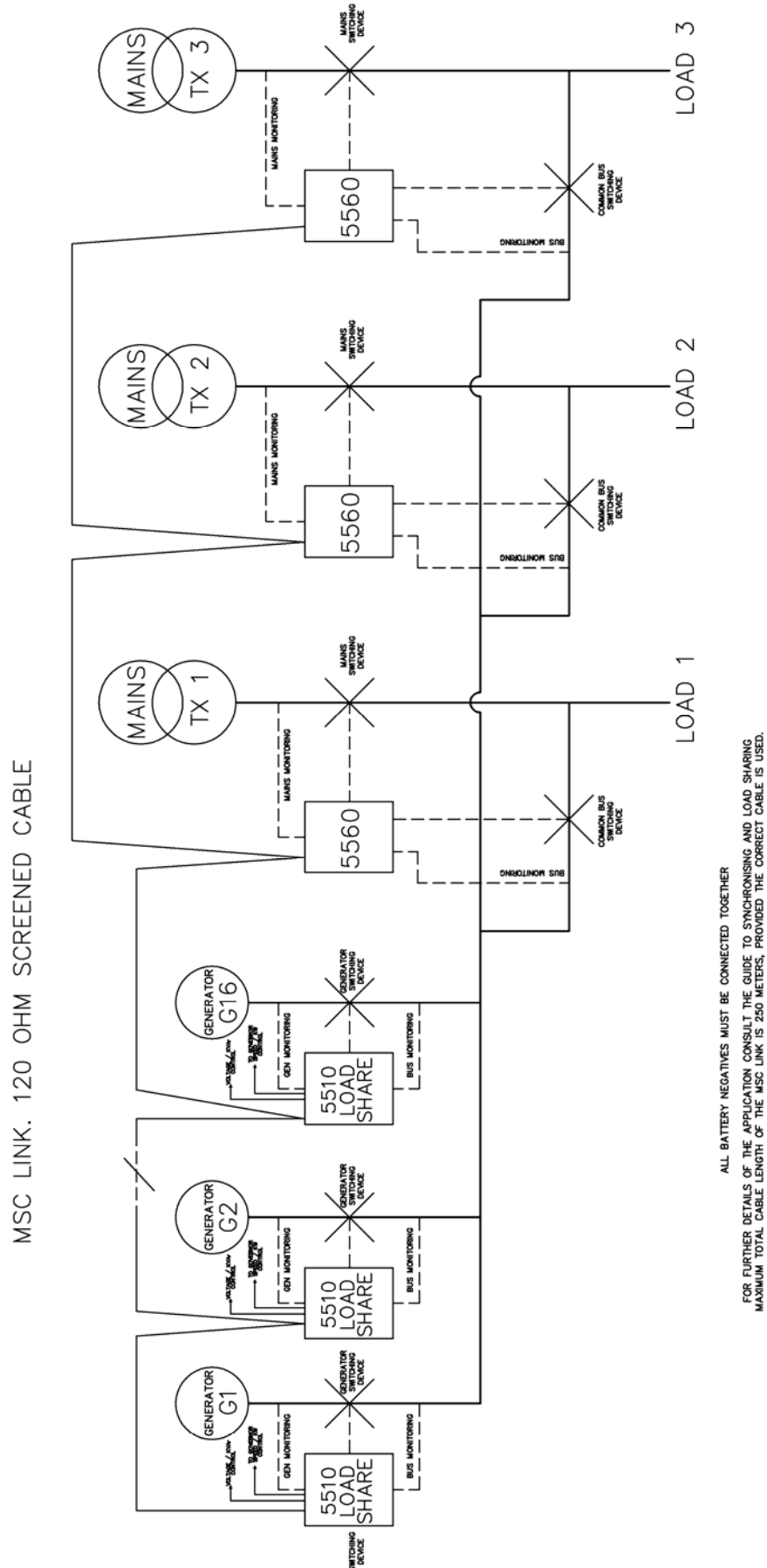


ALL BATTERY NEGATIVES MUST BE CONNECTED TOGETHER

FOR FURTHER DETAILS OF THE APPLICATION CONSULT THE GUIDE TO SYNCHRONISING AND LOAD SHARING.  
MAXIMUM TOTAL CABLE LENGTH OF THE MSC LINK IS 250 METERS, PROVIDED THE CORRECT CABLE IS USED.

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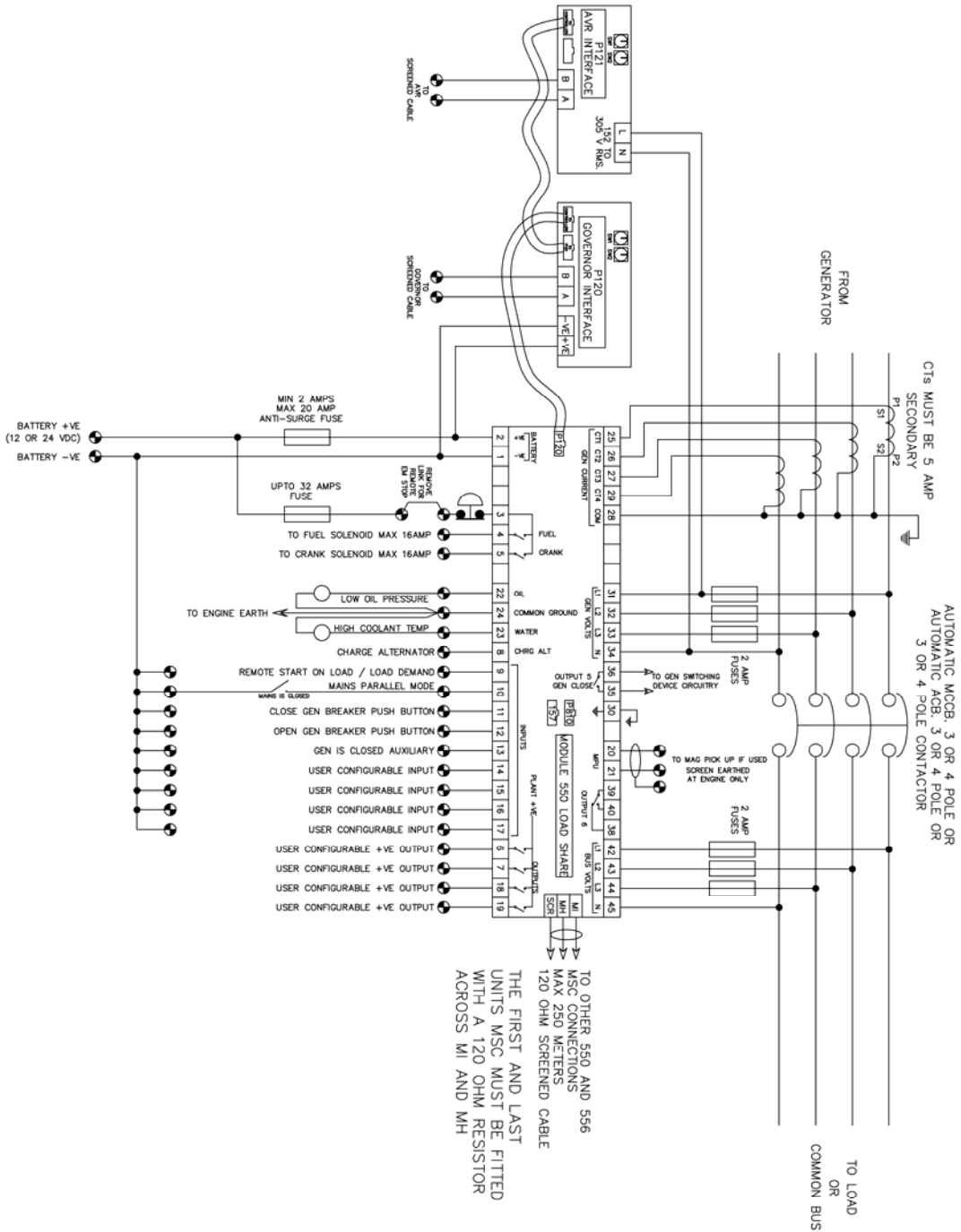
### 13.1.6 SINGLE LINE DIAGRAM OF MULTI MAINS SYSTEM



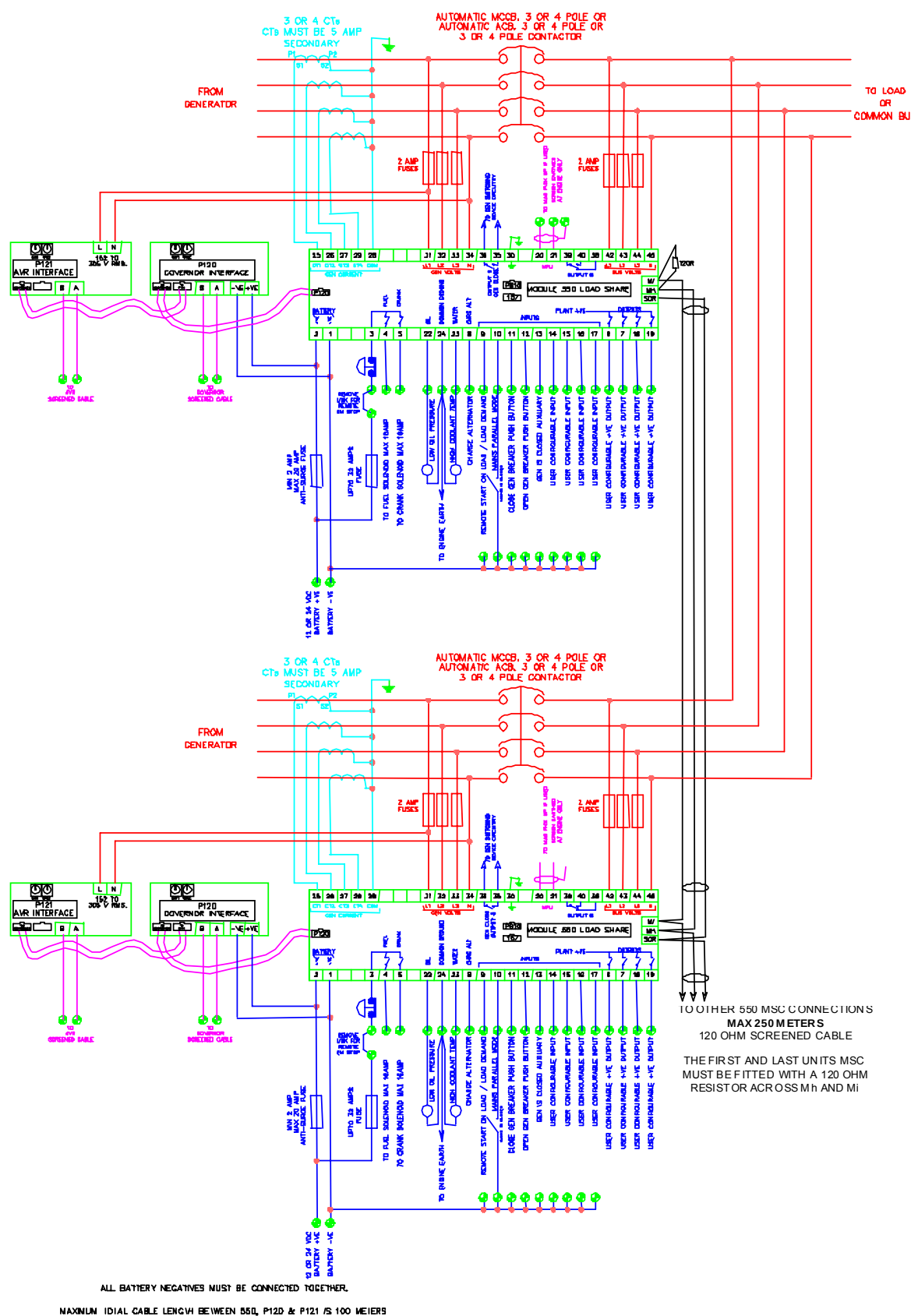
## 13.2 550/555/556/557 CONTROLLERS

### 13.2.1 TYPICAL CONNECTIONS FOR A SINGLE 550 LOAD SHARE UNIT.

ALL BATTERY NEGATIVES MUST BE CONNECTED TOGETHER.  
FOR FURTHER DETAILS OF THE P120 & P121 CONSULT THE GUIDE TO SYNCHRONISING AND LOAD SHARING  
MAXIMUM TOTAL CABLE LENGTH BETWEEN 550, P120 & P121 IS 100 METERS

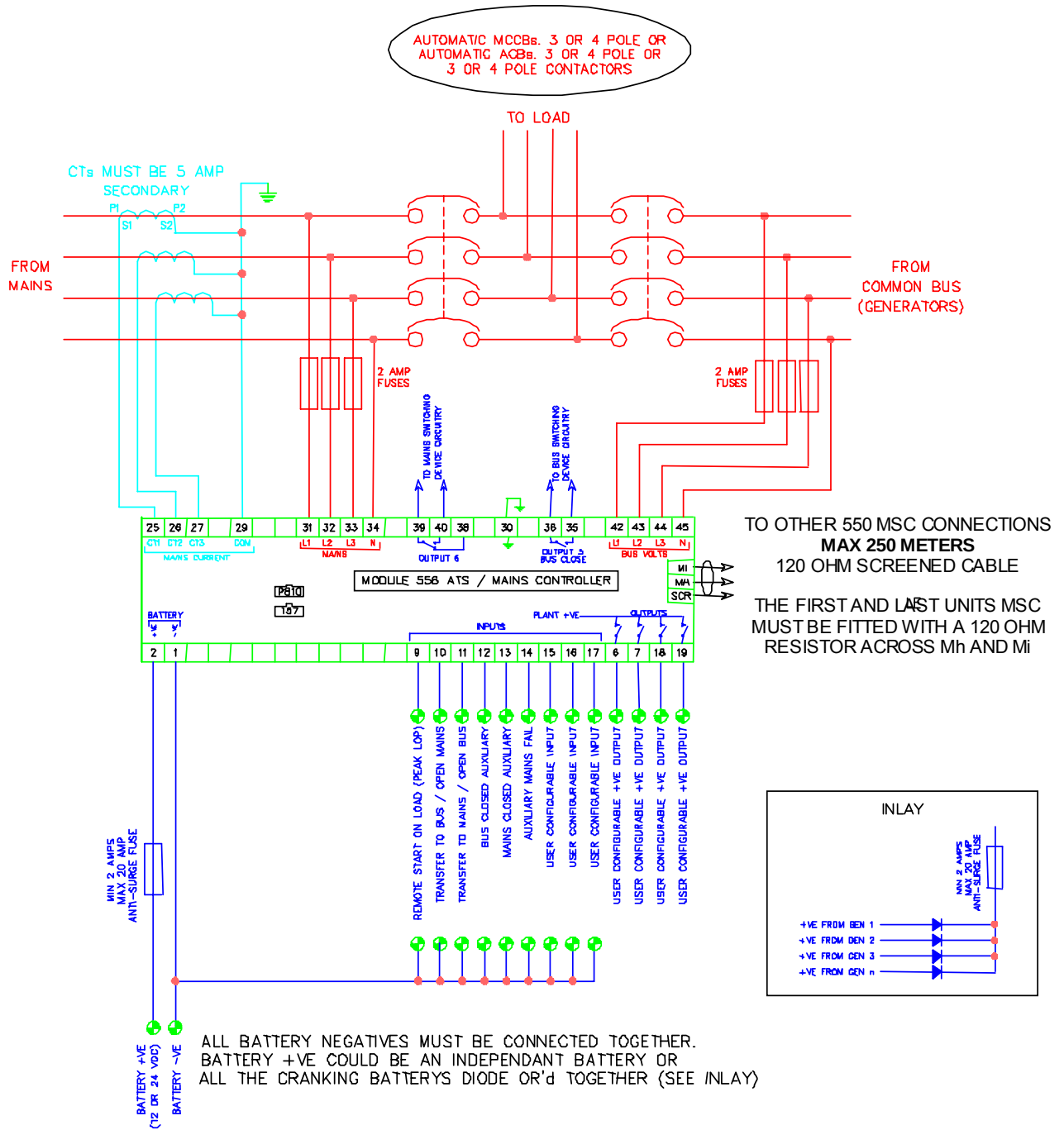


### 13.2.2 TYPICAL CONNECTIONS FOR TWO 550 LOAD SHARE MODULES IN PARALLEL



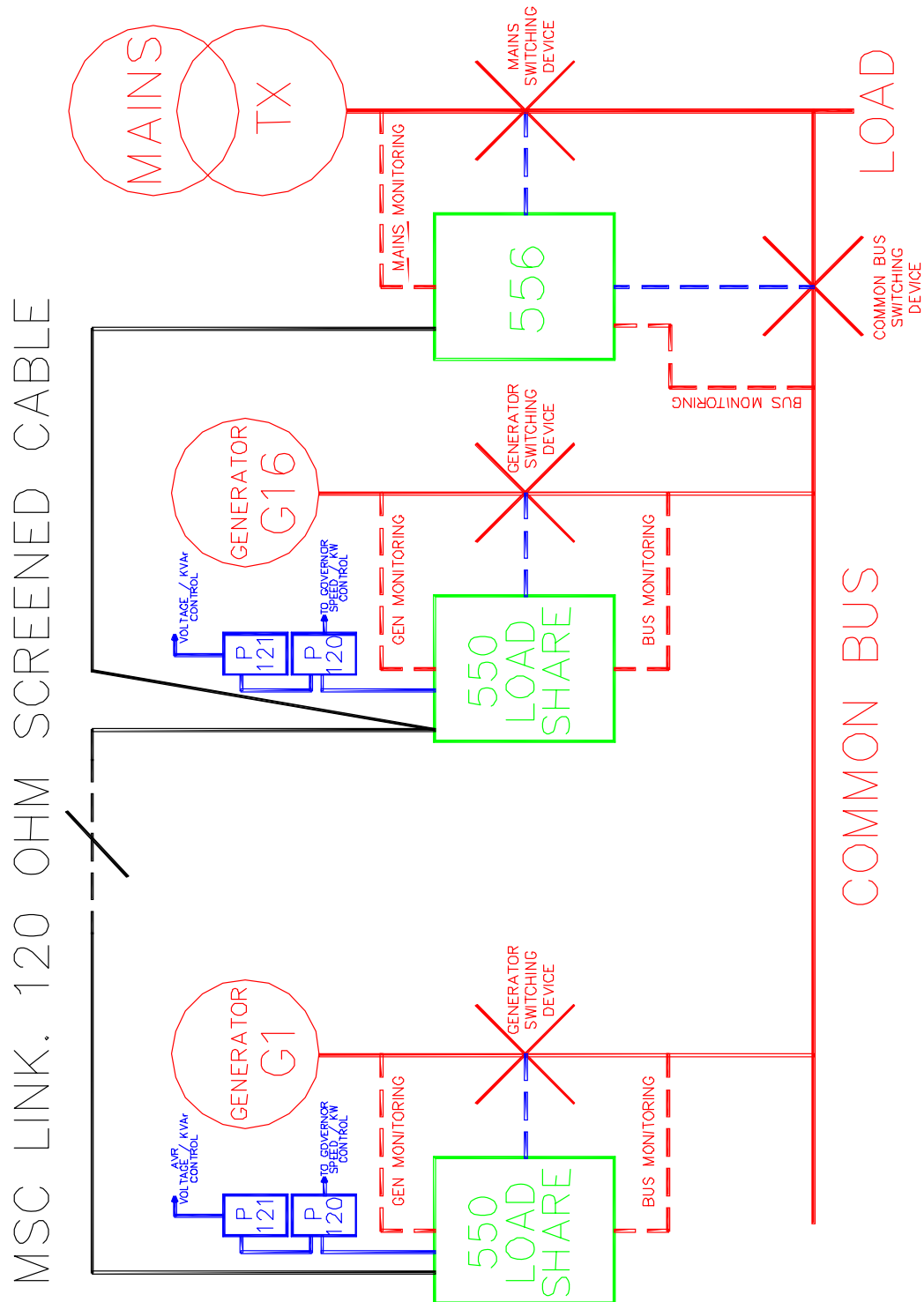
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### 13.2.3 TYPICAL CONNECTIONS FOR A 556



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### 13.2.4 TYPICAL SINGLE LINE DIAGRAM OF MULTI SET MAINS FAIL (550/556)

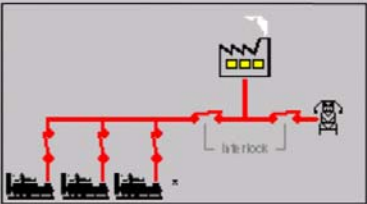


ALL BATTERY NEGATIVES MUST BE CONNECTED TOGETHER

FOR FURTHER DETAILS OF THE APPLICATION CONSULT THE GUIDE TO SYNCHRONISING AND LOAD SHARING  
MAXIMUM TOTAL CABLE LENGTH BETWEEN 550, P120 & P121 IS 100 METERS

## 14 APPENDIX

### 14.1 530 AS MAINS / GENERATOR BUS TRANSFER SWITCH



It is possible to use the DSE model 530 to control the generator bus load switching device of a MultiSet system (2-16 controllers), rather than the 5560/556 controller. This allows a lower cost (but less featured) MultiSet backup to the mains supply.

Upon a mains supply failure, the 530 instructs all sets in the system to start, the first closing onto the dead bus, with the remaining sets synchronising and paralleling with it. When all 'available' sets are on the generator bus, a signal is made to the 530's "Aux. generator ready" input, allowing the 530 to changeover the transfer switch. This signal comes from an auxiliary output on each 5510/550 module (outputs paralleled together), configured to *All available sets on bus*.

Any sets not in the 'Auto' mode, or with shutdown faults present will not be 'available' so are not required to be on the bus before the signal to close the generator bus switching device is given.

**NOTE:** - When using version 3 or earlier model 550, the All available sets on bus output source is not available, this feature is included in version 4 or higher model 550s and all 5510's. However a similar function can be achieved using external logic derived from a module output configured to System healthy and an auxiliary contact on each generator's bus contactor / breaker to indicate availability on the bus (see diagram below).

