AVTRON
POWER SOLUTIONS

3000 SERIES Load Banks

User Manual

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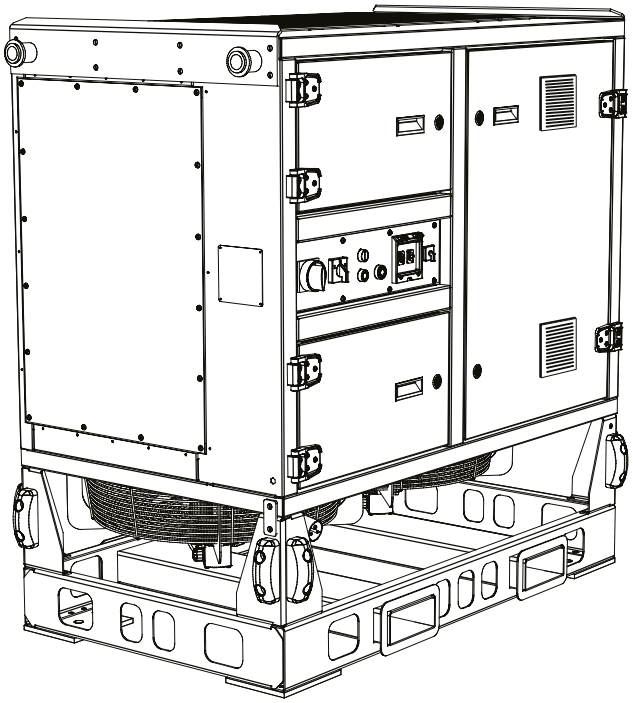
3000 SERIES Load Bank User Manual



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Introduction

This manual should provide you with all the information that you need to safely setup and operate Avtron 3000 SERIES load banks.

The manual is divided into five chapters:

Chapter One provides an introduction to the general principles of power supply testing and explains how a Avtron load bank makes the process easier, safer and more reliable. It then provides an introduction to the 3000 SERIES load banks and their main features.

Chapter Two covers all of the procedures that need to be carried out before a load bank can be put into operation. It explains how to transport and install the unit safely and then how to commission it to check that it will operate correctly.

Chapter Three explains the basics of how to operate the load bank. It describes the load bank controls and explains how they are used in an emergency. This chapter also explains how the load bank can be operated when a Hand-held or other control unit is not available.

Chapter Four provides a detailed reference to the SIGMA Hand-held, including details of its more advanced features.

Chapter Five covers the maintenance procedures you will need to follow to keep a 3000 SERIES load bank operating correctly. It also explains how to troubleshoot should a problem occur.

In addition to these five chapters there are a number of Appendices containing information that did not fit easily within the main body of the text. These include installation drawings, a certificate of conformity and some information about electromagnetic compatibility.

An Important Note on Safety

All Avtron load banks are designed with safety as a very high priority, but their operation does present some risks. In common with other test equipment, the safety of all concerned is dependent on the way that the unit is operated. Do not use this equipment unless you have read and understood this manual, and are familiar with the accepted practice for the industry. The equipment should not be used by unskilled personnel. Misuse could result in serious injury and damage to the equipment.

Be sure to follow all of the safety warnings in this manual. In particular, pay careful attention to the following points:

- Keep all personnel who are not directly involved with tests well away from the load bank and the equipment under test.
- The discharge air can be very hot and could cause serious flesh burns. Do not touch the outlet grille while the load bank is running, or for a few minutes afterwards.
- Ensure that there is no risk of the hot discharge air re-circulating back to the air inlet of the load bank, extensive damage is possible due to short-circuiting the cooling air.
- Ensure the air inlet and outlets are completely unobstructed and that there is no loose paper, plastic bags, or other debris that may be drawn on to the air inlet grille, obstructing the airflow.
- Combustible material left near the air discharge should be removed.
- Only operate the load bank with all the guards in place, with doors closed and with all of the covers and protective screens securely in position.
- Always route cables into the terminal compartment through the gland plate or strain relief system provided. The terminal compartment door must be closed during the test.
- Make sure that all equipment is adequately grounded; this applies equally to the Supply-on-Test, and the load bank.
- Ensure all cables are in good condition and adequately rated for the planned load, and that all connections are securely made.
- Ensure all cables are long enough to lay in smooth curves, and are unstressed, undamaged, and protected from mechanical damage. Lay the cables to minimise the risk of personnel tripping or accidentally tugging on the cables.
- Do not switch off the cooling fan immediately after a test. Allow the fan to run for 5 minutes after removing the load.
- Store the equipment in a clean, dry place when not in use. Only install and operate the load bank in environmental conditions suited to the enclosure classification of the load bank.

Chapter One

Introducing Avtron Load Banks

If you are not familiar with the use of Avtron load banks then you should start with this chapter. It provides an introduction to the general principles of power supply testing and then it explains how an Avtron load bank makes the process easier, safer and more reliable.

If you are an experienced load bank user you may want to skip the earlier sections, but you should certainly read the introduction to Avtron 3000 SERIES load banks which appears at the end of the chapter.

Why is Power Supply Testing Required?

There are many different ways of generating electrical power and many reasons why generating equipment may be required. All of them have at least one thing in common: it is essential that the generator be capable of operating effectively at its maximum rated output when it is required.

Unfortunately, it is not so easy to be absolutely sure that this will be the case. Many generating sets operate at a fraction of their rated output for a large proportion of the time, and many others are intended to run in an emergency situation which may occur only occasionally.

In both cases the only way to ensure that generating equipment is capable of providing the performance required is to regularly test it whilst it is operating at its full rated output.

The various regulatory authorities and other concerned parties such as insurance companies are aware of this, and the testing of new installations is mandatory. In many cases there is also a requirement for regular testing for existing equipment, particularly those that provide emergency or standby power supplies.

How can a generator be tested effectively?

The answer to this is very straightforward: apply a load that is equivalent to the generator's maximum output and then run the generator and observe how it performs.

The careful measurement of the generator's output will reveal any problems with its ability to meet the specification. Then, after repairs or modifications have been made, the test can be repeated to verify that the fault has been rectified.

The load bank

For reliable testing it is important to provide a load that is suitably sized for the generator's output. It must provide a consistent and repeatable load so that the test can be accurately measured and recorded and it must also be capable of dissipating the large amount of heat that is generated during the test. And, it is critically important that the test does not put the site load at risk.

To achieve all this requires a specialist item of equipment: the load bank. These consist of an array of load elements combined with a control system designed to ensure that a precise load can be applied in safety.

How Do Load Banks Work?

Load banks are complex precision engineered machines, but to explain the general principal we can provide a very simple model of how they work:

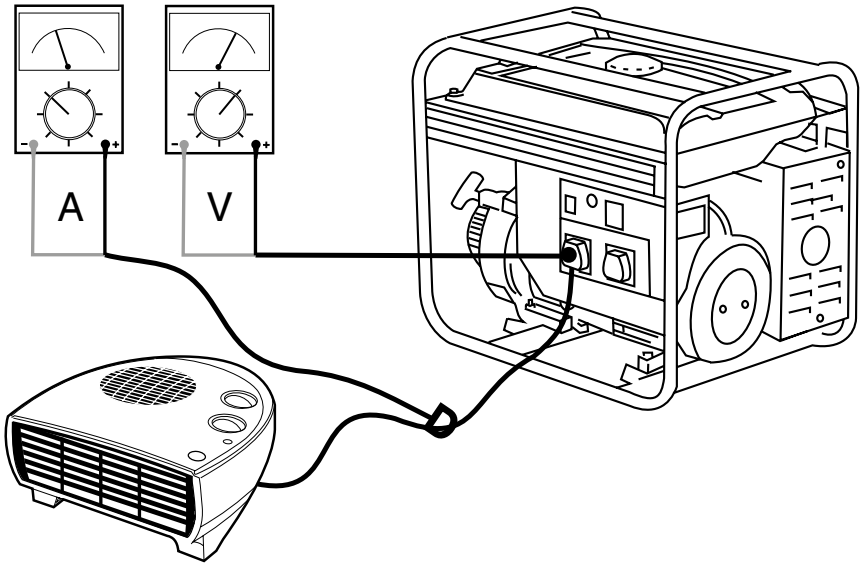


Figure 1-1 Basic DIY generator output test system.

Figure 1-1 shows the general arrangement of a very basic DIY generator testing system. It's simple, but it contains the four basic items necessary to test a generating set safely:

The fan heater's heating elements provide an electrical load that is large enough to ensure that the generator runs at full capacity.

The fan heater's switch gear provides a control system that will ensure that the load can be applied safely, and in a way that will not cause damage to the generator and its control circuits, or injury to the personnel running the test.

The fan in the heater provides a method of safely dissipating the considerable amount of heat generated by the test.

The voltmeter and ammeter provide instrumentation that will allow the results of the test to be monitored.

Of course, this kind of arrangement can provide only a crude test for a low powered generator and its ability to match the generator's output accurately is very limited. As the output of the generator increases, the cabling, switchgear and control equipment required for this becomes increasingly heavier and more sophisticated. In addition, because of the large amount of heat generated during testing, the issue of how to conduct the test safely becomes increasingly significant.

Introducing Avtron Load Banks

Avtron load banks are purpose designed to provide all of the facilities needed to quickly, safely and reliably test generating equipment with outputs up to several megawatts.

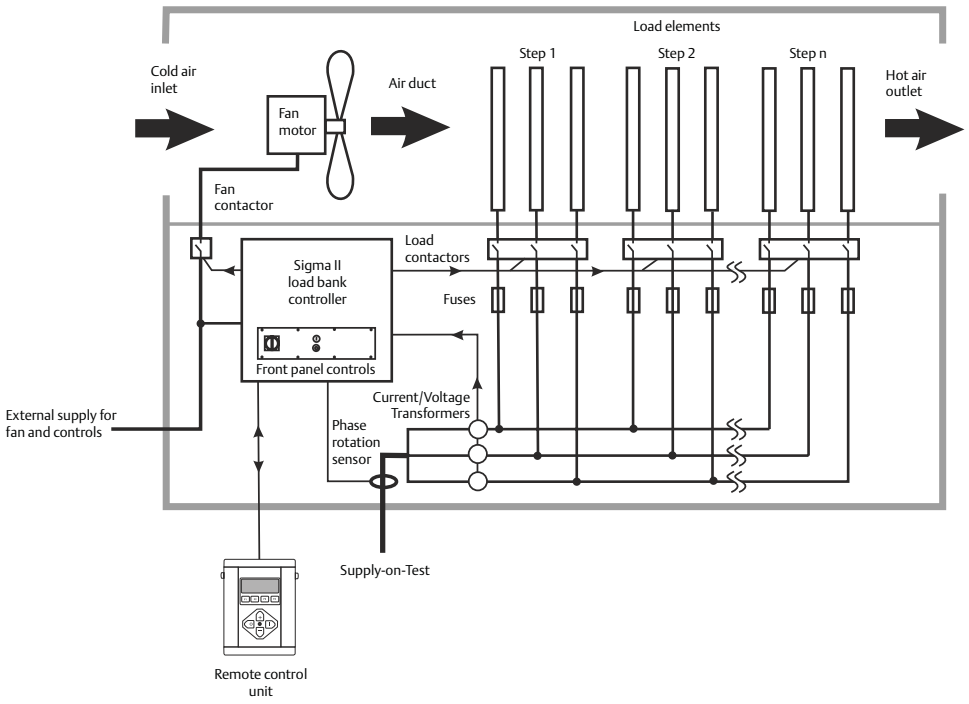


Figure 1-2 Avtron load bank core components

There are many variations between different Avtron load bank models, but Figure 1-2 shows a simplified schematic of the core components to be found in most units.

The diagram contains:

- An array of load elements grouped in small steps that are individually activated by switchgear to allow the load applied to the generator to be precisely controlled.
- A fan and duct forced air system which ensures that the heat generated during testing is vented safely to atmosphere.
- Fuses and safety interlocks that ensure that the test can be shut down in a controlled fashion if any problems occur.
- A microprocessor based control and three phase instrumentation system connected to a number of highly accurate voltage and current transformers. This provides automatic precision control of the test and allow the results to be displayed with better than 0.5% accuracy.

Avtron Load Bank Control Options

Reliable testing requires precise control of the load applied to the generator and accurate real-time measurement of the generator's output. To achieve this, most Avtron load banks are fitted with a SIGMA 2 load control system. SIGMA 2 is a microprocessor-based control and instrumentation system specifically developed for load bank applications.

SIGMA 2 provides precise control over the operation of each load element during the test whilst simultaneously measuring the results. The unit also provides safety monitoring and interlocks which shut down the load bank safely should a problem occur.

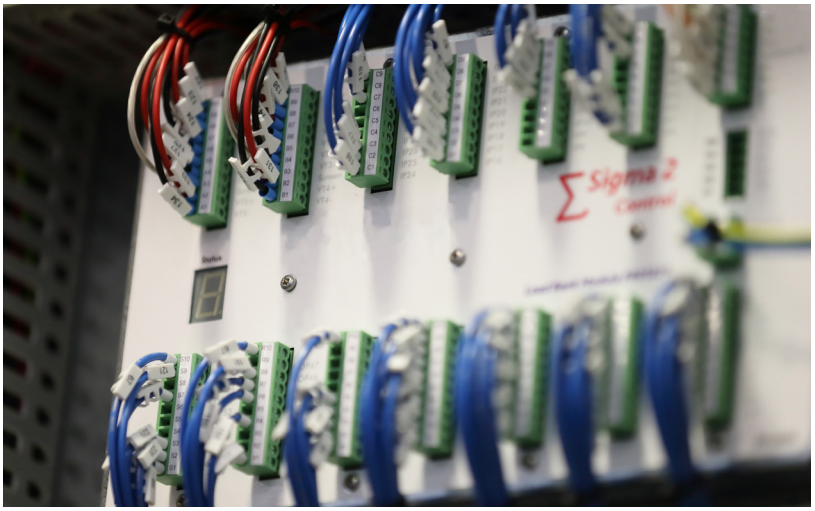


Figure 1-3 SIGMA 2 load bank control unit.

User control interfaces

The wide variety of different applications for load banks require a wide variety of user control interfaces. These range from a very basic switch controlled system through to sophisticated computerised control, instrumentation and data logging systems.

All Avtron load banks are supplied with a built-in switch plate which contains a Fan and Controls Supply Isolator, Start and Stop switches and (for SIGMA 2 controller equipped units) SIGMA control cable connectors. The switch plate may contain other controls, depending on the specific load bank variant.

Depending on the application, the SIGMA controller unit can be operated by a number of different control interfaces. These include:

Decade switch local control panel. The simplest form of control is via a series of decade switches mounted on the unit's switchplate or on a remote control panel. These provide basic manual control and are only available on units fitted with purely resistive load elements.

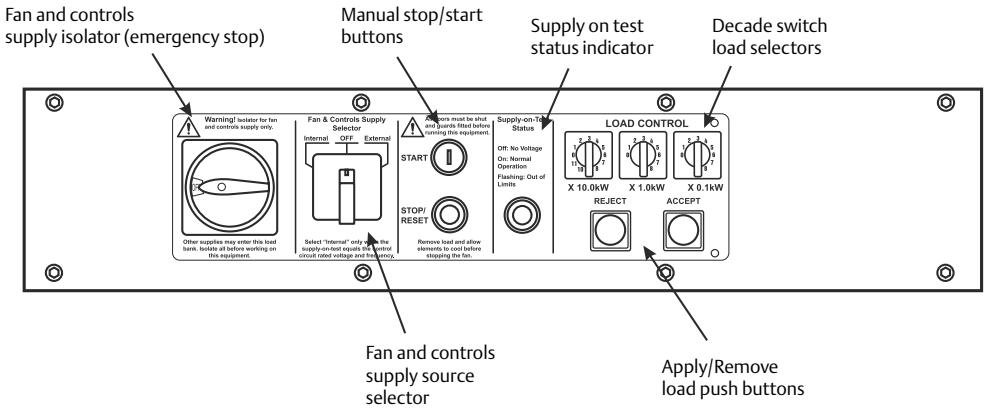


Figure 1-4 Decade switch local control panel

SIGMA Hand-Held. The Hand-held unit provides load control and instrumentation on SIGMA controlled load banks.

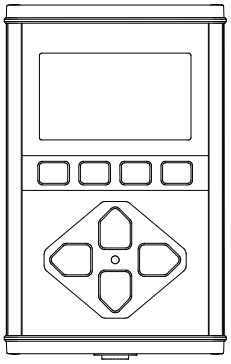


Figure 1-5 SIGMA Hand-held

The Hand-held contains a membrane keyboard and built in display unit and is connected to the load bank by a control cable. The Hand-held's simple user interface provides a way for generator tests to be conducted in an intuitive way with minimum of calculation.

SIGMA PC Load Control Software. As an alternative to the Hand-held, the load bank can be connected to a PC running Avtron SIGMA PC Load Control software.

This Windows™ application provides all of the facilities of the Hand-held with an enhanced user interface, improved instrumentation and facilities for response analysis, data acquisition, and reporting. Test data can be exported for use by other applications such as Microsoft™ Excel.

Figure 1-6 SIGMA PC Load Control Software

Note: Both the Hand-held and the PC software can control up to 14 SIGMA controlled load banks simultaneously. Tests can be run manually or automatically using a pre-programmed test sequence.

SIGMA Modbus Interface. Every SIGMA controlled load bank has the capability to be remotely controlled using the industry standard Modbus serial communications protocol. This will allow the load bank to be integrated with a wide range of test, automation, supervisory and monitoring systems. Modbus control is beyond the scope of this manual. If you need more information please contact the Avtron technical support department.

Non-unity Power Factor Testing

It is unusual for a generator to be presented with a purely resistive load. In real-world applications it is much more likely that the load is made up of a combination of resistive, inductive and capacitive elements (electric motors, lamp ballasts, etc.) which may be continuously changing as various items of equipment are switched on and off.

The inductive and capacitive (reactive) parts of the load tend to store and then return energy, and some proportion of the power supplied to the circuit is returned to the generator. Consequently, more current has to flow to provide the required amount of power to the circuit and the circuit is said to have a low (or non-unity) power factor. For instance, to get 1kW of real power, a load with a power factor of 0.8 will require 1.25 kVA apparent power to be supplied.

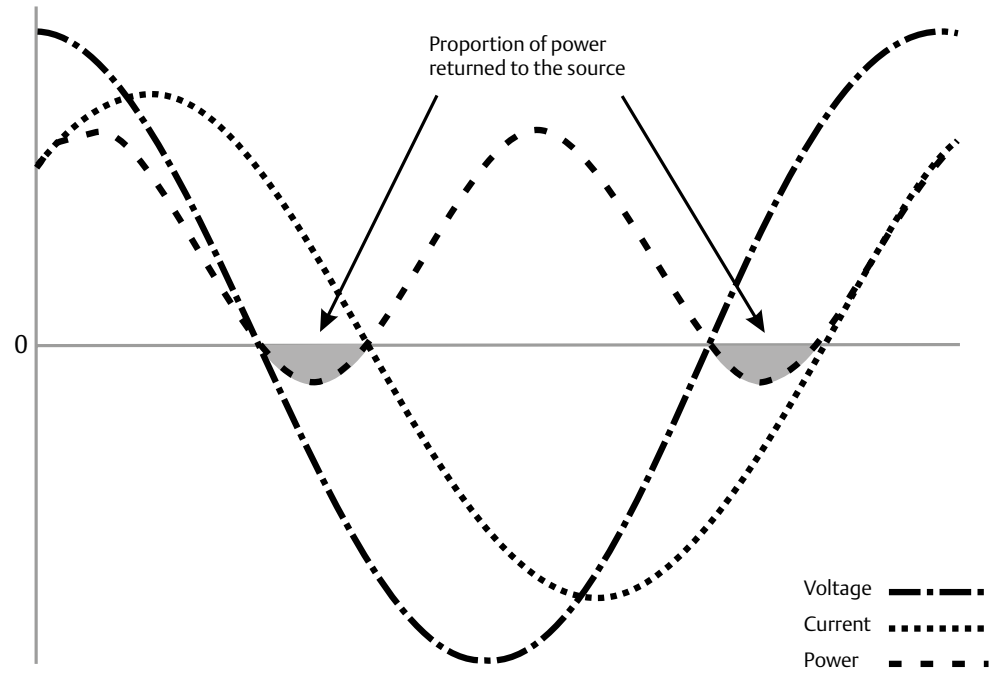


Figure 1-7 Typical power curve for power factor of 0.8

A low power factor puts additional stresses on alternators, voltage regulators, and switch gear without necessarily putting additional load on the engine. Many generating sets are designed to reach their maximum output when connected to a non-unity power factor load.

To provide a realistic test, it is necessary for the load bank to simulate this situation. To achieve this, the load bank elements need to consist of a mixture of resistive heating elements and inductors. In some applications, capacitors are also used.

When is non unity power factor testing required?

This depends on the type of test that is required.

Sometimes, for smaller generators where a standardised alternator design is in use, the electrical performance of the alternator and control gear can be assumed to be adequate. In this case the only requirement during testing is to prove that the motive source of the generating set is capable of operating at full power without overheating and a purely resistive load is all that is required. This is sometimes referred to as active load (power factor 1.0) or unity power factor.

However, in many situations the electrical performance of a generating set is of critical importance. In these cases it is necessary to put the motive source, alternator and its associated control gear all under stress during testing. To do this a combined load made up of resistive and reactive elements is required.

Combined loads are also required to set up systems where multiple generating sets are running in parallel or where it is necessary to simulate the start up of a large motor.

Multiple generator testing

Multiple generating sets running in parallel can present a problem for installers when it comes to setting up load sharing and voltage regulation on a new system. A purely resistive load will not provide the required load characteristics and a combined load is required for initial calibration and testing.

What equipment is required?

Combined load testing can be accomplished by using a combined load bank (a load bank consisting of a mixture of resistive and reactive load elements) or by running two or more different type load banks in parallel.

Note: Avtron combined, inductive and capacitive load banks are in the 6000 SERIES range. Avtron purely resistive load banks are in the 3000 SERIES range and Avtron containerised units are in the 8000 SERIES range.

The exact combination of equipment required will depend on the specific application. Typically power factors from 1.0 to 0.7 are used but motor start simulation may require a power factor as low as 0.4. See the appendices of this manual for more details of the calculations involved.

Movable Load Banks

Many Avtron load banks are supplied for applications where they will be permanently installed at a particular site location. However, in some applications the load bank is as a temporary measure that is only required whilst generator tests are carried out.

This is quite common, for instance, with a new generator installation where the load bank is used during commissioning and acceptance testing.

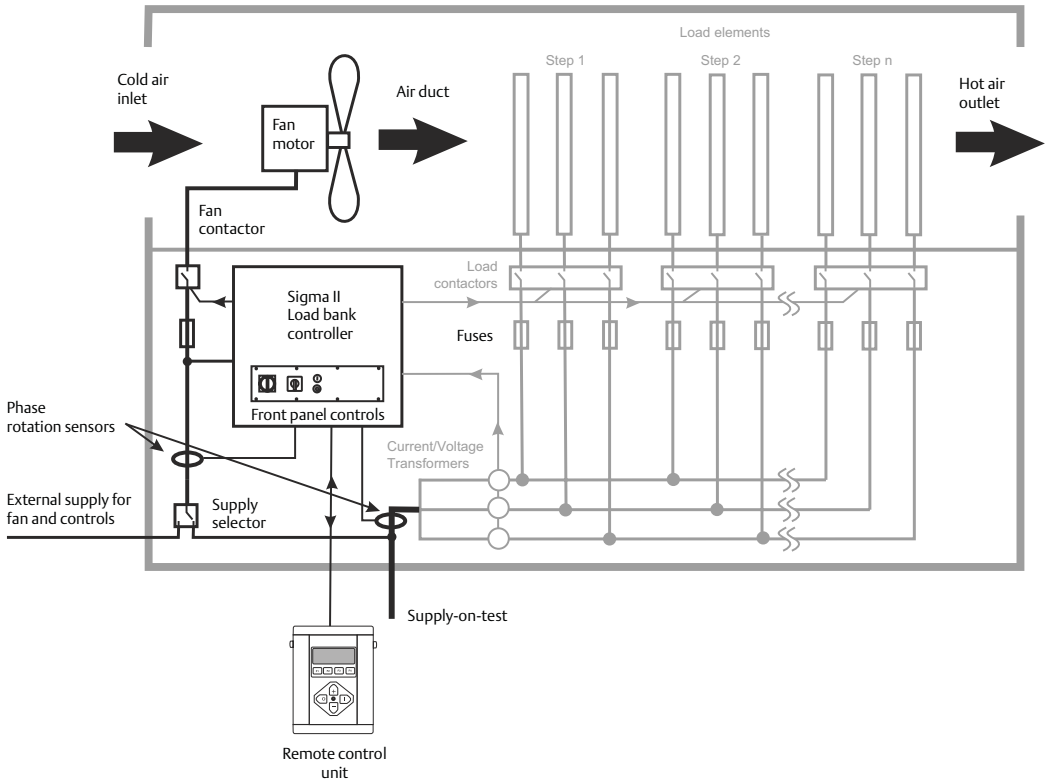


Figure 1-8 Additional components required for a movable load bank

Because of the temporary nature of the installation there are some specific design differences between a load bank intended for permanent installation and one intended to be “movable”.

These include:

External power supply inlet. The load bank’s fans and control electronics can be powered by the generator under test or (as recommended by Avtron) a completely separate, external power source. To make providing external power simple on a movable load bank, a suitably rated IEC60309 connector is mounted on the unit either externally or behind a lockable door with cable access.

Power supply selector switch. The load bank switch panel is fitted with a selector switch, allowing easy selection between Off, Internal supply (generator under test) or external (Auxiliary) supply. The switch is not fitted where the load system is designed for a supply that is incompatible with the fan supply, for example, on low voltage AC, DC, or 400Hz load banks.

Phase rotation sensor and reversing contactors. These ensure that the fans on load banks with three phase fans automatically rotate in the correct direction, irrespective of how the phases are connected.

Control cable socket. The switchplate is fitted with a socket which allows SIGMA 2 control cables to be quickly attached and removed.

Multiple power cable entry options. Avtron load banks designed for permanent installations are provided with a non-ferrous gland plate that allows a fully compliant IP55 installation. The movable load banks are provided with a choice of cable entry options:

- Through a pre-punched, non-metallic plate fitted with protecting shutters or grommets.
- Through a protected slot.
- Through a non-ferrous gland plate.
- Via optional externally mounted multi-pole (IEC60309) or single pole plug and socket connectors.

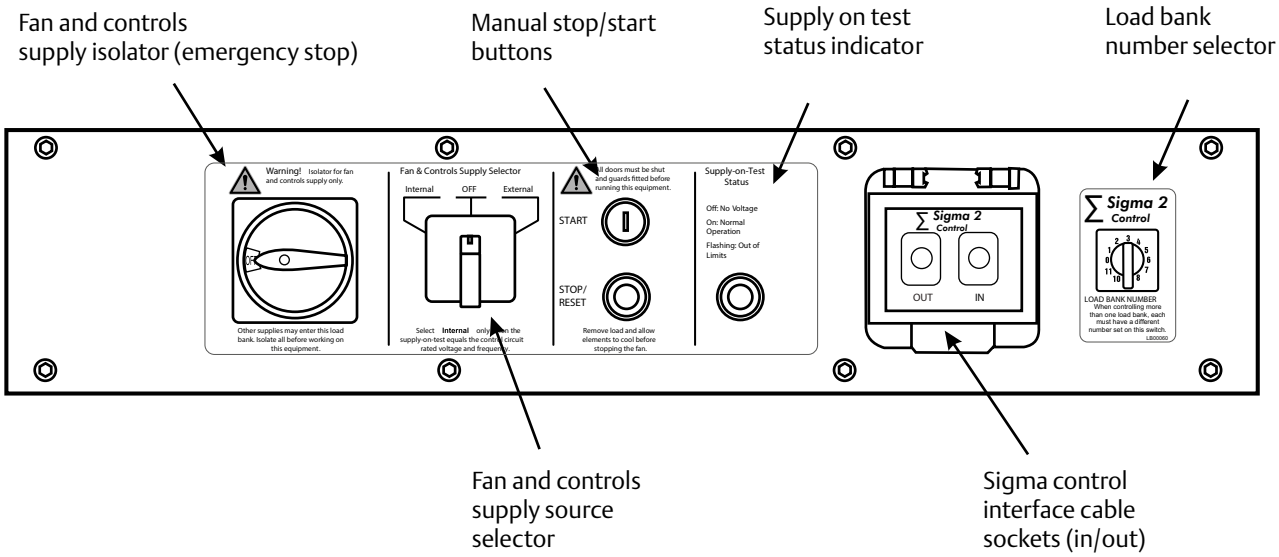


Figure 1-9 Typical movable load bank control panel.

Load Bank Applications

The main application for a load bank is for use during generator testing. However, load banks are versatile devices and they have a number of useful applications that can be applicable during the installation, commissioning and ongoing operation of a generator.

Generating set testing

The specific tests that need to be carried out for a particular installation depend on local regulations, the application, the type of equipment involved and the requirements of insurance companies, local authorities and other interested parties.

Note: The specific details regarding the frequency and type of test required may also be specified by local regulations or other interested parties.

The requirements for the testing of engine driven generators are described in ISO 8528 part 6. This document explains the general test requirements and describes both a functional test and an acceptance test. Functional tests must always be done and usually occur at the manufacturer's factory. Acceptance tests are optional and are often done on site, witnessed by the customer or his representative.

ISO 8528 part 5 defines three performance classes - G1, G2 and G3, each with different criteria:

- G1 is the least stringent and applies to small generating sets intended to supply simple loads.
- G2 is broadly equivalent to commercially available power.
- G3 is intended for sets which are powering loads which particularly require a stable and accurate power supply.

A further class, G4, allows for performance criteria agreed between the supplier and the buyer.

In addition to the testing that is carried out immediately after installation, it is important to carry out regular tests as part of an ongoing maintenance program. This is particularly important for emergency power supplies that may have long periods of non-operation.

The type of tests carried out include:

- Load duration tests (also known as a "heat run"), designed to record steady-state voltages, frequency, and also to calibrate instrumentation and measure emissions and fuel consumption.
- Load acceptance tests, which check changes in frequency and voltage regulation due to sudden load changes. These tests ensure that the rise and fall of the generator's output voltage and frequency remain within limits as load is applied and removed.

Testing UPS systems and batteries

Uninterruptable power supply systems consisting of a generating set combined with a set of batteries are a common feature of data centres and other installations where maintaining a constant power supply is critical. In the event of a power failure the batteries provide an immediate source of power whilst the generator is automatically started, synchronised to the correct frequency and put online.

Regular testing of the batteries, generator and its automatic control gear is extremely important, but testing using the site load could put critical systems at risk and may not provide sufficient load for a complete test. Load banks provide an ideal solution because they will allow the operation of the UPS to be fully tested without posing any risk to the site load.

Site load correction

In many applications a generator may be required to run for extended periods with little or no load applied. For a diesel generator this may mean that the engine does not reach its optimum operating temperature and this can cause a problem sometimes known as “wet stacking” – so called because unburnt fuel can make its way through to the exhaust stack. This can lead to serious maintenance problems, including high levels of cylinder wear, excessive fuel consumption and high levels of emissions.

Avtron load banks provide a function known as Site Load Correction (SLC) which provides an automated solution to this problem. This is where the load bank automatically adds and removes load to keep the generator running at an optimal temperature.

There are many applications for Site Load Correction. Figure 1-10 shows an example scenario where a site that is usually supplied by the public utility supply makes use of a backup generator. The system is designed so that, if the utility supply fails, the generator will start up and supply power to the site until the utility supply is restored.

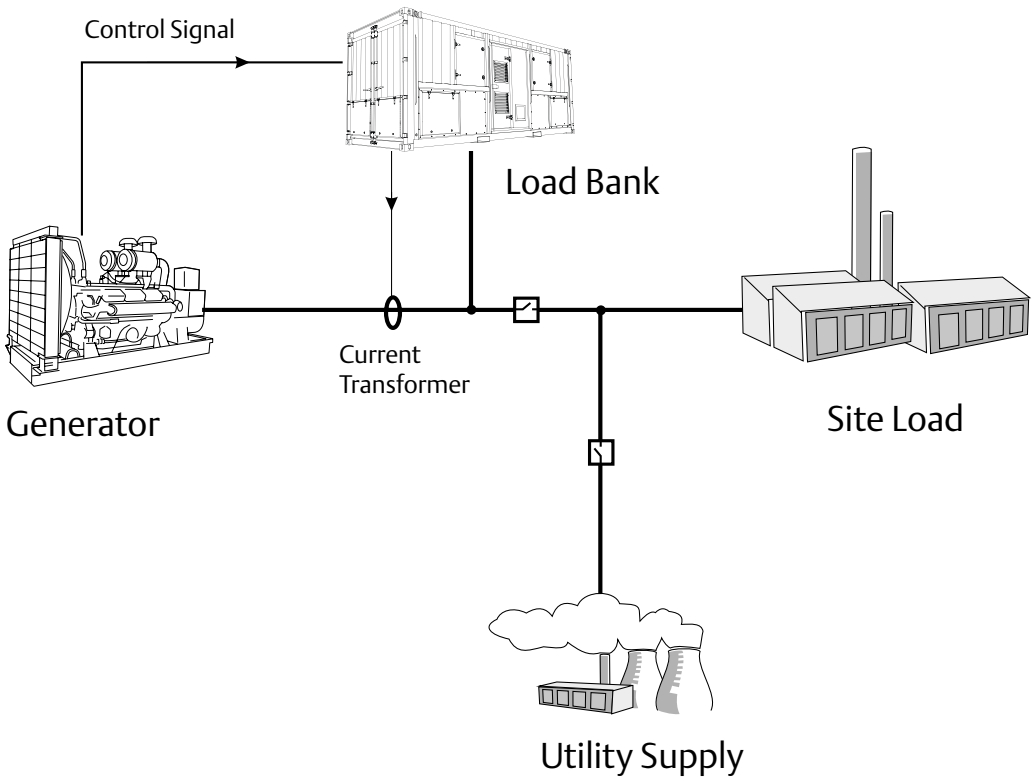


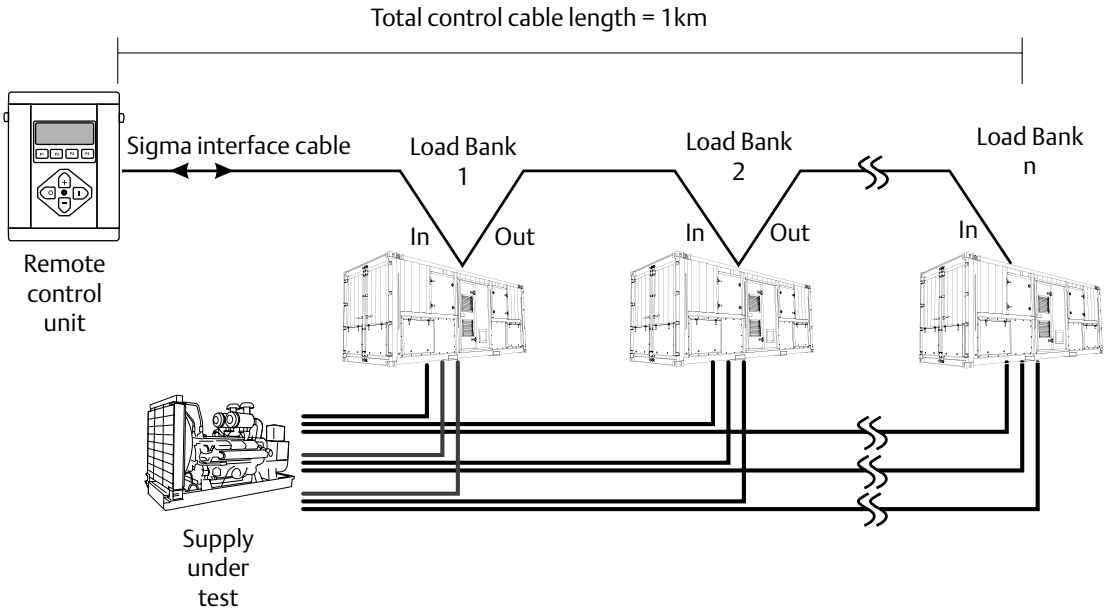
Figure 1-10 Example layout for a typical Site Load Correction system.

The load bank starts up when the generator begins to operate and its control circuits begin to monitor the output current. If this is below a certain set point then the load bank will slowly apply additional load to bring the generator within the optimum range. If the current increases in response to an increase in site load the load bank will remove load accordingly. The load bank can do this very quickly in response to sudden changes of site load such as a lift or pump motor starting up.

SLC is a specialist application for a load bank and it requires careful configuration. Please contact Avtron for more information and advice if you are thinking of configuring your load bank for SLC.

Using Multiple Load Banks

Avtron's SIGMA control system allows up to fourteen load banks to be interconnected and controlled from a single terminal as if they were a single unit. This means that multiple load banks can be combined to match particularly large generating sets, or that a combination of resistive, capacitive or inductive loads can be mixed for special purpose or one-off tests.



Note: When multiple load banks of different capacities are used the load applied is shared proportionally depending on the ratio of the load banks' capacity. The cable sizes for the Supply-on-Test must take this into account.

Figure 1-11 Connecting multiple load banks

One example of the use of multiple load banks might be where a purely resistive load bank is to be permanently installed for ongoing routine maintenance engine tests. A load bank with inductive elements could be added for a short period so that commissioning and acceptance tests can be carried out.

Introducing Avtron's 3000 SERIES Load Banks

The 3000 SERIES load banks are SIGMA controlled resistive-only load banks designed for general purpose generator testing.

There are seven units in the series with capacity ranging from 100 kW through to 2150 kW. All of the units can be configured as movable load banks (plug and socket for external power, phase rotation detectors to ensure correct fan operation, and a gland plate designed for fast temporary power connection) or as static units designed for permanent installation.

All Avtron load banks are manufactured from corrosion resistant, zinc-plated mild steel using Avtron's standard construction method.

The arrangement of fans, load elements and control equipment varies between the different models but, in all units, the resistive elements are cooled by a direct, forced airflow provided by an axial fan (or fans).

The input and output ducts are protected by stainless steel mesh screens. All of the electrical and electronic components are housed behind double skinned recessed doors, which are fitted with seals that provide protection up to IP55.

All 3000 SERIES units are designed to be moved with appropriate handling equipment. Some are fitted with skids, or castors, and the larger units are supplied on a fork lift pocket base. Some units are fitted with an optional lifting frame which provides additional strength, and allows the entire load bank to be lifted and manoeuvred into position by crane.

Four of the units in the 3000 SERIES range (3024, 3044, 3066 and 3110) can be supplied as trailer mounted units that are easy to transport and to manoeuvre into position on site.

As with all Avtron load banks 3000 models are constructed to suit customers specifications for a particular application. The following table describes standard equipment for popular models, but there are many custom options and configurations available. Please contact Avtron sales office for more details.

3000 SERIES Load Bank Specifications

	3024	3044	3066	3110	3103	3164	3220
Nominal capacity @ 400V, 50Hz*	220	400	625	1025	1025	1600	2150
Nominal capacity @ 480V, 60Hz*	240	430	680	1250	1100	1600	2150
Terminal qty / phase & size (mm)	2 x M12	2 x M12	2 x M12	5 x M12	4 x M12	6 x M12	6 x M12
Length along airflow (mm)	1320	1364	2040	2340	1700	2420	2958
Width across airflow (mm)	800	1180	1540	1540	1710	1730	1868
Height on mounting rails/base (mm)	1250	1655	1470	1910	2250	2250	2250
Operational height - fitted to skids (mm)	NA	NA	NA	NA	NA	2550	NA
Weight, approximate (kg)	360	600	840	1290	1300	1980	2400
Trailer mounted load bank ***	Optional	Optional	Optional	Optional	NA	NA	NA
Length of trailer max (mm)	2860	3775	3300	3775	NA	NA	NA
Width of trailer max (mm)	1820	2050	2025	2050	NA	NA	NA
Height on trailer max (mm)	1815	2220	2225	2642	NA	NA	NA
Weight of trailer mounted unit (kg)	800	1000	1200	1820	NA	NA	NA
Fan(s) - no. x diameter (mm)**	2 x 450	1 x 710	1 x 900	1x 900	1 x 900	1 x 1000	2 x 900
Fan Motor (kW/Ph) (50Hz)	0.4/1	1.5/3	2.5/3	7.5/3	4.5/3	6.5/3	4.8/3
Fan Motor (kW/Ph) (60Hz)	NA	1.8/3	7.5/3	7.5/3	7.5/3	15/3	7.5/3
Fan & control current (A)	4	6	10	16	16	18	25
Airflow direction	Vertical	Vertical	Horizontal	Horizontal	Vertical	Vertical	Vertical
Noise level, dB(A) 50Hz @ 90° (@ 3m)	65	70	74	74	75	79	76

* Other capacities & voltages are available.
** 50/60 Hz fans available.
*** Add 15% for packed dimensions.

NA = Not available

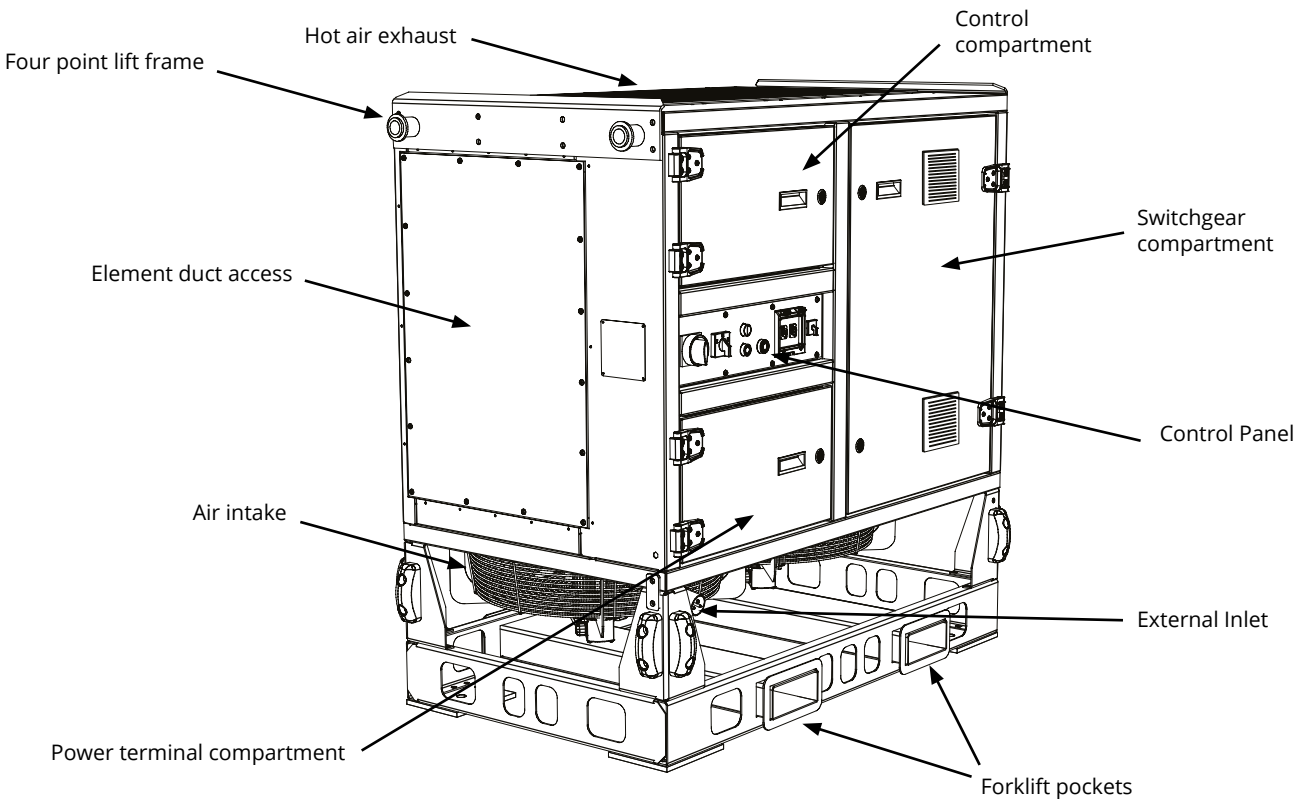


Figure 1-12 Avtron 3024 Load Bank.

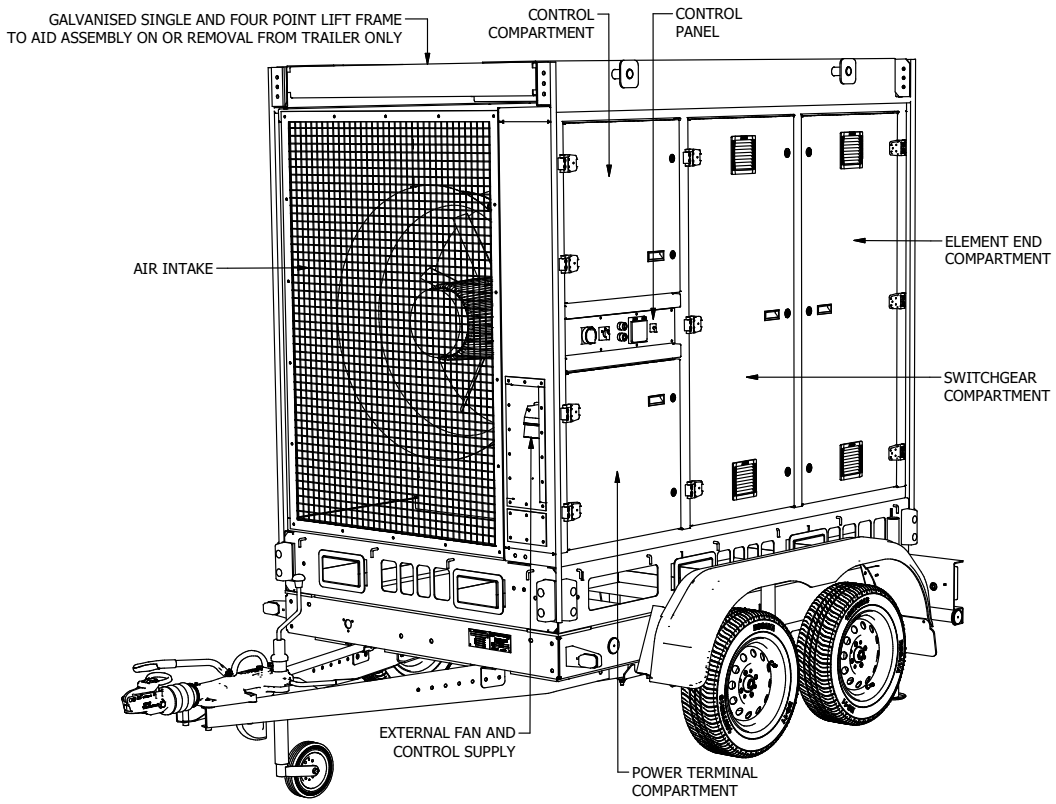


Figure 1-13 Trailer mounted variant of the Avtron 3110 load bank.

Chapter Two

Load Bank Installation and Setup

This chapter covers all of the procedures that need to be carried out before an Avtron load bank can be put into operation. It explains how to install the unit safely and how to commission it to check that it will operate correctly.

Important!
The chapter contains a number of important safety instructions. Do not attempt to install or operate your Avtron Load bank until you have read and understood this chapter. Misuse could result in serious injury and damage to the equipment.

Using an Avtron Load Bank Safely

Your safety, and the safety of those around you, is dependent on your knowledge of this equipment's safe operating procedures. Load banks can be dangerous and must not be used by unskilled personnel, or by those who have not familiarized themselves with these instructions.

You should remain alert to potential danger during transport and installation, when the unit is in operation, and when maintenance operations are performed.

There are four main sources of danger:

Handling hazards. Load banks are large, heavy devices and they often have to be manoeuvred in to tight, difficult spaces before they can be installed.

Contact with high voltage electricity. Serious injury or death could result from contact with electrically live parts. Even though the connections to the load bank may be temporary, they must always be made to the same standards as if they were permanent.

Contact with fast moving parts. The fan, in particular, can cause serious injury if you come into contact with it when it is in operation.

Heat hazards. When a test is in progress the resistive elements can glow cherry red. The heat they produce is removed by the air that the fan forces past them, but that air in turn can become very hot.

To avoid these hazards, pay particular attention to the following points:

- Make use of the correct handling equipment and ensure that all personnel involved in transportation and installation have the appropriate training and experience needed to carry out the operation safely.
- Only operate the load bank with the doors, covers and protective screens securely in position.
- Always route cables into the terminal compartment through the gland plate or strain relief system provided. Do not route cables through the terminal compartment door. The door must not be open during the test.
- Make sure that both the Supply-on-Test and the load bank are adequately grounded.
- Ensure all cables are in good condition and adequately rated for the planned load, and that all connections are securely made.
- Ensure all cables are long enough to lay in smooth curves, and are unstressed, undamaged, and protected from mechanical damage.
- Lay the cables to minimise the risk of personnel tripping or accidentally tugging on the cables.
- Keep all personnel who are not directly involved with tests well away from the load bank and the equipment under test.

- The discharge air from the load bank can cause serious burns. Keep away from the outlet grille while the load bank is running, and do not touch it for at least 10 minutes after the test is completed.
- Do not switch off the cooling fans immediately on concluding a test. After removing the load allow the fans to run for a further 5 minutes to dissipate the residual heat. This will reduce any fire risk and prevent possible damage to the equipment.
- Make sure that the air inlet and outlets are completely unobstructed and that there is no loose material that could be drawn in to the air inlet grille.
- Ensure that there are no combustible material near the air discharge.
- Keep an approved electrical fire extinguisher present at all times when the load bank is in operation.

Transporting Avtron Load Banks

The 3000 SERIES load banks range in weight approximately 100kg through to 2500kg (see nameplate for the exact weight) and (although some models are fitted with castors) will usually require a hoist, forklift or other lifting equipment to move them. A forklift pocket base is provided as standard, and some models are fitted with a lifting frame to make it easier to move the unit with a crane or hoist.

If you do need to move the load bank it is important to pay attention to the following points:

Warning! Avoid walking on the roof of the unit. As far as possible, use a ladder to access each of the top corner lift points, and use a pre-attached hauling line to pull the sling-hook within reach. If walking on the roof is unavoidable use appropriate anti-fall protection equipment attached to the fall-arrest anchorages provided.

Lifting by forklift truck

Check the specifications to ensure that the forklift truck has sufficient capacity to safely lift the weight. Add 5% to the specified weight for minimum packing, and 15% for a unit in an export wooden case.

Lifting by crane or hoist

The crane and any lifting chains or straps used must have sufficient capacity to safely lift the weight of the load bank. If a lifting frame is fitted all of the available lift points must be used.

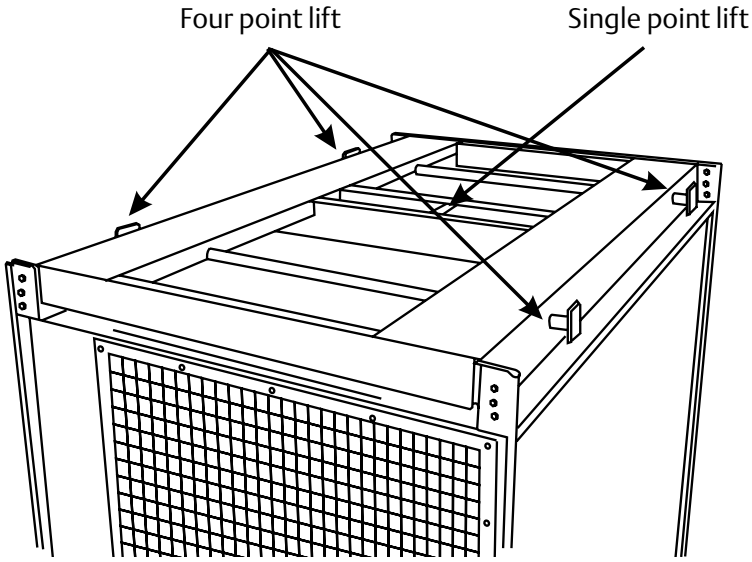


Figure 2-1 Typical load bank lifting frame details

A suitable spreader should be used to ensure that the straps or chains used do not crush or otherwise damage the unit.

Protection and securing on transport

If a load bank is carried on an open goods vehicle, it should be covered with a tarpaulin, or a similar to stop the wind from driving the fan.

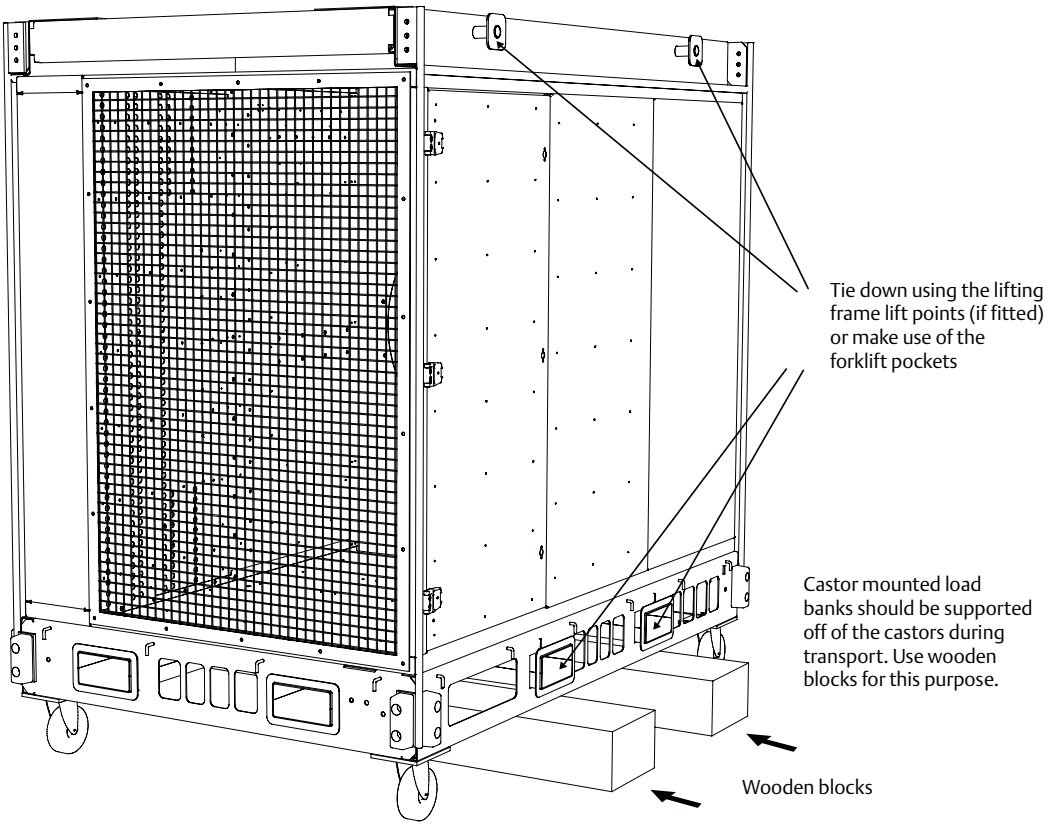


Figure 2-2 Castor-mounted load banks should be supported off the castors and firmly fixed down

Note: Avoid over-tightening ropes or webbing, particularly at the top edge. The tie-down should be made through the pockets in the forklift pocket base if possible.

Storage

The original transport packaging should be left in place on the load bank and it should be stored under cover, in a heated warehouse, until it is ready to be installed and commissioned. This recommendation applies, even if the load bank is intended for installation outdoors. Usually such equipment will be fitted with an anti-condensation heater, which will not be operational until the load bank is finally installed and commissioned.

Trailer Operation

Some Avtron load banks can be supplied as trailer mounted units. Trailer mounting allow the load bank to be simply towed to a site behind an appropriate towing vehicle and this has many advantages, including the fact that no lifting equipment is required to get the unit in position.

Figure 2-3 Avtron 3110 mounted on a trailer

There are a number of factors that need to be taken into account to ensure that a trailer mounted load bank can be used safely, effectively and within the regulations that apply locally.

Installing Load bank onto the Trailer. (When the load bank and trailer are supplied separately). It is important to ensure that the correct orientation of the load bank when fitted on the trailer. The air inlet must be facing the 'A' frame with the hitch assembly, refer to Figure 2-3. There are also alignment labels on the load bank and trailer which indicates the correct orientation.

Towing vehicle. One of the most important things to consider is whether the towing vehicle that you use is a good match for the trailer mounted unit. The vehicle must be fitted with the correct type of towing coupling (Avtron trailers are fitted with a standard 50mm ball and must be capable of towing the trailer's weight).

The weight of all Avtron load bank trailers is shown on a rating plate fixed to the chassis. You can find the recommended towing weights for both braked and unbraked trailers in the vehicle handbook and on a rating plate fixed to the chassis.

Driver. It is important that the driver has an appropriate license to allow them to drive the particular vehicle and trailer combination. The requirements for a licence can vary between countries and may be dependent on the weight of the trailer.

Load distribution. Avtron equipment mounted trailers are supplied correctly load balanced so that an appropriate amount of nose weight is applied. This is important to maintain stability when towing. If additional equipment is added to the trailer, ensure that its weight is distributed evenly so that the load balance is maintained. The nose weight should be approximately 7% of the total trailer weight, up to a maximum of 100kg.

Brakes. All Avtron trailers are fitted with a hydraulically damped overrun braking system and auto reverse brakes. An emergency breakaway cable is provided. The end of this should be clipped or fixed round some fixture on the towing vehicle (not the towing ball). The other end is attached to the trailer braking system so that the cable will apply the parking brake automatically if the trailer becomes separated from the towing vehicle.

Before towing

1. Cover the load bank with a tarpaulin, or a similar to stop the wind from driving the fan.
2. Check the ball head cup is well greased.
3. Inspect the break-away cable. If it is kinked, frayed or damaged replace it immediately.
4. Inspect the lighting cable and plug. If it is damaged replace it immediately.
5. Check that the trailer lights are undamaged and working correctly.
6. The trailer is in a roadworthy condition
7. Check that the tyres are fully inflated, have adequate tread and are free from cuts, bulges or other damage.
8. Ensure that a number plate showing the registration number of the towing vehicle is attached to the trailer.
9. When hitched to the towing vehicle, release the hand brake and check that the jockey wheel is retracted and locked in place.

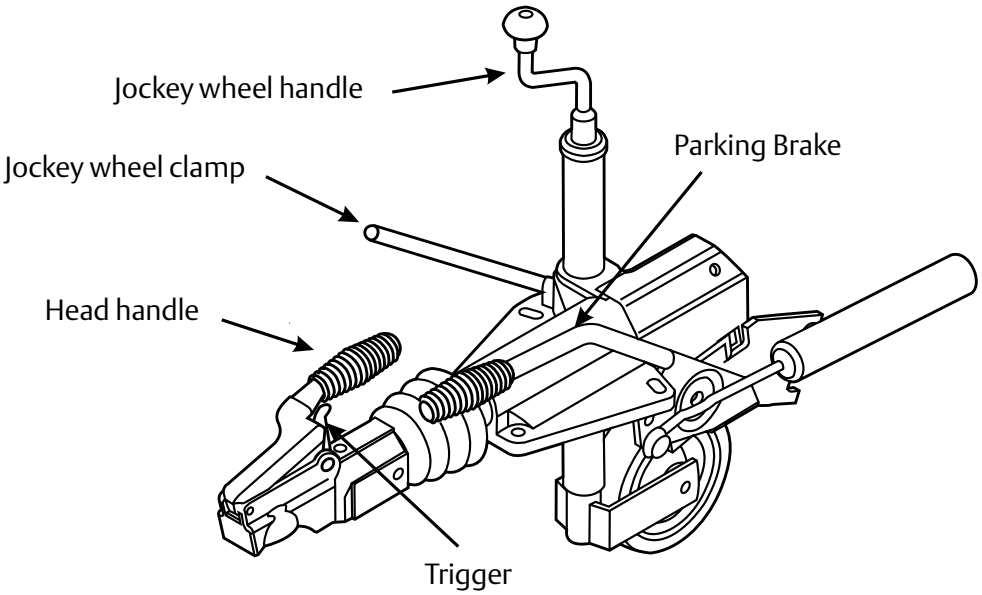


Figure 2-4 General arrangement of the trailer towing hitch.

Installing Avtron Load Banks

There are a number of factors that need to be considered before you select a load bank for a particular installation. Obviously it is important to ensure that the load bank has sufficient electrical capacity to test the supply, but you also need to ensure that it can operate correctly and safely in the position you have chosen.

Refer to the Appendices for details of the installation requirements of the different 3000 SERIES models.

Location

The first thing to decide when installing a load bank is where the unit is to be located. You need to consider the following to ensure that the unit can be operated safely:

Environment. The load bank should be located only where the environmental conditions will not exceed the IP classification of the load bank, bearing in mind the required cable runs and safety procedures. Note that load banks equipped with a cable entry slot, or a plate with grommets, have a reduced enclosure classification (terminal box to IP21, control gear compartment to IP23).

A standard 3000 SERIES load bank can be used in an ambient temperature between -10°C and +50°C, at 90% relative humidity (non condensing), and at altitudes up to 1000m above sea level (Units rated to operate in more extreme conditions are available to special order).

The load bank must be protected from direct solar radiation, particularly on the control gear compartments. For an outdoor installation in the northern hemisphere this is most easily achieved by arranging the unit so that the control gear panels are facing north (do the opposite in the southern hemisphere). In high ambient temperatures (above +50°C) you should provide shade for the entire unit.

Loading. The load bank is heavy and must be installed on a level surface that is capable of supporting its weight (see nameplate).

Space. There must be sufficient space to provide access for maintenance to all of the doors and the protective inlet and outlet grilles. There must be at least one metre of clear space on the air intake side of the load bank (the fan side) and five metres of clear space on the air outlet side. See the appendices of this manual for the specific requirements of individual units.

Note: If necessary, a barrier should be erected around the hot air outlet to prevent any possibility of personal injury.

Airflow requirements. When it is operating a 3000 SERIES load bank can require up to 12.5 m^3 of cooling air per second. As it passes through the unit, the air becomes hot enough to provide a risk of fire or personal injury.

When installing the unit you need to make sure that there is adequate air available, that it can be discharged safely, and that there is no risk that the hot air will recirculate to the air intake of the unit.

Installation in a plant room

If the load bank is installed in a plant room you will need to pay particular attention to the airflow requirements of the unit. The temperature of the surrounding air must not rise above the maximum rated ambient temperature of the load bank (50°C is standard) and steps should be taken to prevent re-circulation of the discharge air.

You must take into account the requirements of any other equipment (heating plant, generating sets, compressors, or another load bank) that may also require a supply of cooling air. In these cases the total air requirement of all the plant must be added together to arrive at the required fresh airflow.

The air inlet and air outlet of the load bank must be in the same room, or space.

Inlet

The free area of any inlet grille or opening into the plant room should be at least twice the area of the load bank air outlet. If other plant in the same plant room requires air, then the size should be such that the maximum air inlet velocity is below 3m/sec. This should ensure that the depression within the plant room would always be less than 10Pa, relative to the outside environment. The distance from the fan inlet to a blank face of a wall or panel, square to the fan centre line, should be not less than 1m, or one fan diameter, whichever is the greater.

Attenuators incorporated in the plant room inlet grilles should be sized for a maximum pressure drop of 10Pa.

Outlet

The outlet opening must have a total free area of twice that of the load bank air outlet, plus whatever is required for any additional plant.

Wind effects

The load bank must be protected from the effects of the wind, which in some circumstances could defeat the fan. The inlet and outlet grilles or louvres should preferably be on the same side of the building. The effect of natural wind is then cancelled out, regardless of its direction. Other arrangements need careful attention, combined with detailed site and local knowledge to ensure satisfactory operation in all expected weather conditions.

Sound attenuators

Please contact our sales department for advice if you intend to fit a sound attenuator to the duct work.

Using ductwork

If the plant room air supply is not adequate, or there is a danger that the hot outlet air will recirculate, a system of duct work can be installed. When designing the duct work it is important to ensure that the airflow is not impeded, and that the heat from the outlet air does not present a safety hazard.

Short lengths of straight duct connected directly to the load bank flanges will have very little effect on the airflow through the load bank. However, if you need to install a system where restrictions occur , such as bends or changes in the cross sectional area of the duct, then an uprated fan or other modifications to the load bank may be required.

If this is the case please contact our sales department for advice before placing your order for the load bank.

Duct insulation

We recommend that any duct work connected to the outlet of the load bank. be double-skinned or otherwise insulated against excessive heat.

Un-insulated ductwork will get very hot when the load bank is in operation. There is a risk of burns from the hot duct surface and the heat gain from an un-insulated duct may be considerable. Ensure that any insulation materials used are suitable for high temperature operation.

Avoiding hot air re-circulation

To reduce the risk of hot air re-circulation place air inlets at low level and air outlets at high level. If this is not possible the inlets and outlets should be spaced well apart. Inlet and outlet louvres on the same level should have a clear space between them of at least three times the width of the largest opening. Strategically placed barriers and screens can help to separate the two airstreams.

Careful consideration should be given to the likely effect of nearby buildings, walls or even parked vehicles, which could seriously disrupt the free escape of hot air, and result in hot air re-circulation.

Other nearby air handling plant can also interfere with the airflow to, or from, the load bank. Equipment should be spaced well apart and positioned so that their airflows complement each other rather than compete.

When multiple load banks are being used it is important to ensure that the hot air from one load bank does not exhaust directly or indirectly on to any other load bank.

Packaging

Before starting the installation remove all packaging. Dispose of it in the appropriate way.

Electrical Installation

Note: The Load Bank supply cables must be protected by a Short Circuit Protective Device (SCPD), which is suitably rated to the capacity of the supply cables.

The electrical installation for a load bank consists of making connections both for the Supply-on-Test and for an external supply that is used to power the load bank's fans and control system.

The requirements for the two supplies are described separately here, but the following general points apply in both cases:

- The work must be carried out by a person with the appropriate training, qualifications and experience.
- All cables should be appropriately rated and installed in accordance with current standards and accepted practice.
- The connections to the load bank may be intended to be temporary, but it is essential to apply the same standards to the cable glands and terminations as if the installation were permanent. The cables for the supply must be sized appropriately and properly fitted terminals must be used.

Voltage and frequency ratings

The external supply required may be of a different voltage or frequency from the Supply-on-Test. The voltage and frequency ratings are specific to the equipment supplied and are shown on the rating plate.

Exceeding the voltage ratings or supplying the wrong frequency can cause damage to the load bank so please check the plate carefully before starting the installation.

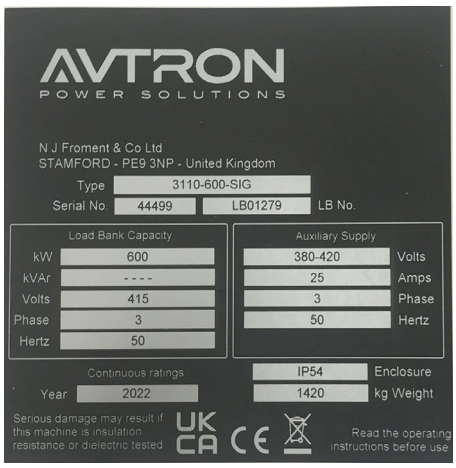


Figure 2-6 Consult the load bank's name plate for voltage and current ratings before making connections

External supply wiring - the fan and controls power source

We recommend that you use an external power supply that is independent of the Supply-on-Test. This ensures that the load bank will continue to operate without interruption if the Supply-on-Test becomes unstable or fails.

Refer to the load bank's rating plate for the external power supply requirements. The supply must be capable of supplying the fan motor starting current, and must be fused accordingly.

Static load banks - external supply connection

On load banks designed for static installations the cables for the external supply can be fed into the load bank through a separate gland plate. The external supply should be connected using the terminals provided inside the load bank (see appendix or supplied drawings for details).

Movable load banks - external supply connection

Load banks designed to be movable are fitted with an external power input plug on the outside of the load bank and a 3-position supply selection switch. If you are making use of this socket, switch the 3-position supply selection switch to the EXTERNAL position.

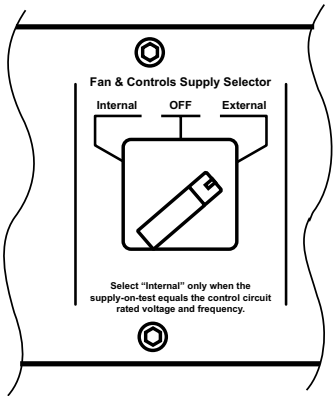


Figure 2-7 The fan and controls supply selector fitted to movable load banks

If there is no independent supply available (and the Supply-on-Test is the correct voltage and frequency rating) then you can power the load bank from the Supply-on-Test by setting the supply selection switch to the INTERNAL position.

Movable load banks are fitted with an automatic phase rotation detection system to ensure that the fan rotates in the correct direction irrespective of how the phases are connected.

Connecting the Supply-on-Test

The supply cables for the Supply-on-Test are fed into the load bank through an opening near the power terminal compartment. On movable units they pass through either a protected slot or a non-metallic plate with multiple holes (maximum 38mm, 1½" diameter) and then through a protective shutter into the terminal compartment. Static load banks have a non-ferrous cable gland plate that allows the maximum IP rating for the unit to be maintained.

Connectors

The load bank may be fitted with a series of busbars, providing bolt-on connections for crimped terminal lugs, or it may be fitted with optional single pole power connectors to allow quick connection and disconnections of the cables. The terminal bars can accept both copper or aluminium cables. Refer to local regulations and size accordingly.

Supply-on-Test wiring - general points

- The cable lugs should be clamped directly to the bus-bar by means of the studs provided and all securing nuts must be tight (maximum torque 30nm).
- It is good practice to route the three phase conductors in a close tre-foil layout, held together with cable-ties. This minimises stray magnetic fields from the cable array, and reduces inductive losses in the cables. In the event of a high fault current flowing this arrangement minimises the risk of sudden and violent cable movements.
- To eliminate induced magnetic fields and their associated eddy currents and heating effects all three phase conductors must pass through the same opening into the load bank terminal area.
- If the connections are made using more than one conductor for each phase connection all the cables on any one phase should be of exactly the same length, and laid along a similar route. Ensure that the three phase conductors are equally shared between multiple cable entry openings, to minimise eddy current losses.
- The load bank supply cables must be protected by the short circuit protective device (SCPD) which is suitably rated to the capacity of the supply cables.

Is a local isolator required?

When planning the installation consider if a local isolator switch is required. If the output circuit breaker of the Supply-on-Test is easily accessible, then this can perform the isolating function.

Star (wye) or delta configured load bank terminals

The power terminal compartment contains terminals for each of the three supply phases, earth and neutral. Depending on the load bank specification they may be configured to provide a star or delta connection.

Delta configured load banks are provided with an instrumentation neutral only. The terminal is not connected to any of the load elements and is provided for connection to instrumentation only.

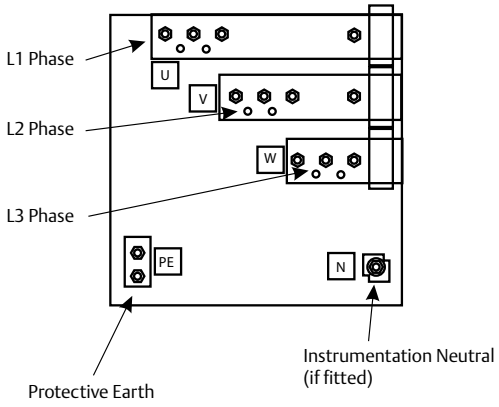


Figure 2-8 Typical arrangement of the Supply-on-Test terminal bus bars for a Delta configured load bank.

Star connected load banks have a power neutral terminal which is connected to the load elements during testing and is capable of carrying a load.

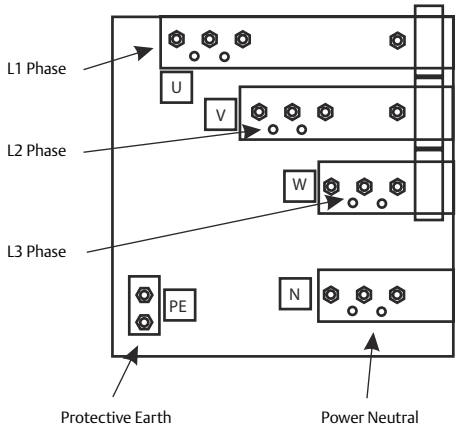


Figure 2-9 Typical arrangement of the Supply-on-Test terminal bus bars for a star configured load bank.

Protective earth connection

An earth conductor must always be bonded to the frame of the Supply-on-Test and connected to the grounding terminal of the load bank (marked PE).

Making connections for three phase operation

For connection to a three phase generator the star or Delta configuration of the load bank makes little difference to the wiring. Irrespective of how the load bank is configured, if the Supply-on-Test has a neutral terminal it must be connected to the load bank neutral terminal to achieve maximum accuracy of the instrumentation.

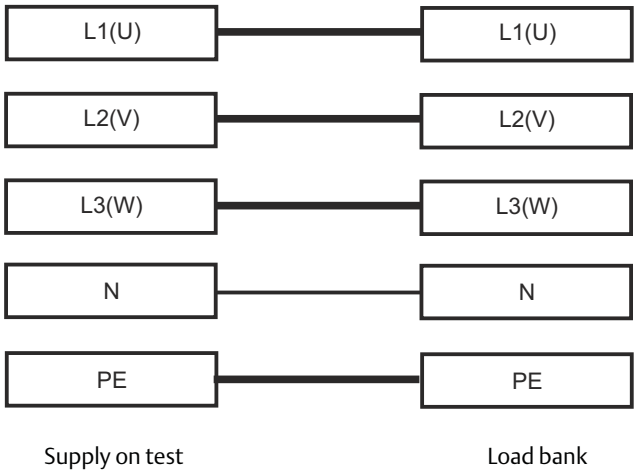


Figure 2-10 Connection for a three phase supply with a neutral connection.

Making connections for single-phase operation

3-phase load banks can be used for testing single-phase supplies. The method of connection (and the load available) will vary depending on the rating of the load bank, the supply voltage and frequency, and whether the load bank is configured to provide star or delta connections.

Automatic single phase connection check

Note: If the load bank is fitted with a 3-phase fan motor, an external 3-phase mains input will be required for the controls and fan supply.

The SIGMA controller checks and provides confirmation when a single-phase supply is connected to the bus-bars correctly. If the system detects an incorrect connection then the hand-held terminal will indicate the required connection method. The SIGMA control software will also automatically adjust the loading to take account of the connection options and the supply voltage.

Single phase wiring for delta configured load banks

Delta configured load banks have only an instrumentation neutral (marked N in the terminal compartment). This is not connected to any of the load elements and is not capable of carrying any load current. Because of this, single-phase operation is achieved by connection between two phase terminals, one of which is used as neutral. The neutral terminal is connected only for instrumentation purposes.

Basic connection. The basic connection shown in Figure 2-11 will give approximately 50% loading capacity when the nominal load bank supply voltage is connected or 17% loading capacity when a single-phase ($\sqrt{3}$) equivalent supply is used.

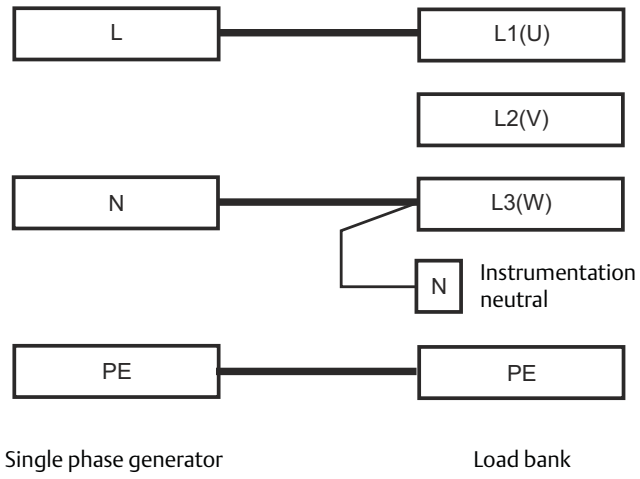


Figure 2-11 Basic connection for a delta configured single phase supply

The maximum permissible single-phase supply voltage for this connection is 100% of the 3-phase load bank rated voltage.

Alternative connection for maximum loading. The loading capacity can be increased by linking together L1 (U) and L2 (V) as shown in Figure 2-12.

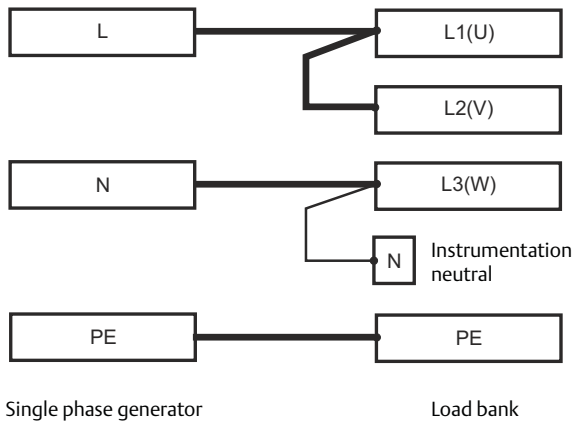


Figure 2-12 Alternative Delta configured connection for maximum loading

In this case the connection will provide approximately 67% loading capacity when a 400V single-phase supply is connected or 22% loading capacity when a 230V single-phase supply is used.

Single phase wiring for star configured load banks

Star configured load banks have a power neutral that is connected to the load elements, and this can be used to carry current during single phase testing. The load available depends on the connection method.

Normal Connection. Normally the load bank can be operated at 33% (one third) of full load capacity by connecting between one phase and neutral. The Supply-on-Test should be connected as shown in Figure 2-13.

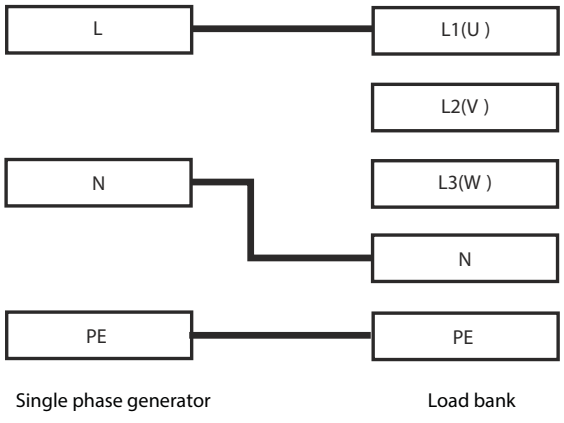


Figure 2-13 Normal star configured single phase connection

The maximum single-phase voltage that can be applied in this connection is 58% of the 3-phase load bank rated voltage. For example, a 230V single-phase supply can be connected to a 400V 3-phase star configured load bank, giving 33% loading capacity.

Full load connection. To obtain full load capacity the load bank neutral terminal must be rated at the full single-phase current. Confirm the rating before connecting. The Supply-on-Test should be connected as shown in Figure 2-14.

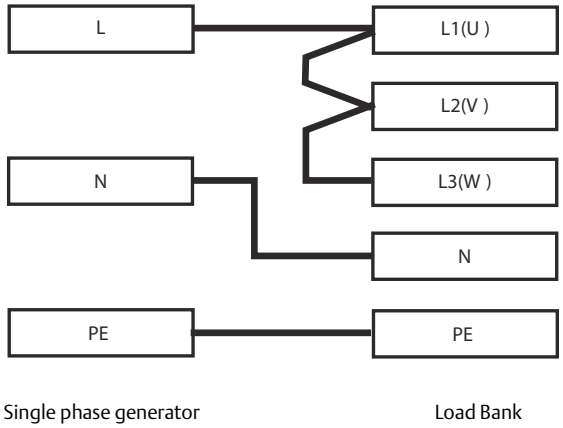


Figure 2-14 Full load star configured connection

The maximum single-phase voltage that can be applied in this connection is 58% of the 3-phase load bank rated voltage. For example, a 230V single-phase supply can be connected to a 400V 3-phase star configured load bank, giving 100% loading capacity.

Control System Connections

Movable load banks are usually operated using a SIGMA control device connected to the SIGMA Control cable socket on the control panel. To connect the SIGMA device simply plug the control system control cable in to the front panel socket.

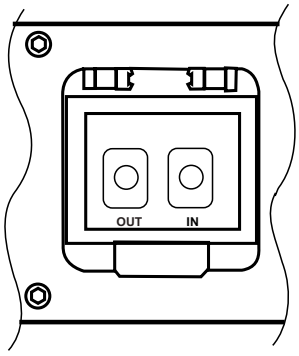


Figure 2-15 The SIGMA control cable connector.

Remote panels for static load banks

Some static load bank installations include a remote control station. This duplicates some of the controls on the main control panel and provides sockets for connecting the SIGMA 2 control cable.

Remote station control panels are connected to the load bank using a set of terminals which are located in either the main power termination compartment or the control compartment (refer to the supplied drawings for details of the specific location and wiring).

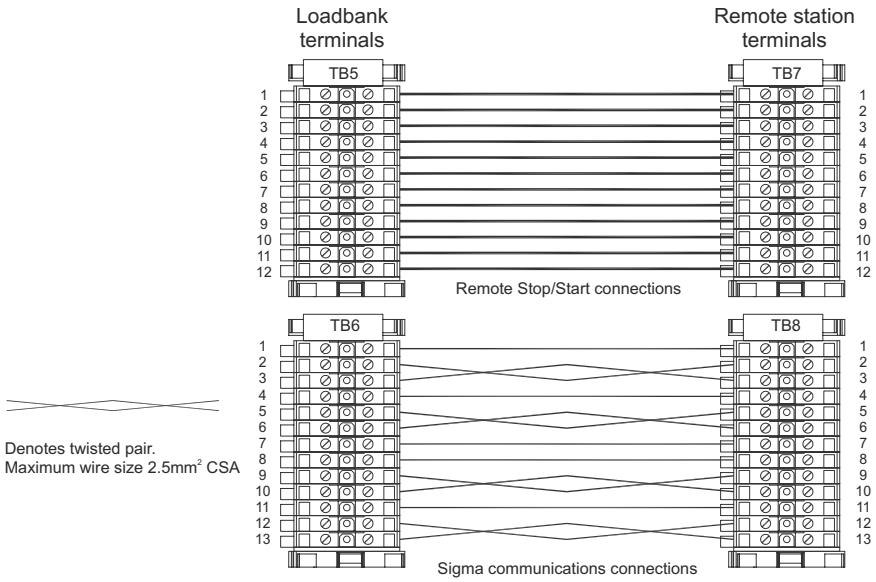


Figure 2-16 Typical wiring for a remote station control panel

Commissioning

Before operating the load bank carry out the following three-stage commissioning procedure.

The following instructions assume that a SIGMA Hand-held is available. If you are working with a different type of controller, refer to the instructions for operation provided with it.

Visual inspection and safety check. Inspect the load bank and ensure that:

- All terminations are secure and correctly wired.
- All cables are positioned and safely secured.
- All doors are closed and guards are in place and fixed.
- Packing material and loose items are removed from the area of the load bank to ensure nothing is picked up by the airflow.

Movable load banks are fitted with automatic phase rotation sensors and will adjust the direction of rotation accordingly. On static units the fan may run in the reverse direction if the phases are wired in the wrong sequence. If the fan rotation is incorrect, switch off and isolate the load bank before making any alterations.

Verify control circuit and fan operation. Use the following steps:

1. The Fan and Controls Supply Isolator is in the OFF position.
2. Check that the Supply-on-Test is isolated from the load terminals.
3. Check that the airflow path through the load bank is clear.
4. Switch on the external power supply to the fan and control circuit.
5. Rotate the Fan and Controls Supply Isolator, to the ON position.
6. Select the EXTERNAL position on the supply selection switch.
7. Press the START button.
8. Using the Hand-held select zero load, and press the green I key. The fan will then start and run up to speed.
9. Check the fan rotation. If this is correct cold air should be drawn over the fan motor and through the element pack.
10. Press the red 0 key to initiate the fan run-on timer. The fan will stop after the pre-set time. Alternatively, press the STOP/RESET button on the load bank to stop the fan immediately.
11. Press the STOP/RESET button and rotate the Fan and Controls Supply Isolator to the OFF position.

Troubleshooting

If the fan does not run as expected check the wiring connections and the status of the external supply. If there is no obvious problem with the installation refer to the troubleshooting procedures in Chapter Five.

Chapter Three

Load Bank Operation

This chapter explains how to operate the load bank's local control panel. It describes the function of each control and explains the operation of the status indicator lamps. It then provides specific examples of how the control panel is used to carry out a load function test and how it can be used to operate the load bank when an external control system (such as the SIGMA Hand-held) is not available.

Before Operating the Load Bank

Ensure that:

- The load bank has been installed according to the instructions and safety warnings in Chapter Two.
- The external supply (for fans and controls) is connected according to the instructions in Chapter Two.
- The supply under test is connected according to the instructions in Chapter Two.

The following assumes that a SIGMA Hand-held is connected to the load banks and will be used as the controller for the equipment. Only the basic functions of the Hand-held are covered in this chapter. For a more detailed explanation of its use refer to Chapter Four.

Safety warning

Do not attempt to operate the load until you have read and understood this manual. Misuse could result in serious injury and damage to the equipment.

- Keep all personnel who are not directly involved with testing the supply well away from the load bank and from the equipment under test.
- The discharge air can be very hot and can cause serious burns. Do not touch the outlet grille while the load bank is running, or for a few minutes afterwards.
- Only operate the load bank with all the guards in place, with doors closed and with all of the covers and protective screens securely in position.
- Ensure that there is no risk of the hot discharge air re-circulating back to the air inlet of the load bank, extensive damage is possible due to re-circulating the cooling air.
- Ensure that there is no loose paper, plastic bags, or other debris that could be drawn in to the air inlet, or any combustible material left within range of the air discharge.
- After removing the load at the end of a test allow the fan to run for five minutes to dissipate the residual heat.

3000 SERIES Control Panel Options

Avtron load bank control panels are highly customisable and the controls provided depend very much on the specific application intended for the unit. For 3000 SERIES load banks there are two general control panel configurations that custom variations are based on.

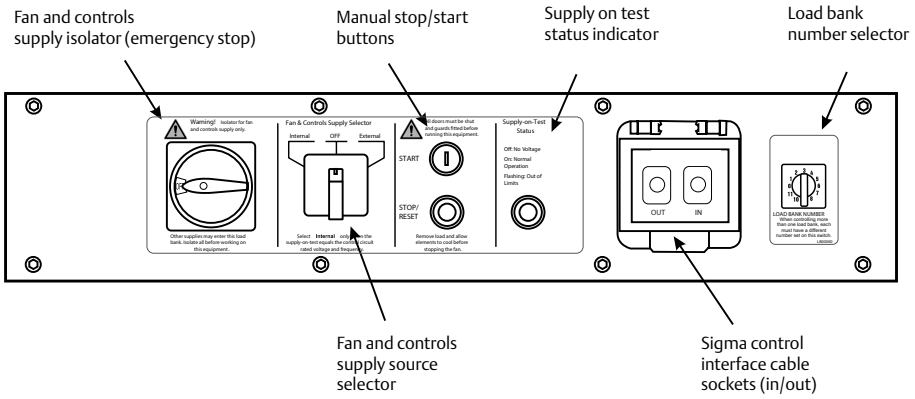


Figure 3-1 Standard movable 3000 SERIES control panel

The Standard SIGMA control panel is intended for applications where the load bank is to be remote controlled via the SIGMA interface cable. This provides access to all of the advanced control and instrumentation features provided by the Hand-held, SIGMA PC Load Control Software or the SIGMA Modbus interface. It also allows multiple load banks to be connected together and simultaneously controlled from the same control device.

The Standard panel contains the following:

Warning! The Fan and Controls Supply Isolator does not isolate the main power wiring from the Supply-on-Test. Some of circuits within the load bank will remain live when the switch is in the off position.

Fan and Controls Supply Isolator. The Fan and Controls Supply Isolator is used to interrupt testing in the event of an emergency. When operated it isolates the control circuit which immediately stops the fan and removes any load.

Fan and controls Supply Selector Switch (movable units only). This selects whether the fan and controls power supply to be provided from either the external mains supply (External) or from the Supply-on-Test (Internal).

Start Stop/Reset buttons. The Start and Stop push buttons are used to enable and disable the load bank's electronics and control system. They are also used to reset any error conditions (such as over-voltage or over-temperature) that may have caused an automatic shutdown. Both buttons contain indicator lamps that show the load bank's status.

Supply-on-Test status indicator. This indicator lamp provides information about the status of the Supply-on-Test.

Note: Pressing the Start button enables the control system, but may not start the fan or apply load unless the control system requests it.

SIGMA control system In/Out sockets. These provide the plug-in connections for the SIGMA control system cable.

Load bank number selector. This rotary switch is used to configure a unique load bank number which identifies the unit to the control system when multiple load bank units are used together. It can also be used as an alternative control switch if the Hand-held or other SIGMA controller is not available. See “Load Bank Emergency Operation” on page 3-11 for a more detailed explanation of how to do this.

The SIGMA Decade Switch control panel

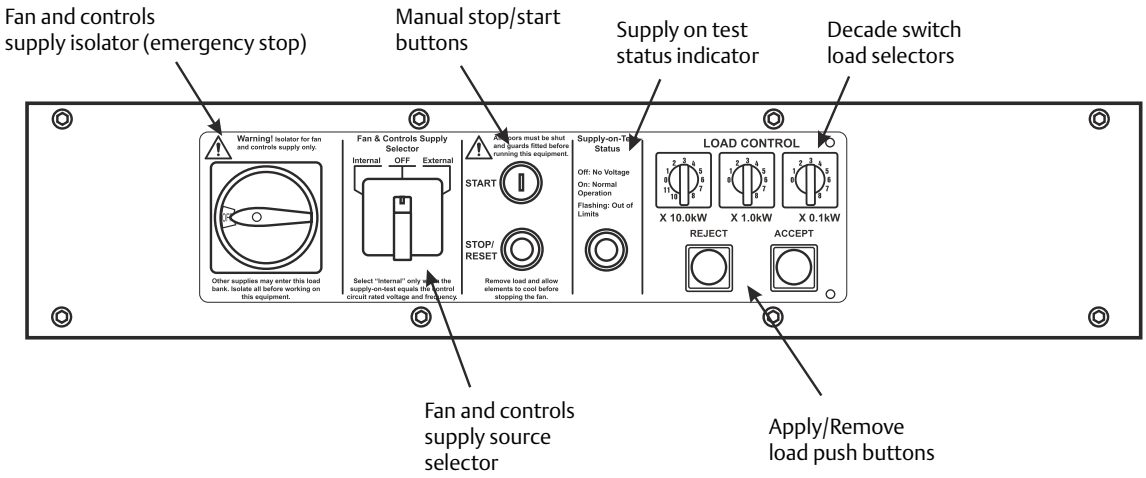


Figure 3-2 The SIGMA decade switch control panel

Note: Despite the apparent simplicity of the decade switch control’s manual interface, the load elements are controlled by the SIGMA controller’s software so that all of the SIGMA advanced control and safety features, such as load correction, are still in operation.

The SIGMA decade switch control panel is intended for applications where direct manual control of the load is required and the existing instrumentation is assumed to be adequate. Decade switch control is the simplest of the Avtron control options and is only available for resistive load banks such as the 3000 SERIES.

The SIGMA decade switch control panel contains the same supply isolation, supply selection, supply status and Stop/Start controls as the Standard panel, but without the load bank number selector switch.

In addition is a control panel containing three rotary switches and two buttons labelled Accept and Reject. The rotary switches allow a precise value of load to be chosen. This pre-selected load is then applied or rejected by the pushing the push buttons.

Status Indicator Lamp Operation

The Start and Stop indicator lamps, located in the Start and Stop/Reset push buttons, and the Supply-on-Test status lamp work together to provide a visual indication of the load bank's operational status.

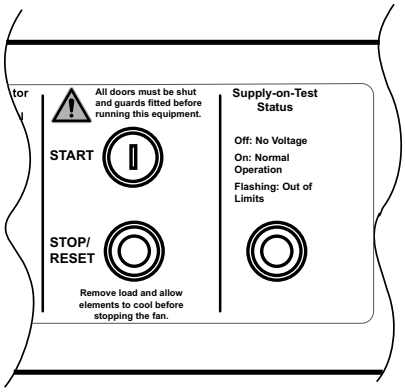


Figure 3-3 The Start and Stop indicator lamps located in the control panel push buttons.

When the load bank controls are first powered up all indicators will illuminate. This provides a lamp test and indicates that the SIGMA 2 processor's self test sequence is running. When the self-test sequence has completed successfully the Start lamp is extinguished and Stop lamp will be illuminated steadily.

If the Supply-on-Test has been connected correctly the Supply-on-Test status lamp will also glow steadily.

The load bank is now operational and waiting for the Start button to be pressed. Pressing the Start button activates the control system and will illuminate the Start indicator. The Stop lamp will extinguish.

Fault indicators

The indicators flash to provide a visual indication of faults detected by the SIGMA controller. Faults are classified as either a warning or as an error.

Errors. These are serious fault conditions which result in the load bank performing a controlled shut down when they occur.

If an error occurs the Start indicator lamp will be extinguished and the Stop indicator lamp will begin to flash. An error code will be displayed on SIGMA controller LED (See "SIGMA 2 Load Bank Status Display" on page 5-7 for more details). If a SIGMA Hand-held or PC system is connected to the load bank the error message will be displayed on the screen.

Warnings. A warning will alert you to an abnormal condition such as high temperature, but will allow the unit to continue to run if required.

General load bank warnings are indicated by the Stop indicator lamp flashing continuously.

A warning related to the Supply-on-Test will result in the Supply-on-Test indicator lamp flashing (See "Warnings" on page 5-8 for more details). Depending on the nature of the fault, the Hand-held unit may display a message.

To reset the error condition. Clear the cause of the fault and press the Stop button followed by the Start button. The load bank will resume operation if the fault has been cleared correctly.

The following table summarises the indicator lamp operation:

Warning! The Supply-on-Test lamp will glow steadily to indicate that the supply is connected correctly. However, it is important to note that it only operates when the fan and controls supply is connected, and that indicator bulbs can fail. If the lamp is off this does not indicate that the Supply-on-Test is disconnected, or that it is safe to work on.

Start	Stop	Supply-on-Test	Description
On	On	On	Start up lamp test.
Off	On	On	Load bank in stopped state, ready for start. Supply-on-Test healthy.
On	Off	On	Load bank is operational. Supply-on-Test healthy.
-	-	Flashing	Supply-on-Test fault warning. The load bank will remain operational and can be operated if required.
Off	Flashing	-	Load bank in error condition. If the error occurs when the load bank is operating the load bank will shut down in a controlled fashion (see page 5-8 for more details).
On	Blinking	-	Load bank warning - general fault. The load bank will remain operational and can be operated if required (see page 5-7 for more details).

Emergency Shutdown Procedures

The load bank provides two methods of quickly shutting down the load bank in an emergency:

Warning! Operating the Fan and Controls Supply Isolator or Stop Button does not isolate the Supply-on-Test from the load bank wiring. Some of circuits within the load bank will remain live.

The Fan and Controls Supply Isolator. This is a two position switch which isolates the power supply to the fan and controls when it is in the off switch. It can be used to perform an emergency stop, but it can also be padlocked in the off position and this means it can be used to secure the load bank from unauthorised operation.

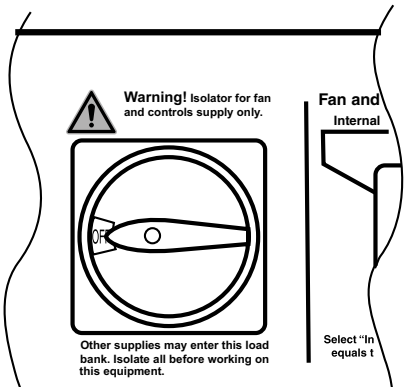


Figure 3-4 The Fan and Controls Supply Isolator

Warning! If the fan is stopped when the load elements are hot the temperature with the load bank will increase considerably. The load bank is designed to withstand this without damage, but the hot air that builds up inside the load bank could prove to be a hazard. Please ensure that the fan outlet is kept clear when the fan is restarted.

The Stop Button. Pressing the Stop button will result in an immediate shut down in a similar way to the Fan and Controls Supply Isolator, but with one important difference. The load will be removed, the fan will stop running and the control system will be disabled, but it will still be powered. To re-enable the control system, simply press the Start Button.

Load Function Test

Immediately after the installation has been completed run a brief load function test to confirm that the load bank has been installed correctly and that it is fully operational.

This involves running the load bank for a few minutes with a load applied. If the load bank operates normally without any errors and the fan rotates in the correct direction then you are ready to proceed with your testing program.

1. Connect a proven 3-phase power source of the correct voltage to the Supply-on-Test terminals (see Chapter Two).
2. Select the source of supply for the fans and controls (External or Internal. See “External supply wiring - the fan and controls power source” on page 2-13) by adjusting the fan and controls supply selector switch (below).

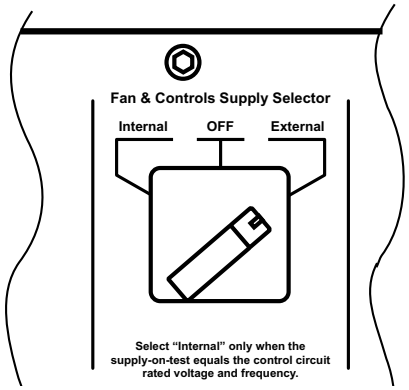


Figure 3-5 The Start and Stop indicator lamps located in the control panel push buttons.

3. Rotate the fan and controls supply isolator (Figure 3-4) to the On position.
4. As the control circuit power is applied, check that the both Start and Stop button indicator lamps light during the lamp test. The Start lamp should go out after a few seconds, leaving the Stop lamp on steadily.
5. Press the Start button. The Start button indicator will light and the Stop button indicator will go out.
6. Now apply some load. You can do this using either the SIGMA Hand-held (See “Manual Test Mode” on page 4-24), the SIGMA PC Load Control Software, or (if a load bank ID selector switch is fitted) using the load bank emergency operation procedures described on page 3-11.
7. Check the voltage, current and power readings are as expected and that none of the load bank indicator lamps is flashing.

Note: If you apply load using the load bank emergency operation procedure the Start lamp will blink during the test.

8. Check the rotation direction of the fan. Movable load banks are fitted with automatic phase rotation sensors and will adjust the direction of rotation accordingly. On static units the fan may run in the reverse direction if the phases are wired in the wrong sequence. Cold air should be drawn over the fan motor and through the element pack. If the fan rotation is incorrect, switch off and isolate the load bank before making any alterations.
9. Remove the load (press the O button on the Hand-held, or select <0> if you are using the control panel).

Under normal operating conditions, the fan(s) should be allowed to run on for a few minutes until the equipment has cooled.

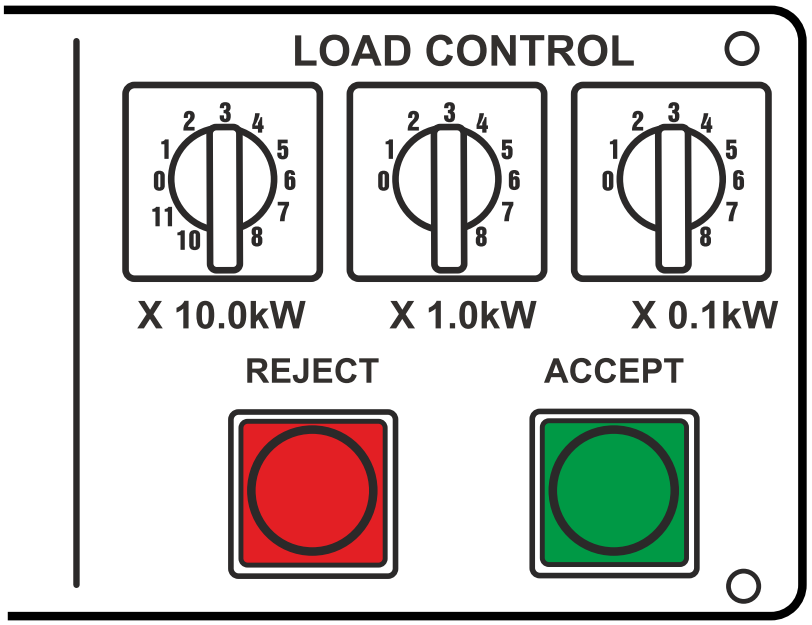
If a problem occurs during the load function test the SIGMA controller may shut the load bank down and the stop button will flash. Refer to Chapter Five for further advice.

Applying Load with the Decade Switch Panel

To apply load using the decade switch panel:

1. Power-up the load bank control circuit and start the unit as explained on page 3-8.
2. Check that the Stop lamp is off and the Start and Supply status indicators are glowing steadily. This indicates that the load bank is operational and the Supply-on-Test is healthy (see page 3-5).

Note: You can force the load bank to apply load when the supply is out of limits (if, for example, the supply phase rotation is incorrect, or there is no voltage on the load bank). To do this press and hold the Accept button until the load control responds.



3. Select the required load using the rotary decade switches.
4. Apply the selected load by pressing the Accept button.
5. The Accept button indicator will light to show that load is applied and the cooling fan will start automatically.
6. To change the load select the new load value on the decade switches, and then press Accept to apply the new load.
7. When testing is completed remove the load by pressing the Reject button. The load bank fan will run for a few minutes to allow the elements to cool before stopping.

Note: When accept is pressed the Supply-on-Test voltage is measured and used to correct the load applied to the supply. This ensures the load applied is what is selected.

Note: Load can be removed at any time by pressing the Reject button.

Load Bank Emergency Operation

If a SIGMA Hand-held is unavailable, it is possible to use the load bank ID rotary switch to control the load bank.

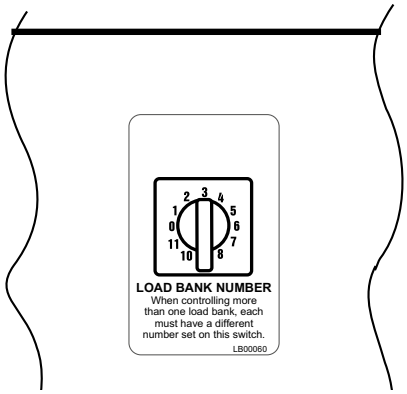


Figure 3-6 The load bank ID selector switch

Note: To prevent accidental operation of this mode the timing for this procedure must be exact. If it does not work the first time you try it, try again.

Ensure that no SIGMA Hand-held is plugged into the load bank and that the load bank is powered up.

1. Press the Stop button.
2. Select <1> on the small rotary switch.
3. Press the Start button.
4. Select <6>. Wait for one second.
5. Select <0>.

When this control mode is enabled the local Start indicator will be illuminated and will blink off at regular intervals.

6. Select <1> to <11> to apply proportionally more load. For each step the load increases by approximately 9% of the total load bank capacity.

Position <11> provides the maximum load available. The fan will start automatically when required. If the load bank has inductive load element available load will be applied at a power factor of 0.8.

Warning! These values refer to the capacity of the load bank - not to the capacity of the Supply-on-Test. Be careful not to overload the supply.

7. Select <0> to reject all load.

The fan will stop after a time delay.

8. Press the Stop push button. To disable Emergency Control Mode.

Load Bank Operation Using a Remote Station

The remote control station duplicates some of the controls on the main control panel and provides sockets for connecting the SIGMA 2 control cable to a suitable control interface.

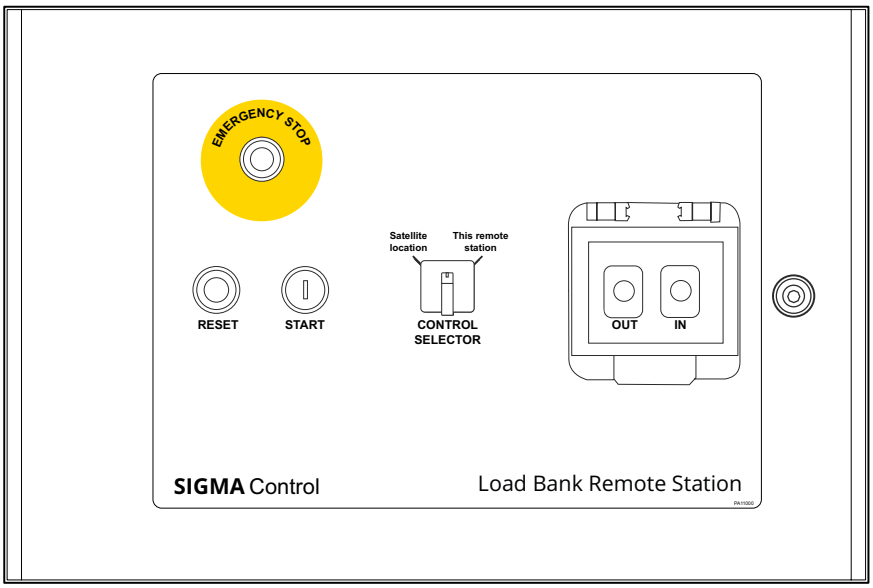


Figure 3-7 Load bank remote station control panel

The remote station control panel is used in a similar way to the main control panel. However the function of the main panel's Stop/Reset button has been divided between two buttons.

The remote station control panel is usually fitted with the following controls:

Note: Both the Start and Reset buttons contain indicator lamps that duplicate the operation of the main panel Stop and Start indicators see (page 3-5).

Emergency Stop Button. Operating this causes the load bank to immediately shut down. The fans, control circuits and load elements will be isolated but the Supply-on-Test may remain live.

Reset Button. This is used to reset any error conditions (such as over-voltage or over-temperature) that may have caused an automatic shutdown.

Start Button. Pressing this enables the load bank's control system ready for testing.

SIGMA 2 Control Selector. This selects between the SIGMA 2 connector on the remote station and an additional connector at a satellite location (for example, in a secondary control room).

Chapter Four

SIGMA Hand-held Reference Guide

The SIGMA Hand-held provides a very simple to use, direct means of controlling the operation of SIGMA controlled load banks whilst simultaneously monitoring the performance of the generator under test. This chapter provides an in-depth look at the hand-held control system with an overview of its more advanced features.

The SIGMA Hand-held

The hand-held is one of a number of available user interface options for SIGMA controlled Avtron load banks. It is a hand-held unit containing a purpose designed microprocessor-based control system for SIGMA-equipped load banks.

The hand-held has a IP65 rated enclosure with a custom-designed membrane keyboard and 4.3" colour TFT screen. These provide a simple control panel interface and instrumentation to allow the progress of load tests to be monitored.

In operation, the hand-held synchronises the load events and ensures that the load is shared proportionally between each connected load banks. Instrumentation information from all load banks is summed and displayed on screen.

This manual describes Version 1.0 of the Hand-held software.

Figure 4-1 The Hand-held provides a simple and robust method of directly controlling up to 14 load banks.

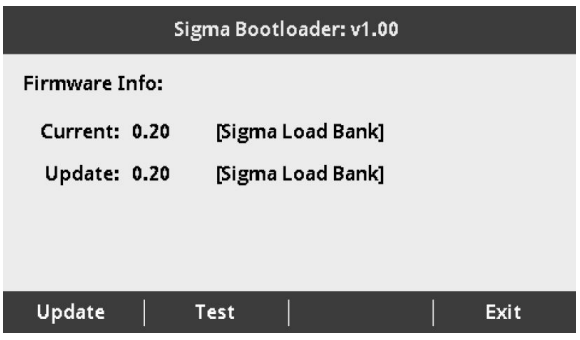
Firmware Updates

Making sure the firmware is up to date on the SIGMA Hand-held is important to maximise load testing capabilities and ensure correct operation. The SIGMA Hand-held has a micro USB port to enable firmware to be updated from a USB flashdrive. The current version of the firmware is displayed on start up in the bottom right corner of the screen.

To update firmware ensure you have the latest firmware .sig file on a USB flash drive. This can be downloaded from: www.avtronpower.com

1. Connect SIGMA Hand-held to power supply or use supply from load bank. (Hand-held power supply can be ordered directly from froment.sales@ascopower.com).
2. Connect USB drive to micro USB connector using USB-OTG Adapter (order from RS Part: 790-3647) - see below.

3. Power on hand-held and check bootloader has been entered - see below.



4. F1 (update) will start the main application programming.
5. The current firmware version will be updated once programming is complete.
6. Remove USB adapter and press F4 (Exit) to finish the update.

Connecting the Hand-held to the Load Bank

The Hand-held connects directly to the load bank's SIGMA control "in" socket using a SIGMA control cable which can be up to a kilometre in length.

The Hand-held can connect to and control up to 14 load banks at the same time. The load bank units are interconnected using a daisy chain arrangement as shown in Figure 4-2.

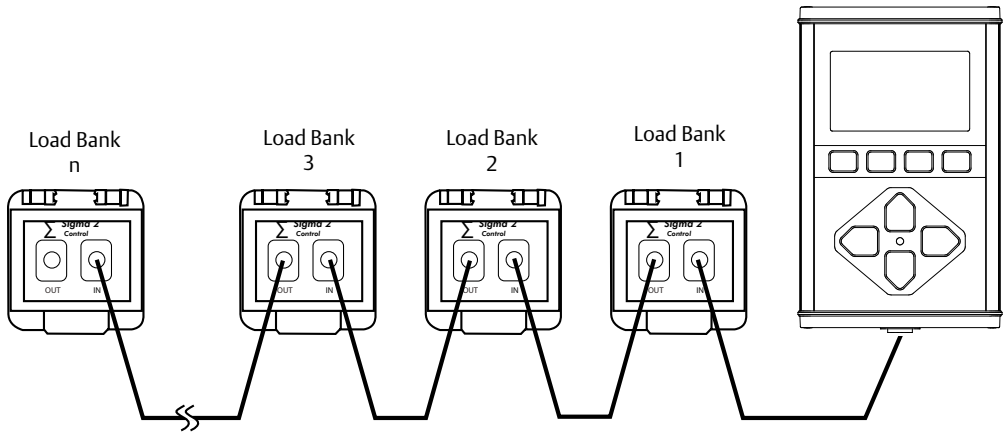


Figure 4-2 The Hand-held SIGMA control cable connecting multiple units in a daisy chain arrangement

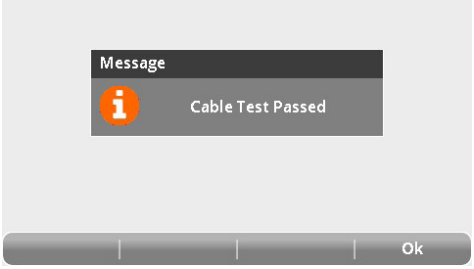
Setting the load bank number

Note: Voltage and frequency instrumentation displayed on the Hand-held display is taken from the load bank with the lowest number.

Each load bank connected must have a unique number in the range from 1 to 14. The default number for a particular load bank is assigned during manufacture or on commissioning. If there is a number selector switch on the load bank this can be used to change the number to any value from 1 to 11. Setting the selector switch to 0 selects the default number as stored in the load bank.

SIGMA control cable testing

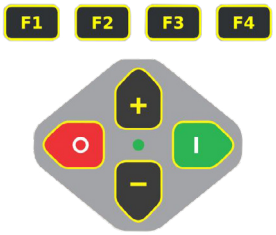
With the addition of a small, mains powered adaptor, the Hand-held can be used as a SIGMA control cable test unit. This provides a fast method of identifying control cable faults. Contact Avtron's Sales department for more details on this.



The Hand-held Keypad

The keypad contains eight membrane switches and a single LED indicator. The switches provide four function keys (marked F1 to F4) arranged below the screen and a quadrant of four control keys arranged around the LED.

The function keys



The operation of the function keys is context dependant. A menu bar, containing labels for each of the keys, appears at the bottom of the screen. The labels for each function key change to indicate the function (PAGE, EDIT, etc.) in the particular context.

The quadrant keys

The four quadrant keys are used to make adjustments, to apply or reject a load, or to start an automatic test sequence if one is configured.

The + and – keys are used to increase or decrease values that are highlighted or displayed on screen.

Pressing I applies load if in Manual Test mode, or starts an automatic test if in Automatic Test Mode.

If a load is already applied pressing I forces the Hand-held to carry out a load correction (that is to say that it will adjust the number of load elements applied to correct for changes in voltage or temperature, etc.).

Pressing O at any time will reject the load or abort any automatic load test that is running. If the load is set to ramp down on reject (indicated by fast blinking of the green LED) pressing O a second time will drop the remaining load immediately.

The LED status lamp

The LED indicator provides feedback of the current load status:

Continuously On. Load applied (manual mode) or test sequence paused (automatic mode)

Half Second Blink. Automatic test running

Rapid blinking. Ramping down on reject

The Hand-held Menu Display System

The Hand-held uses a menu display system for initial settings and also during the testing process. The screen provides real-time instrumentation readings, status information and labels for the four function keys (F1 to F4).

The screen shows details of the supply settings, built-in help and also provides access to instrumentation to allow monitoring during testing.

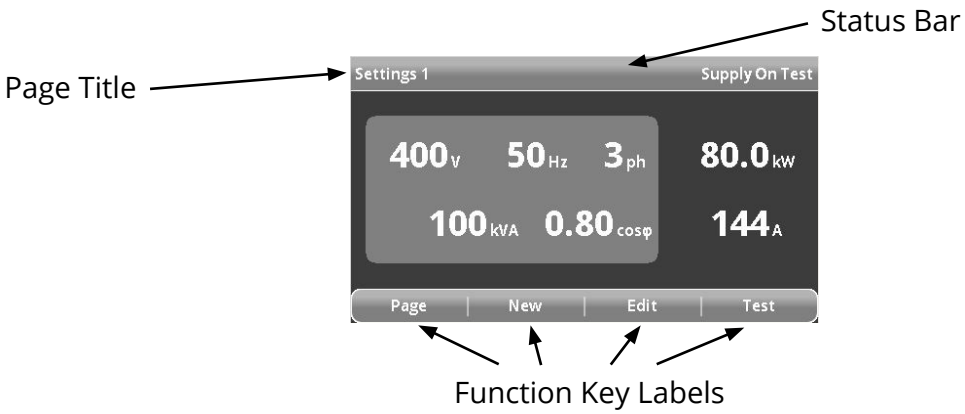


Figure 4-3 The Hand-held screen display.

SIGMA Status Messages

A message window is used to display status information and other messages from the load banks.

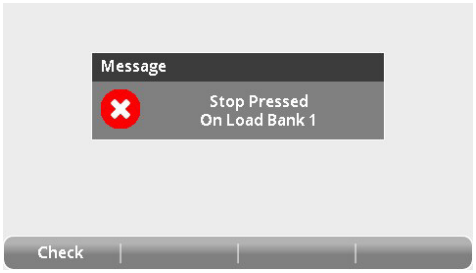


Figure 4-4 Typical SIGMA status message

The following table lists the messages that may appear:

Error Message	Description	Possible Causes
Stop Pressed on Load Bank nn	Load bank emergency stop signal is present.	• Start button has not been pressed or was pressed before the load bank had performed its power on self-test (both Start and Stop illuminated). Wait until the Stop button only is illuminated before pressing the Start button. • External Emergency Stop buttons (if fitted) are depressed. Release all Emergency Stop button and press the Start button. • Load bank ESR not energising or faulty auxiliary contact.
No Load Banks Active Check Cable	No load banks are responding to the Hand-held.	• If two, or more, load banks are connected - check setting of station number switch. Each load bank should be a unique number. • Ensure each load bank Stop button is pressed when station number changed. • Faulty cable between Hand-held and load bank.
Fan Tripped On LoadBank nn	Fan Overload signal not present when fan run output energised.	• Fan Circuit Breaker or Overload Tripped. Check fan is not obstructed and that it is free to rotate. Then reset Trip or Circuit Breaker. • Check motor current.
Fan Not Running On LoadBank nn	Fan Contactor auxiliary contact signal not present, when fan run output energised.	• Fan contactor not energising or faulty auxiliary contact.
Fan Power Fault On LoadBank nn	Fan/Control Circuit Power supply is outside limits on voltage and/or frequency or a phase is missing.	• Check control voltage, frequency and phases. If the generator rating is incorrect run the load bank from an auxiliary supply. • Check the Fans and Controls Supply Selector switch is in the correct position. • Load bank fan supply VT fuses blown or VT's faulty. Check fuses and VT output.
Over Temperature On LoadBank nn	Over Temperature signal not present.	• Load bank is over temperature. Ensure that the load bank ambient temperature is not exceeded and check hot air discharge is not recirculating. Allow the load bank to cool, and then press Stop and Start buttons. • Over temperature trip faulty. More than one over temperature trip may be fitted. These devices will automatically reset when they cool down.
Air Flow Failure On LoadBank nn	Air Flow signal not present after fan output energised.	• Fan or Duct obstructed. Flow detector faulty. Check flow detector operation.
Supply Over Limits On LoadBank nn	Load Supply frequency is too low for voltage applied.	• The supply is outside the voltage/frequency limit. To maintain the same voltage increase the frequency of the Supply-on-Test or, alternatively, to maintain the same frequency reduce the voltage.
Duct/Louvres Closed On LoadBank nn	Duct Covers or Louvres proximity detector (if fitted) signal not present.	• Duct covers or louvres closed. Open duct covers or louvre. • Proximity detector faulty - Check detector operation.
Lost Communications On LoadBank nn	Load bank and/or Hand-held have lost communications.	• Hand-held disconnected from load bank whilst load applied. Press Stop, and then Start on the load bank. • Hand-held or load bank interconnecting cable fault. Check and replace.

Using the SIGMA Hand-held

The Hand-held's on screen menu system is designed to be simple and intuitive, and the best way to learn it is to use it. The quick-start demonstration on the following page shows how you can carry out a full manual generator test with only a few key presses.

There are two parts to the sequence. The first part is to make sure that the generator specification shown on screen matches the details that are shown on the generator's rating plate. This is important because having the correct generator size information allows the Hand-held to calculate the load that is to be applied correctly. This provides protection from overload during testing and will allow the percentage loads applied to be calculated accurately.

The second part is concerned with carrying out the test itself. Various percentage loads are applied, and the SIGMA instrumentation is used to view the generator's response.

However, there is much more to the Hand-held than the ability to conduct basic manual tests. We will explain all this in more detail and cover the use of automatic test sequences and other advanced features later in the chapter.

General assumptions

The following explanation assumes that:

- The load bank has been installed according to the instructions provided and all of the necessary safety precautions have been followed.
- A Hand-held unit is connected to the load bank using an appropriate cable.
- Both the fan and controls supply and the Supply-on-Test are connected and any circuit breakers are closed.

Hand-held Quick Start

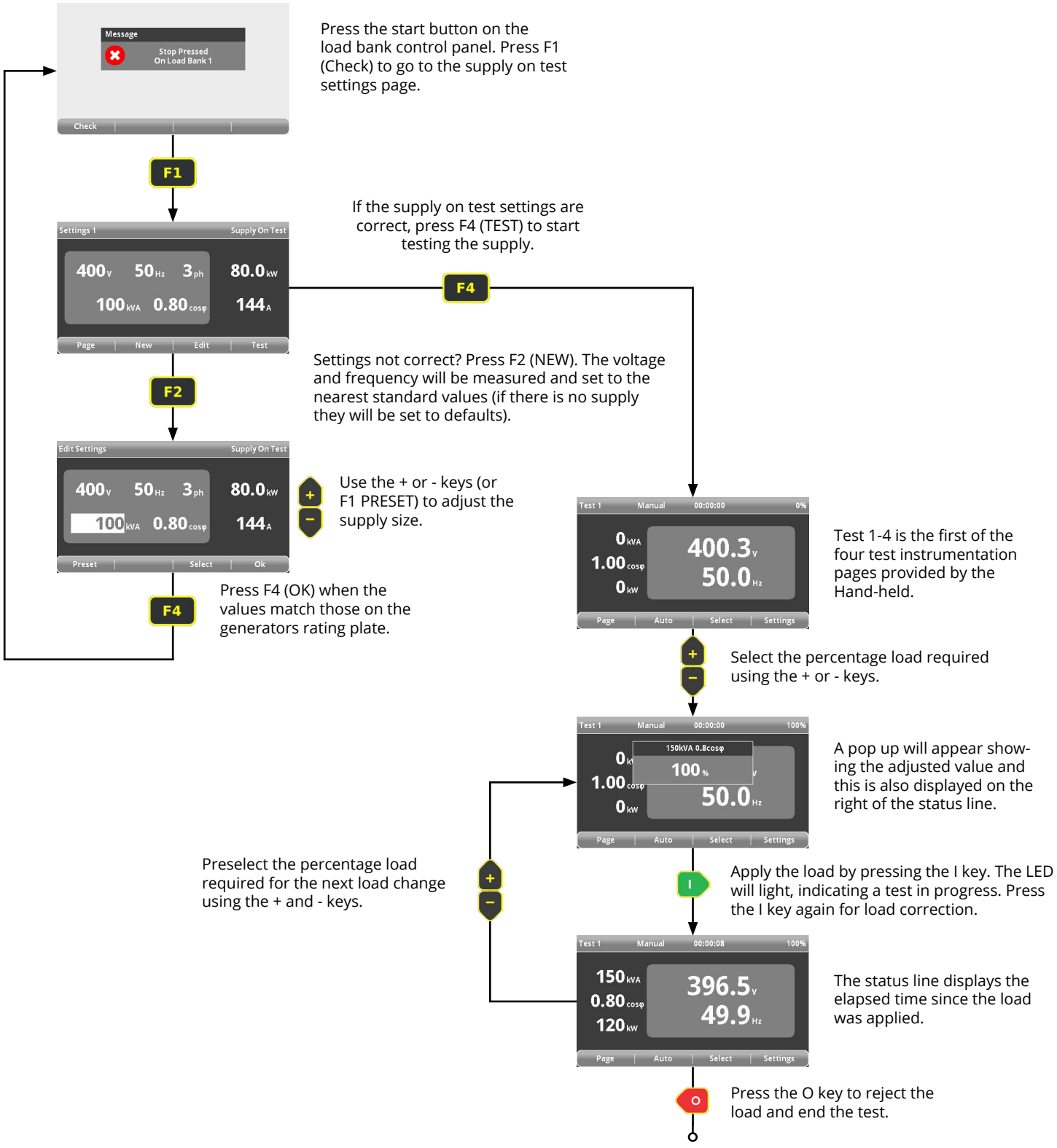


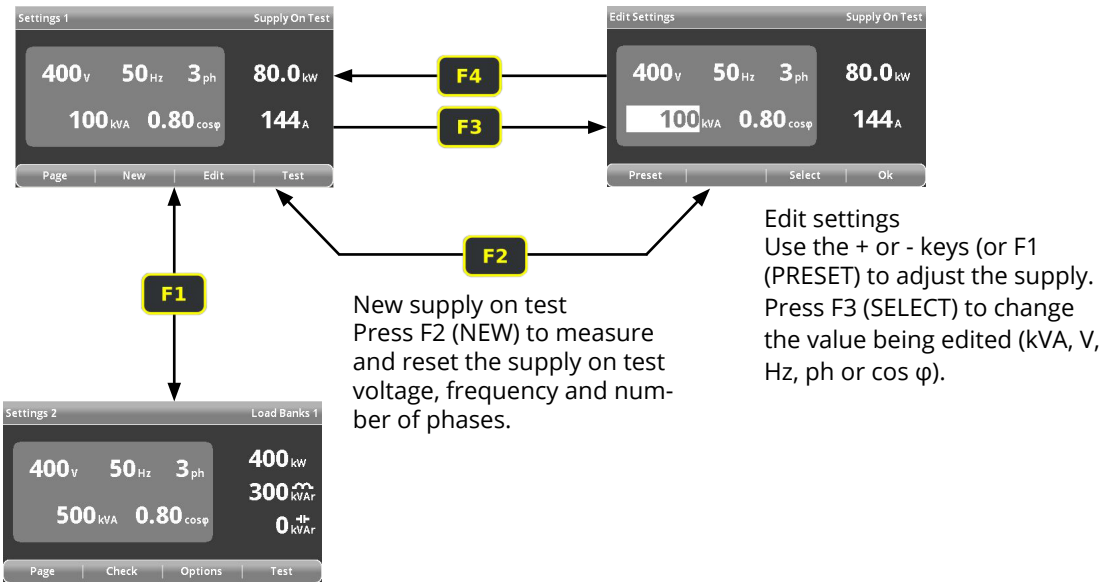
Figure 4-5 Hand-held quick start manual test sequence.

Using the Settings Pages

Before testing begins it is important to set up the Hand-held so that it is able to control the load bank correctly.

The Hand-held provides two Settings pages for this purpose. The first of these is used to set the details of the Supply-on-Test. The second allows you to check the load bank capacity and make adjustments to the Hand-held and load bank's operation.

Settings 1
This page is the starting point of the Hand-held menu system. It is displayed immediately after start-up and shows details of the supply-on-test.



Edit settings
Use the + or - keys (or F1 (PRESET) to adjust the supply. Press F3 (SELECT) to change the value being edited (kVA, V, Hz, ph or cos φ).

New supply on test
Press F2 (NEW) to measure and reset the supply on test voltage, frequency and number of phases.

Settings 2
This screen displays the capacity of the load bank and the number of load banks connected. Press F3 (OPTIONS) to access the load bank options pages.

Figure 4-6 The settings menu pages.

Settings 1 - Supply-on-test

The Settings 1 page is used to set up the details of the Supply-on-Test and it is important to make sure that these are set correctly before applying any load. The load bank uses the values set here to limit the load that is applied. If the values are incorrect the generator may be overloaded and damaged during the test.

Figure 4-7 The Settings 1 page.

Setting the Supply-on-Test rating values

If the Supply-on-Test is connected to the load bank and F2 (NEW) is pressed the Hand-held will carry out the following sequence of operation:

- Check the voltage and frequency on each load bank connected.
- Check voltage and frequency stability.
- Check phase rotation on each load bank.
- Checks voltages to determine whether this is a three or single phase connection.

Note: The Standard Supply Voltage values are: 120, 200, 208, 220, 230, 240, 277, 380, 400, 415, 440, 460, 480, 500, 600, and 660. The Standard Supply Frequency values are: 50, 60 and 400

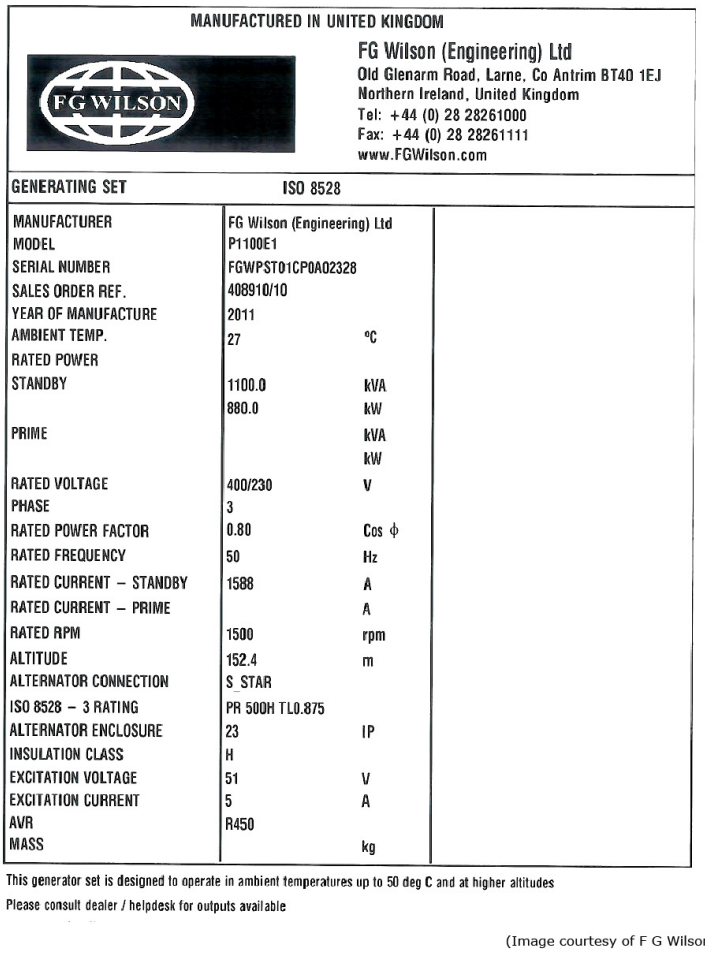
At the end of this sequence the Hand-held will:

- Display a warning message if any of the above checks fail.
- Automatically set the supply voltage, frequency and number of phases to the nearest standard values.
- Enter the Edit Settings page so you can to verify the supply size (kVA).

Checking the rating values

The voltage, frequency and number of phases set are the SIGMA Hand-held's best estimate of the supply rating, based on the measurements it makes. However, if the generator is uncalibrated, non-standard, or is under performing in some way, then these values may need adjustment before testing can begin.

It is very important to check if the automatically set values are acceptable, and you can usually do this by comparing them to those on the generator's rating plate.



MANUFACTURED IN UNITED KINGDOM

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www.FGWilson.com

GENERATING SET	ISO 8528	
MANUFACTURER	FG Wilson (Engineering) Ltd	
MODEL	P1100E1	
SERIAL NUMBER	FGWPST01CP0A02328	
SALES ORDER REF.	408910/10	
YEAR OF MANUFACTURE	2011	
AMBIENT TEMP.	27	°C
RATED POWER		
STANDBY	1100.0	kVA
	880.0	kW
PRIME		kVA
		kW
RATED VOLTAGE	400/230	V
PHASE	3	
RATED POWER FACTOR	0.80	Cos ϕ
RATED FREQUENCY	50	Hz
RATED CURRENT – STANDBY	1588	A
RATED CURRENT – PRIME		A
RATED RPM	1500	rpm
ALTITUDE	152.4	m
ALTERNATOR CONNECTION	S_STAR	
ISO 8528 – 3 RATING	PR 500H TL0.875	
ALTERNATOR ENCLOSURE	23	IP
INSULATION CLASS	H	
EXCITATION VOLTAGE	51	V
EXCITATION CURRENT	5	A
AVR	R450	
MASS		kg

This generator set is designed to operate in ambient temperatures up to 50 deg C and at higher altitudes
Please consult dealer / helpdesk for outputs available

(Image courtesy of F G Wilson)

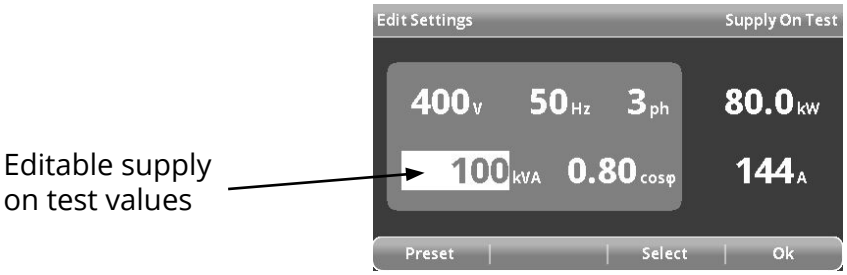
Figure 4-8 Typical generator rating plate.

Note: In this example the generator is rated at 400V, 50Hz with an apparent power of 1100kVA at 0.8 cos φ.

The voltage, frequency, number of phases, apparent power (kVA) and power factor (cos φ) values shown on the Supply-on-Test page are all adjustable from the Supply-on-Test Edit page. You can reach this page directly by pressing F3 (EDIT) or (after automatically measuring the supply on the busbars) by pressing F2 (NEW).

To edit the supply rating values:

1. On entering the Supply-on-test Edit page the kVA value will be highlighted, ready for editing.



Note: The maximum preset is 83% of the load bank size. This is the largest generator that can be tested to 110% allowing for a 4% voltage droop. The minimum preset is approximately 25% of the maximum value.

2. Press F1 (PRESET) to step through a series of pre-defined values for kVA. Use the + or – keys to make fine adjustments to the value.
3. Press F3 (SELECT) to choose the next value to be edited. Each press will step from power factor (cos φ), voltage (V), frequency (Hz) and the number of phases (ph). Pressing F2 (HELP) provides further information on each selected item.

As the values on the left hand side of the screen are adjusted the active (or resistive) power (kW) and apparent current (A) are re-calculated and shown to the right of the display. This facility will help you verify that ratings for the cables you are using are adequate. It can also be useful if the generator does not have a kVA value on its rating plate.

Note: The setting for power factor should reflect the generator's rating, not the capability of the load bank. Most generators are rated at 0.80 cos φ and if that is the case you should set this even if you intend to test the supply at unity power factor.

4. Press F4 (OK) when the values are set correctly. The load bank will be set to operate at the supply ratings set and the display will return to the Settings 1 page. A warning symbol will be displayed if the load bank is not large enough to carry out a test to at least 110% of the supply.

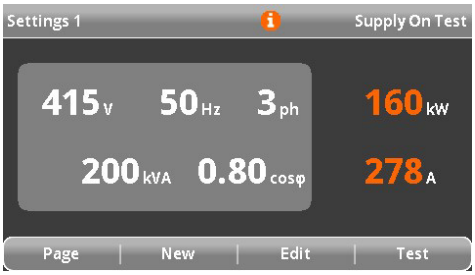


Figure 4-9 Settings 1 warning symbol

Settings 2 - Load bank

The load bank settings page shows the number and total maximum capacity of all the load banks under control of the Hand-held. It also provides access to the Options pages, which allow a number of aspects of the load bank's operation to be modified.

The load bank capacity is calculated at the Supply-on-Test rating (voltage and frequency and number of phases) and the values may change if you edit the supply voltage or frequency on the Supply-on-test page (SETTINGS 2)

From Settings 1, press F1 (PAGE) to move to the Settings 2 page:

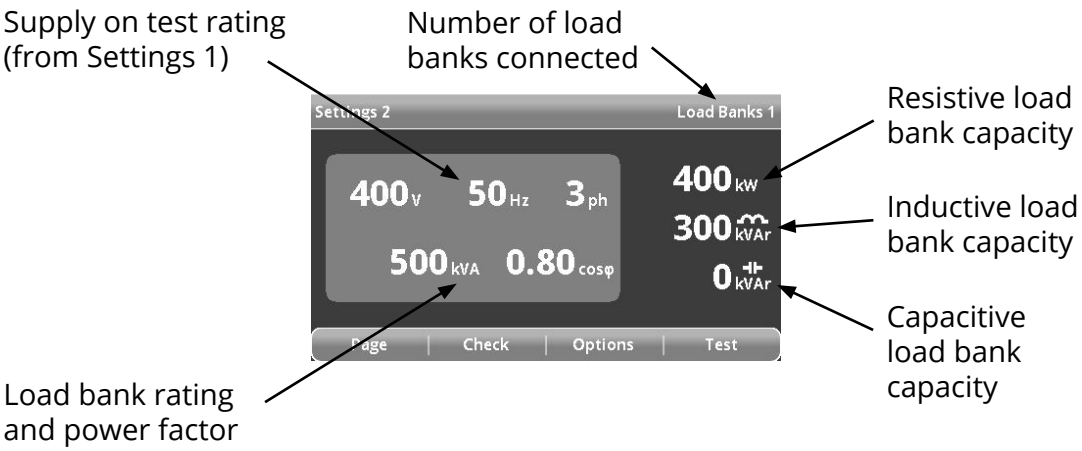


Figure 4-10 The Settings 2 - load bank page

Checking for load banks

Pressing F2 (CHECK) will cause the Hand-held to check the number of load banks connected. It should be used to clear any errors on a load bank or when changing the number of load banks connected to the Hand-held.

The status bar shows the total number of load banks that are connected. The load bank rating (kVA) and power factor, displayed on the lower left of the screen, is calculated from the load bank capacity at the Supply-on-Test ratings. The total Resistive, Inductive and Capacitive load bank capacities are displayed on the right.

The Options Pages

There are three options pages which will allow you to adjust various aspects of the load bank's operation. To reach the first of the Options pages press F3 (OPTIONS) from the Settings 2 - load bank page.

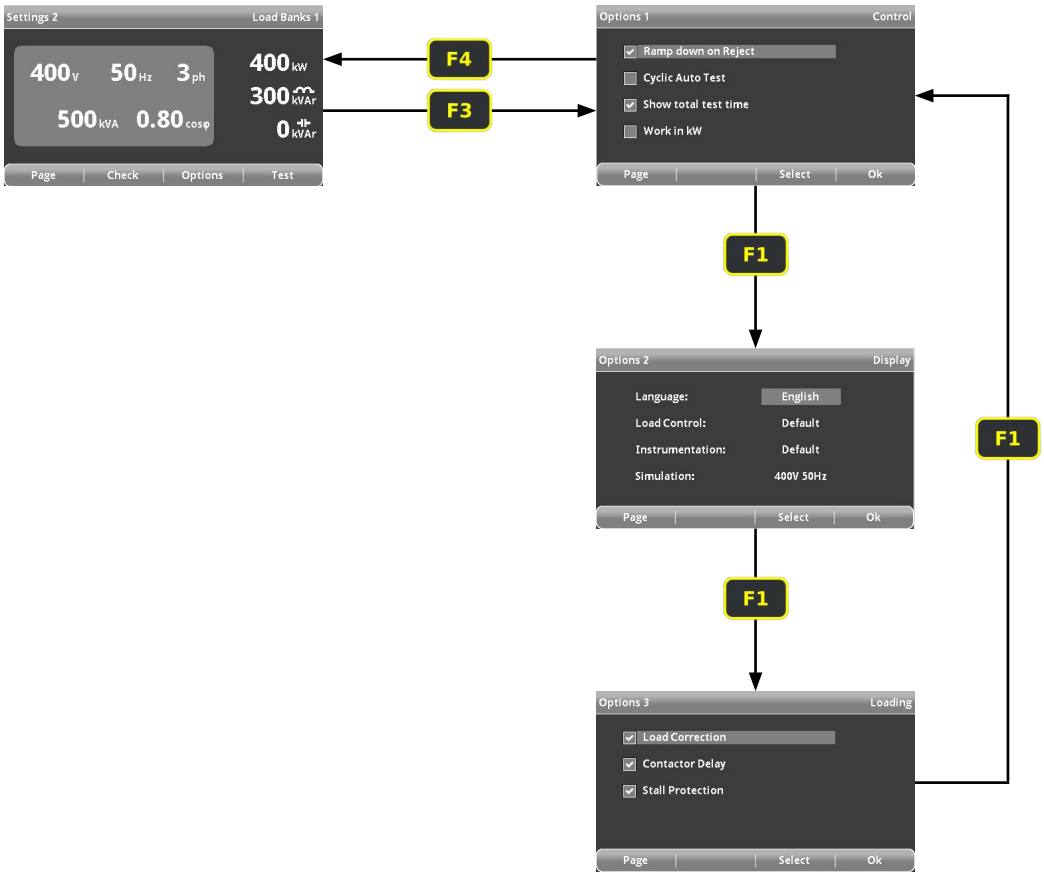


Figure 4-11 The Options Pages

Navigate between the options pages by pressing F1 (PAGE). Pressing F3 (SELECT) selects a list item for adjustment. You can enable or disable the selected option by pressing the + or - key.

Press F4 (OK) at any time to exit the options pages and return to Settings 2.

Options 1 - Control:

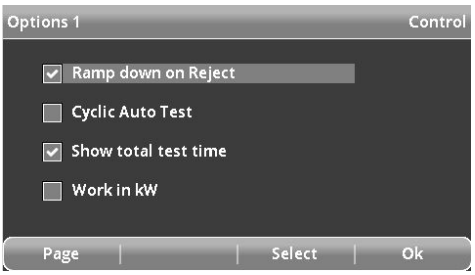


Figure 4-14 The Options 1 page.

The control options change the Hand-held's load control behaviour.

Ramp Down on Reject. Protects the Supply-on-Test from damage by removing the load gradually when the O key is pressed. When this option is selected the load will ramp down in ten equal steps over a period of 12 seconds. Press O a second time to reject the load immediately. The Hand-held's LED will blink rapidly during the ramp down period.

Cyclic Auto Test. When the automatic test sequence reaches the last step it will restart the sequence at step 1.

Show Total Test Time. If this option is selected the status line on the Test pages will show the total accumulated test time. Otherwise it will show the time since the current load was applied.

Options 2 - Display:

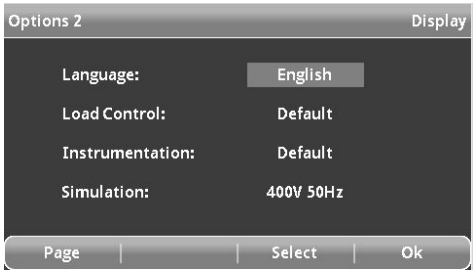


Figure 4-12 The Options 2 page.

Language. Select the default language. Five languages are supported as standard. These are English, French, German, Spanish and Italian. Changing the language setting will change all of the text on the display, including function key labels and help messages.

Load Control. Lets you override the default increment for load selection. The default resolution for load control is determined by the load bank size and minimum load step. For example it could be in tenths of kW or whole kW or tens of kW. On this page you can select one more or one less resolution then the default selection by setting these to "Fine" or "Coarse".

Instrumentation. Lets you override the default resolution for current and power instrumentation. The default resolution for instrumentation is determined by the load bank size and minimum load step. For example it could be in tenths of kW or whole kW or tens of kW.

On this page you can select one more or one less resolution then the default selection by setting these to “High” or “Low”.

Simulation. Select from two voltage and frequency modes when in simulation mode. To enable simulation mode a loop back adapter is required. Contact the sales team for more information.

Options 3 - Loading:

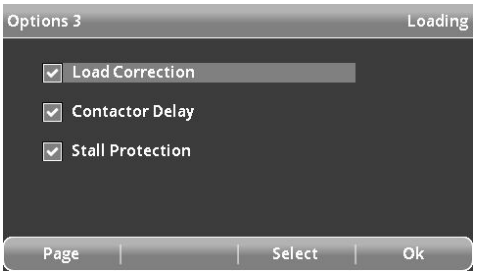


Figure 4-13 The Options 3 page.

The loading options are important for ensuring that the correct load is applied and the automatic stall protection feature can prevent generator damage. Unless you have a good reason for doing so, we recommend that these three options remain selected.

Load Correction. Provides closed loop load control. This adjusts the load applied to compensate for variations caused by changes in voltage, frequency or temperature. Load correction will also compensate for the fan load if the fan is being powered by the Supply-on-Test.

See “Using load correction” on page 4-23 for more details on the operation of load correction.

Contactor Delay. Turning on Contactor Delay ensures that all of the connected load banks synchronise load events to ensure the cleanest possible load change on the Supply-on-Test. Switching off Contactor delay can result in the generator AVR response appearing worse than normal.

Stall Protection. If the supply frequency drops by more than 20% for 3 seconds a pop-up warning message is displayed. After 5 seconds the load will be dropped and the warning message will change to “Stall Rejected”.

The Test Pages

There are three Test pages which allow you to select and accept load, and to monitor the test as it proceeds. To reach the first of them, press F4 (TEST) from either of the Settings Pages.

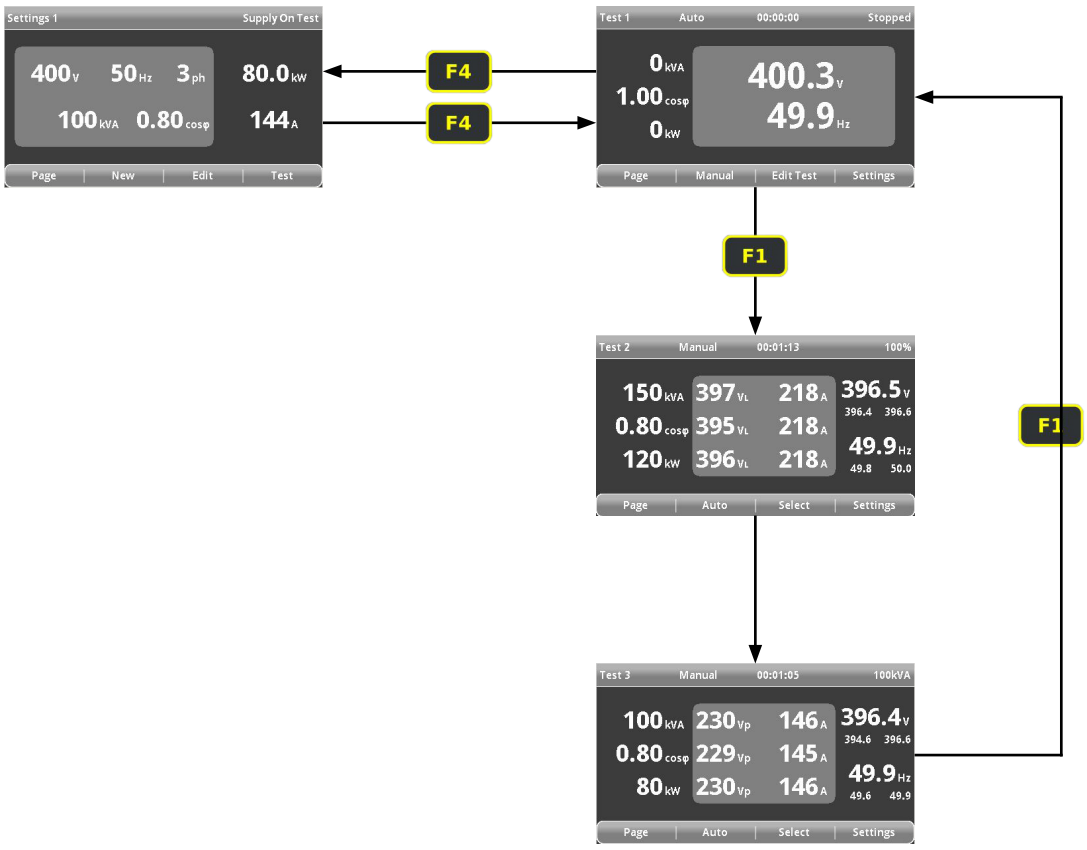


Figure 4-14 The Test pages

Press F1 (PAGE) to cycle through each of the pages in turn.

Note: The Test pages (Test 1 to Test 3) are available for viewing at any time, irrespective of whether a test is running.

As the generator test runs the instrumentation will show the generators response to the load applied in real time. The three test pages offer different views of the instrumentation, each of which can be useful at different stage of the generator testing process.

Test 1 - AVR and governor adjustment setup

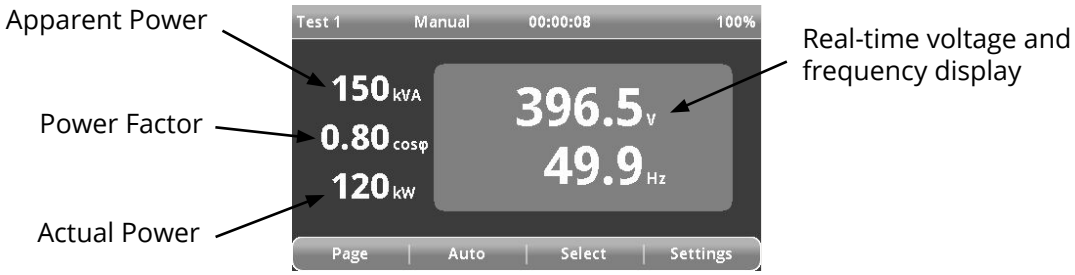


Figure 4-15 Test 1 page.

This first Test page shows the real-time Voltage and Frequency of the supply as it is tested, with the calculated instrumentation powers in the left hand column. Use this test page for adjusting the generator's initial AVR and governor settings before starting a full load test.

Test 2 - Full load testing (line to line)

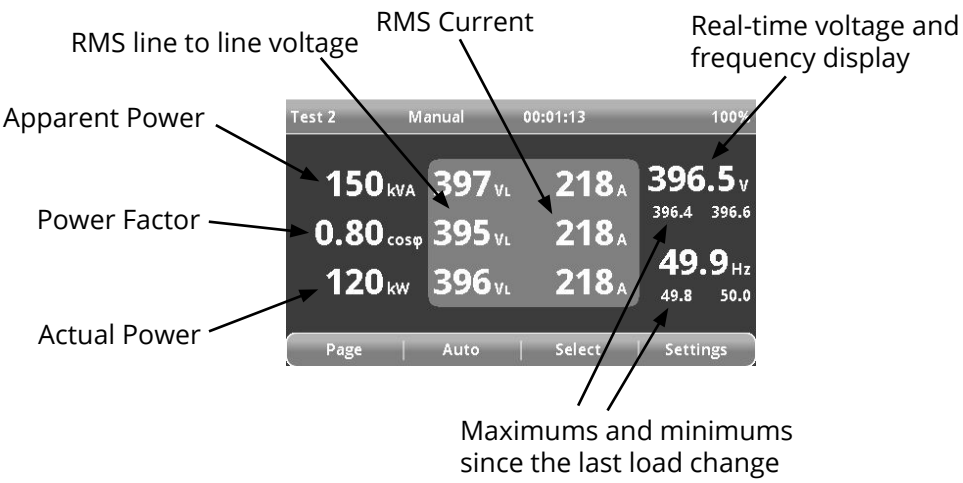


Figure 4-16 Test 2 page.

The second and third Test pages display the electrical data required for full-load testing from different perspectives. Test 2 displays true rms three-phase measurements of the line to line voltage (VL), and current (A) in the central column of the display, with the calculated instrumentation powers in the left hand column.

Test 3 - Full load testing (phase to neutral)

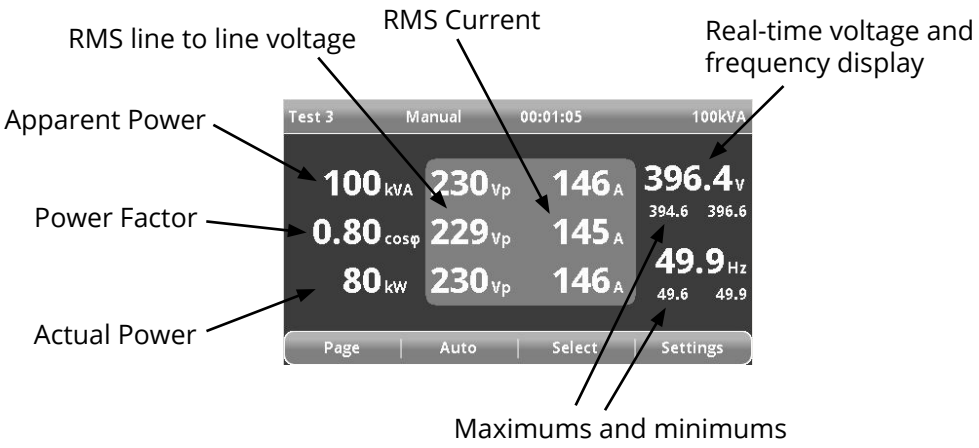


Figure 4-17 Test 3 page.

Test 3 displays true rms three-phase measurements of the phase to neutral voltage (VP), and current (A) in the central column of the display. Again, the calculated instrumentation powers are shown in the left hand column.

Assessing supply performance

The voltage and frequency maximum and minimums and transient response graphs can be used to assess the performance of the Supply-on-Test.

ISO8528 defines three classes of generator performance (G1, G2 and G3) and specifies deviations and recovery times for each class as follows:

Parameter		Unit	Operating Limit Values Performance class G1	G2	G3
Transient frequency deviation from rated frequency	100% sudden power decrease	%	<= +18	<= +12	<= +10
	Sudden power increase	%	<= -15	<= -10	<= -7
Frequency recovery time	100% sudden power decrease	s	<= 10	<= 5	<= 3
	Sudden power increase	s	<= 10	<= 5	<= 3
Transient voltage deviation	100% sudden power decrease	%	<= +35	<= +25	<= +20
	Sudden power increase	%	<= -25	<= -20	<= -15
Voltage recovery time	100% sudden power decrease	s	<= 10	<= 6	<= 4
	Sudden power increase	s	<= 10	<= 6	<= 4

The generator class will be indicated on rating plate. For example, in Figure 4-8 the generating set is rated G3 (ISO8528 - 3 Rating).

The test screen status bar

The status bar provides important information during testing. The information shown varies depending on the test mode (manual or automatic) as shown in Figure 4-20.

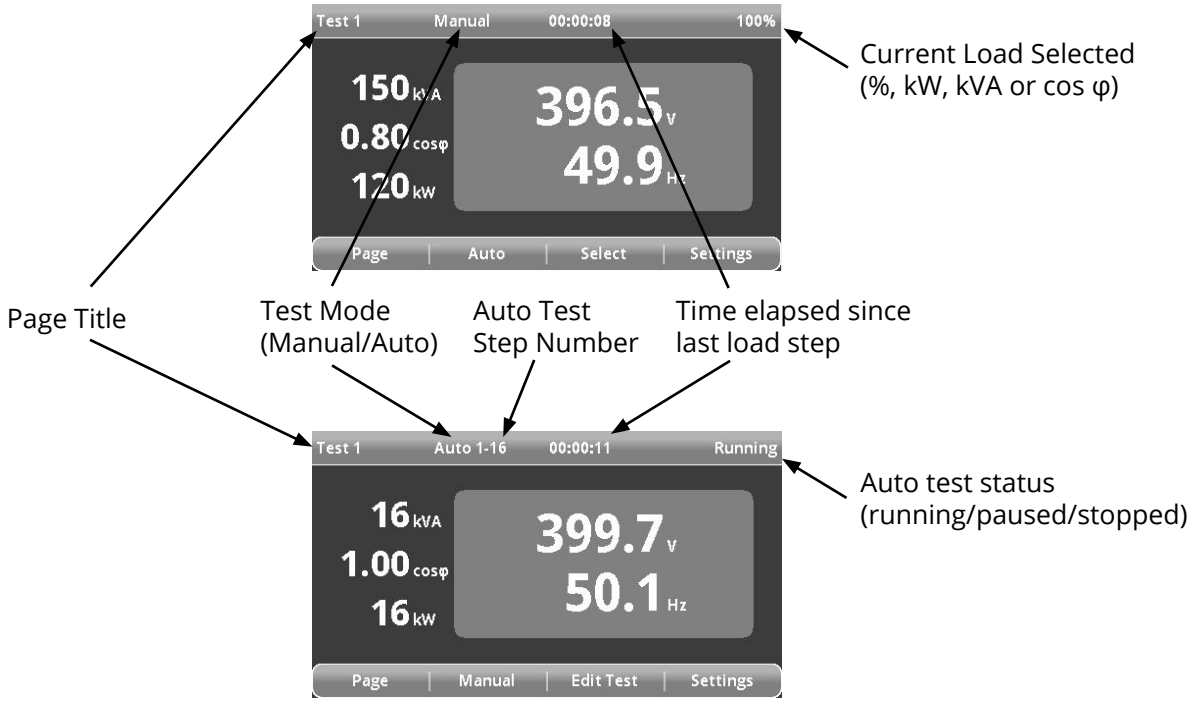


Figure 4-18 The Test screen status bar - showing the differences between automatic and manual modes.

Manual Test Mode

The Hand-held's manual test mode provides direct, real time control over the load bank's operation.

The following assumes that:

- The Supply-on-Test and load bank settings have been made as described earlier in this chapter.
- You have pressed F4 (TEST) from either of the Settings screens on the Hand-held to get to the test 1 page.

Using load correction

By default, the Hand-held provides closed loop load correction whenever you press the I key. This operates as follows:

- The first time that a load is applied the Hand-held will look up in its internal load table to see if it has a stored correction for that load value. If so, it will apply the stored correction.
- If no correction is found then it will calculate the load correction based on the actual power measured with a compensation for the actual voltage and frequency
- If the same load is applied a second time the Hand-held will always calculate a new load correction. This load correction will be stored, replacing the previous correction.
- You can force a new load correction at any time by pressing I when the a load is applied.
- The last sixteen load corrections are stored in the Hand-held's memory. Restarting the Hand-held, or pressing either NEW or CHECK, will clear the stored corrections from memory.

Setting the load values

By default, the Hand-held allows you to set the load as a percentage of the Supply-on-Test from 0% up to a maximum of 120%. The actual load applied is based on the Supply-on-Test and load bank settings made on the Settings 1 and 2 Pages.

However, by pressing F3 (SELECT) you can choose between setting the load using kVA, Power Factor or Percentage load values (If a resistive-only load bank is used, then the selection will be percentage load and kW only).

Power factor can be set between 0.00 and 1.00 cos φ on the Hand-held (most generators are rated at 0.8 cos φ). However, non-unity power factor values are dependant on the load bank capacity and the supply size.

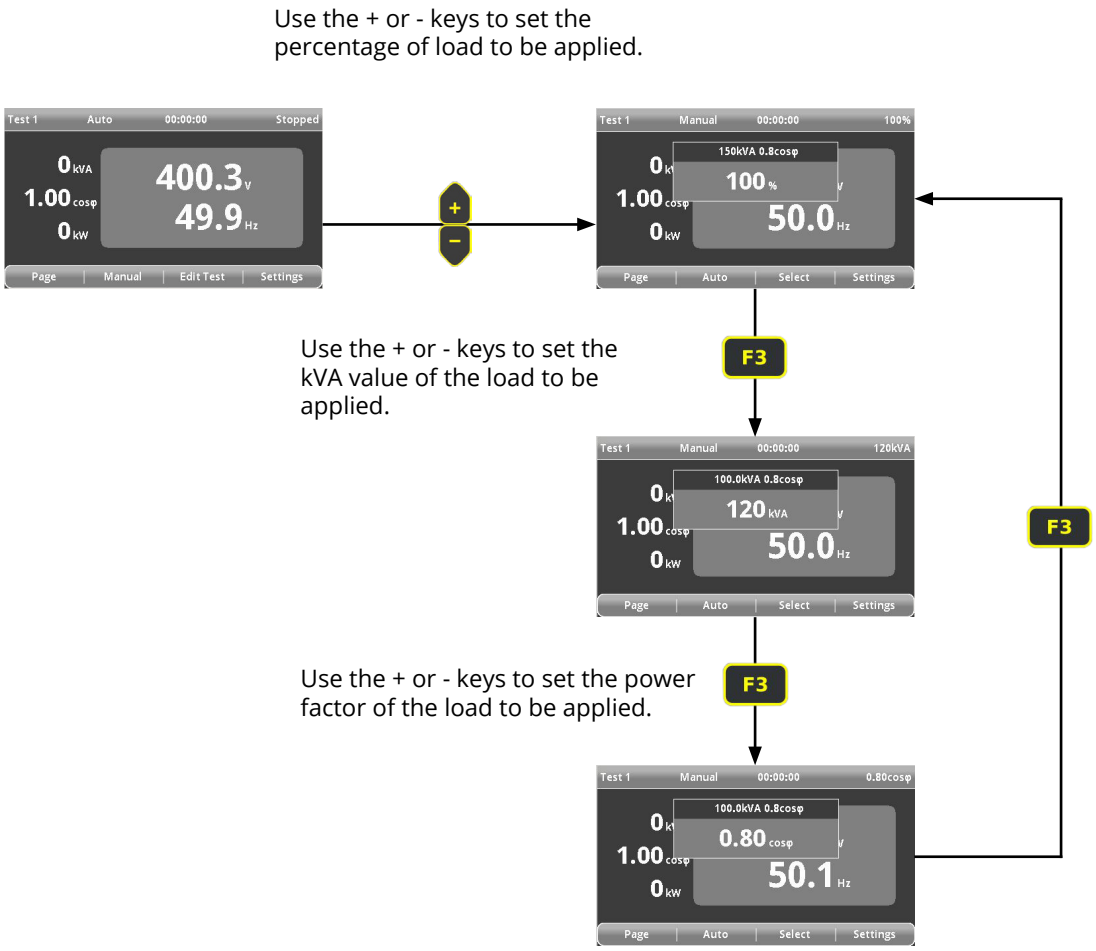
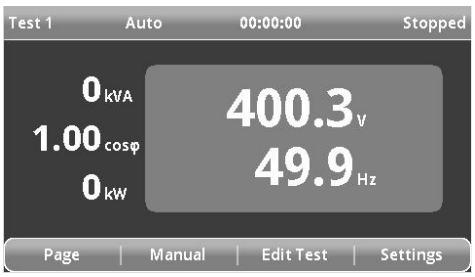


Figure 4-19 Setting load values for the manual test sequence

To set the load:

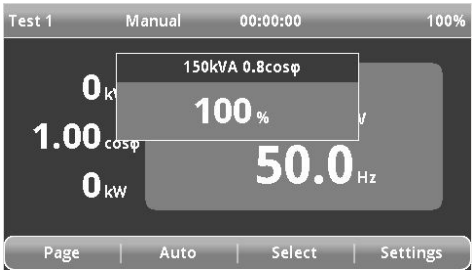
Begin by setting the value of the load that is to be applied by using the Hand-held's + and - keys. The load resolution is set according to the load bank size, and the minimum load step (typically 1kW). The load resolution can be adjusted in the OPTIONS pages if you require finer load steps.

1. On the Hand-held unit press F4 (TEST) from either of the Settings screens to get to the Test 1 page.

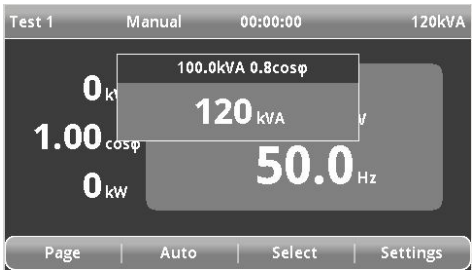


Note: The load select pop-up appears when either the +,- or F3 (SELECT) key is pressed. The supply settings (kW or kVA, and power factor) are displayed in the pop-up header.

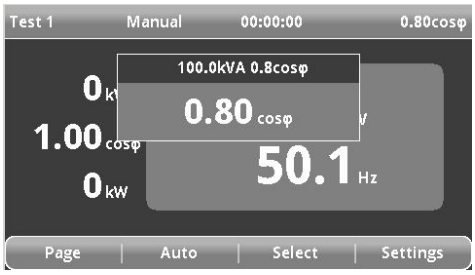
2. Use the + and - keys to select the percentage size of the required load.



3. The pop up window will disappear after a few seconds, but the newly set value will be shown at the top right of the status bar.



4. Press F3 (SELECT) and use the + and - keys to adjust the kVA value.

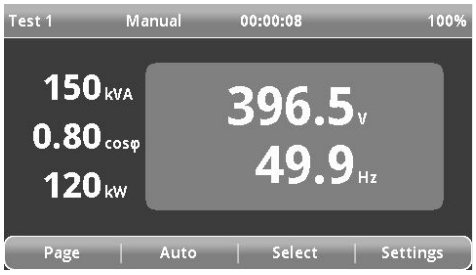


5. Press F3 (SELECT) and use the + and - keys to adjust the power factor value.

Applying the load

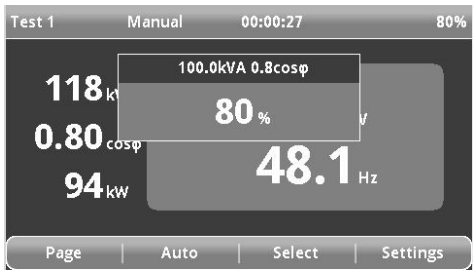
Note: If load correction is turned on, then the load applied will be adjusted for voltage droop. If contactor delay is turned on then the contactor timing will be synchronised such that all contactors will connect simultaneously.

1. Press I to apply the load selected. The Hand-held will calculate the correct load to apply and distribute this between all the connected load banks. The green LED on the Hand-held will light to indicate that a load is applied and the instrumentation screen will reflect the new load.



Note: The fan(s) can be started without any load being applied by selecting zero load and pressing I. This can be a useful feature if you are using the Supply-on-Test to power the load bank - the fans can be started without any transients created during the start-up having any effect on the test.

2. If the power values shown are not as anticipated, press I again to re-calculate and apply a load correction.
3. You can adjust the value of the load applied as the test is running by using the + and - keys.



4. The new value is shown in a popup window Press I to apply the new value.
5. Press F1 (PAGE) to sequence through the different instrumentation pages as the test proceeds (page 4 - 18).

Rejecting the load

Warning! Ensure the Supply-on-Test is fully isolated and protected before starting to remove the power cables from the terminal compartment.

Press O to reject the load and start the fan delay. The load bank should be allowed to run on for a few minutes until the fan delay has completed. This will allow the equipment to cool.

If the Ramp Down on Reject function is enabled (see page 4 - 16) the load will ramp down for 12 seconds before the fan delay starts. The Hand-held's LED will flash to indicate this. Press O a second time to reject the load immediately.

Automatic Test Mode

The Hand-held's automatic load control function will allow you to set up a pre-programmed sequence of up to 16 different loads of up to 99 hours duration. Once configured the test sequence can then be repeated as often as is required. This is useful for transient testing, fault finding or any other situation where a precisely controlled repeated test sequence is required.

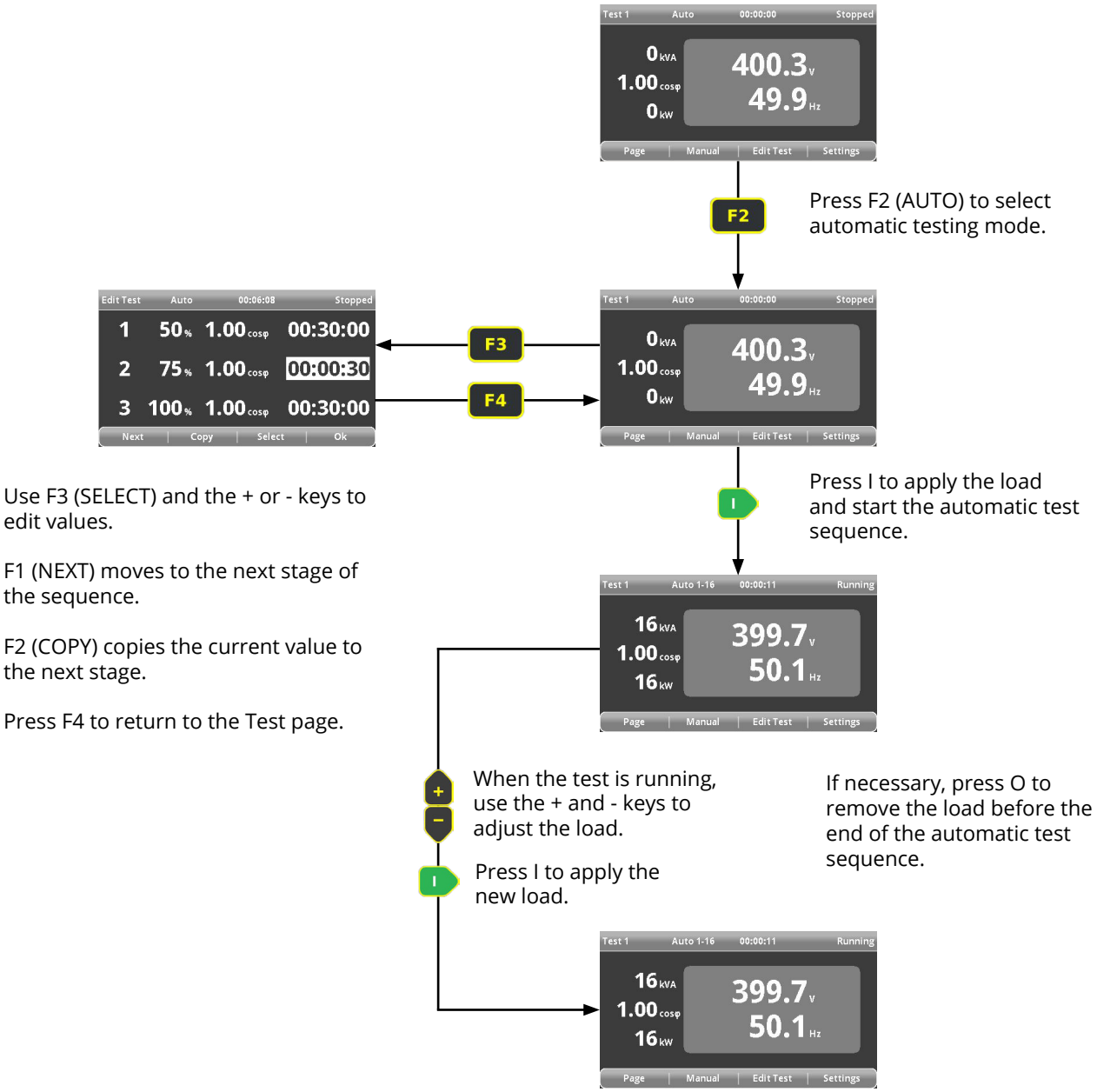


Figure 4-20 The Hand-held automatic test sequence

Editing the automatic test sequence

Press F2 (AUTO) from any of the Manual test pages to switch to automatic test mode. Then press F3 (EDIT TEST) to set up the test sequence stages.

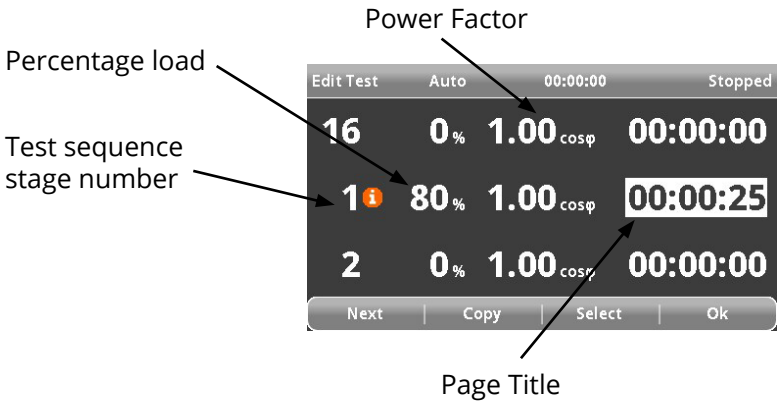


Figure 4-21 Hand-held automatic test sequence edit

The Edit Test page will allow you to specify the percentage load, power factor and duration of each of the 16 test sequence stages.

The ability to make a test sequence setting is not limited by the capabilities of the load bank that the Hand-held is connected to.

If the load bank is unable to apply the load that has been set the stage in the sequence will be marked with an exclamation mark.

Figure 4-22 A warning is shown if the connected load bank cannot apply the load.

This may be shown for a resistive only load setting where the load bank is simply not large enough, or where a non unity power factor setting where there is no reactive load available.

In either case, if you run the test the Hand-held will apply a load as close as possible to that requested.

To edit the test sequence:

1. Press F1 (NEXT) to choose the sequence stage to be programmed.

Note: Setting the time value to 0 will cause the Hand-held to ignore the step. Setting the load percentage for the first step at 0 will allow the fan to start without any load being applied.

2. Press F3 (SELECT) to choose the value to be changed.
3. Use the + and - keys to adjust the value.
4. Pressing F2 (COPY) will copy the current value to the next sequence stage.
5. Press F3 (SELECT) to choose the next value to be changed.
6. When all values are edited, press F1 (NEXT) to choose the next sequence stage to be programmed.
7. Press F4 (OK) to return to the Test pages when programming is complete.

Running the automatic sequence

To run the test sequence press the I key. The green LED on the Hand-held will begin to flash to indicate that the test sequence is running and the status bar will indicate the current stage of the test.

Figure 4-23 Automatic test sequence display

- Press F1(PAGE) to step through the different views of the instrumentation provided by the Test pages (See “The Test Pages” on page 4-18 for more details).
- Press the I key a second time to trigger load correction. See “Using load correction” on page 4-23 for more details on how load correction works.
- Pressing F2 (MANUAL), F3 (EDIT TEST) or F4 (SETTINGS) will pause the sequence at its current load value.
- Resume a paused test sequence by going back into Automatic mode and pressing the I key. The sequence will restart with the time remaining for the load step.
- The + and - keys can be used to adjust the percentage load applied as the sequence is running. Press the I key to apply the new load. This can be useful if you need to reduce the load because the preset load is causing the generator to stall.

Note: If the “Cyclic Auto Test” is selected in the Control Options, then the test will continue from step 16 to step 1 in a constant loop until O is pressed to stop the test.

Press O at any time to stop the test sequence, reject the load and start the fan delay.

If the Ramp Down on Reject function is enabled (see page 4 - 16) the load will ramp down for 12 seconds before the fan delay starts. The Hand-held’s LED will flash to indicate this. Press O a second time to reject the load immediately if necessary.

Chapter Five

Maintenance & Troubleshooting

This chapter describes both the routine maintenance procedures needed to keep 3000 SERIES load banks operating correctly and the procedures you may need to troubleshoot the equipment if you run in to a problem using it.

Safety Warning

Maintenance work should be undertaken only by qualified personnel who are fully aware of the danger involved and who have taken adequate safety precautions.

Always isolate all the supplies to the equipment before inspecting, moving equipment, removing or replacing parts.

Work on the equipment while the electrical supplies are connected is not normally necessary. If it should become necessary for any reason, take extreme care not to come in to contact with live parts.

You should remain alert at all times when the unit is in operation. There are three main sources of danger:

Electricity can kill. Serious injury or death could result from contact with electrically live parts. Even though the connections to the load bank may be temporary, they must always be made to the same standards as if they were permanent.

Load banks contain fast moving parts. The fan, in particular, can cause serious injury if you come into contact with it when it is in operation.

Load banks produce a lot of heat. When a test is in progress the resistive element can glow cherry red. The heat they produce is removed by the air that the fan forces past them, but that air in turn can become very hot.

Routine Maintenance Procedures

To keep the load bank in good working order, carry out the following maintenance tasks at the specified intervals:

Daily (after transportation or before each use of the load bank):

- Inspect the equipment for signs of damage.
- Ensure that the inlet and outlet grilles are free from dirt, debris or obstruction. Remove the grilles and clean them if necessary.
- Check that both the external supply and the Supply-on-Test are properly connected.
- Visually check that all cable connections are tight and that there is no sign of overheating.
- Check that the connecting cables are free from damage.
- Check that all cables are secured and routed so that they do not present a safety hazard.
- Inspect the doors and door gaskets to ensure they are undamaged and make a good seal to the main frame. Replace if necessary.
- Ensure that all opening panels are securely closed.

Monthly

- Clean and inspect painted surfaces for damage or corrosion and touch up as necessary.
- Check that there is no build up of dirt or debris on the load elements.
- Check that the fan rotates freely.
- Check that the fan blades are tight, and that the fan boss is securely fastened to the motor shaft.
- Check that the anti condensation heaters (if fitted) are working.
- Isolate the supply and then inspect both the inductive and resistive load element terminals, ensuring that they are tight and show no signs of overheating.
- Open the load bank switchgear cabinets and visually inspect the wiring, fuses and contactors for signs of overheating.
- Check that all drain holes in the bottom of the load bank are clear of debris.
- Inspect all door seals for damage and replace where necessary.

Warning! The fan, can cause serious injury when it is in operation. Ensure that the supply is isolated before removing safety covers.

Note: The recommended interval for a calibration check is one year, unless the equipment has been subject to misuse or damage. If adjustment is not necessary the calibration check interval could be increased to three years.

In addition, carry out a load check to ensure that load contactors and elements are operating correctly:

1. Connect a supply (at the load bank's rated voltage) to the load bank.
2. Set and apply loads at 30%, 60%, and 100%, and make a note of the power value shown on the instrumentation (or external metering).
3. Check that the power values are within 5% of the load set on the controller.

Annually

Verify the load bank instrumentation's calibration. If adjustment is required contact Avtron for advice.

Air Circuit Breaker (option) Maintenance

Annually

- The inspection procedure according to NEMA AB4, section 3 must be performed once a year.
- The arc chutes and contact system must be inspected according to manufacturer's manual operation instructions

Five Yearly

- Manufacturer's advise a full service

Fault Condition

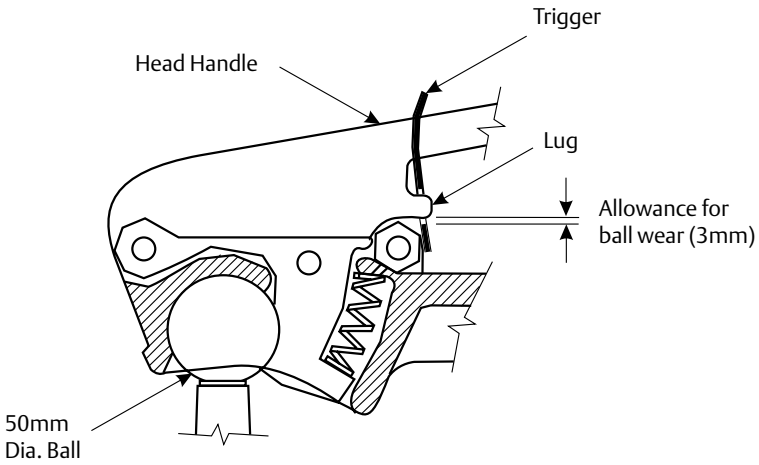
- If a fault condition opens the circuit breaker, the circuit breaker should be inspected before it is re-placed into service
- Optional arc chute covers must be replaced at least after three short circuit interruptions

Refer to the Manufacturer's operation manual for further details.

Trailer Maintenance

Weekly (or before each use)

1. Clean the ball and the cup of the ball head and apply a light coating of grease.



Warning! If you need to replace your coupling head remember to carry out the first check once more as your 50mm ball may also need replacing.

2. When coupled to the trailer, check the clearance below the square lug at the rear of the head handle as it projects through the slot in the trigger lever.
3. If it is resting on the bottom of the slot, either the coupling head, or the tow ball, or both are worn. If so, check further by using a new 50mm ball.
4. If the lug remains at the bottom of the slot the coupling head is excessively worn and should be replaced.
5. However, if the lug is now riding noticeably higher up the slot, your original 50mm ball should be replaced.
6. Oil all moving parts, having wiped away all corrosion and dirt deposits.
7. Inspect the tyres. All tyres must be free from cuts, bulges or other damage. The tyre pressures must be correct.

3 Monthly (or after every 3,000 miles)

Warning! Do not adjust for brake wear other than at the wheel brakes themselves.

1. Using a grease gun filled with general purpose grease apply two strokes to the grease nipples fitted to the coupling.
2. Adjust the wheel brakes at the back plate adjusting points (An indication of worn brakes will be given by increased hand brake travel).

Fault Finding

The following chart covers some of the typical faults you might encounter and some possible solutions.

Fault	Possible Causes	Possible Causes
Cooling fan does not start or run	Correct operation	• The cooling fan may not run until load is applied. Apply the load and verify that the fan starts.
	No power to fan	• Check that the control and fans supply selector switch and the Fan and Controls Supply Isolator are in the correct position and the Start button has been pressed. • Confirm that the control supply fuses are not blown.
	Fan thermal overload tripped	• Allow the load bank to cool, and then press the Stop button followed by the Start button to reset. • Check that the fan is not obstructed and that it is free to rotate. Check the motor current and overload setting.
No load is being applied	Supply-on-test is not switched on.	• Confirm that the Supply-on-Test circuit breaker is switched on. • If fitted, ensure that the load bank circuit breaker(s) is switched on.
	Load bank over temperature trip	• Allow the load bank to cool and then reset. • Check that the airflow through load bank is unobstructed. • Check for any signs of hot air re circulation.
	Faulty or damaged connecting lead	• Check that the Hand-held lead and connectors are not damaged.
Incorrect or wrong load is applied	Supply-on-test voltage and/or Frequency	• Ensure the Supply-on-Test settings are correct.
	Excessive volt drop	• Check rating of cables or if an MV test, transformer. • Check AVR droop setting.
	Single phase operation or phase missing	• When testing a single phase generator, check the method of connection. Refer to Chapter two • For three phase operation verify that all of the phases are present.
	Loading problem	• Check the load fuses • Check the load contactors • Check the load elements

SIGMA 2 Load Bank Status Display

The load bank status is displayed on the seven segment LED located on the SIGMA 2 load bank module.

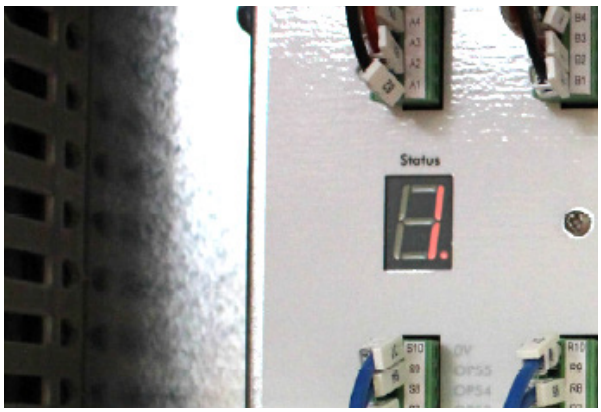


Figure 5-1 The SIGMA 2 control unit showing LED display

During operation the LED decimal point flashes every second.

If the decimal point is not flashing then a software problem is likely. Cycle the fans and controls power supply off and on to restart the SIGMA 2 controller and clear the fault.

SIGMA 2 Normal Operation

In normal operation a single character status code is displayed on the LED:

Code	Load	Fan	Hand-held (or PC)	Description
.	Off	Off		Emergency Stop.
0.	Off	Off	None	Load bank running. Switch (or remote modbus) control or Hand-held (or PC) not plugged in.
1.	Off	Off	Ok	Ready to apply load from Hand-held (or PC).
2.	Off	On	None	Fan running - decade switch (or remote modbus) control.
3.	Off	On	Ok	Fan running - Hand-held (or PC) control.
4.	On	Off	None	Fan starting - decade switch (or remote modbus) control.
5.	On	Off	Ok	Fan starting - Hand-held (or PC) control.
6.	On	On	None	Load applied - decade switch (or remote modbus) control.
7.	On	On	Ok	Load applied - Hand-held (or PC) control.
P.			Ok	'Setup' mode. SIGMA load bank setup/ diagnostic program running.
n.				Load bank firmware upgrade in progress.

Warnings

If an event occurs that generates a warning the load bank Stop button lamp will begin to blink and a warning code sequence will be displayed on the SIGMA 2 control unit LED. Each character in the four step sequence is displayed for 500ms with the code repeating every 2s. The end of the sequence is indicated with the decimal point only.

Three digit warning codes start with H as the first digit. The second digit indicates the operational status as follows:

Code	Description
H0-	High temperature warning.
H1-	Load step error - faulty step disabled. Press and hold the load bank 'Stop' button for 6 seconds to re-enable the load steps.
H2-	Communications to Hand-held (or PC) intermittent.
H3-	Supply-on-test wiring incorrect.
H4-	Supply-on-test phase rotation error.
H9-	Load bank setup corrupt – using backup data.

Errors

If an error occurs the load bank Stop button lamp will begin to flash and a three step code sequence will be continuously displayed in the same way as a warning. Again, each character is displayed for 500ms with the code repeating every 2 seconds. The end of the sequence is indicated with the decimal point only.

Note: The error messages displayed are dependant on the load bank configuration. For example, if the load bank has no duct covers fitted then any associated errors will not be monitored or reported.

When an error occurs any load applied will be dropped and, if the fault is not cooling related, the load bank fan will continue to run for the preset cooling period.

After rectifying the fault press the Stop/Reset button to clear the error. The Stop lamp will stop flashing and will be continuously illuminated. Press the Start button to restart the load bank.

The three digit error codes all begin with an 'E' as follows:

Code	Description	Possible causes / actions
E01	Stop pressed.	Start button has not been pressed or was pressed before the load bank had performed its power on self-test (both Start and Stop illuminated). • Wait until the Stop button only is illuminated before pressing the Start button. External emergency stop buttons (if fitted) are depressed • Release all emergency stop buttons and press the Start button.
E02	Lost communications with Hand-held (or PC).	Hand-held (or SIGMA PC system) has disconnected from load bank while a load is applied. Hand-held or load bank interconnecting cable fault. • Check and replace.
E03	Load contactor switching fault.	A load contactor switching fault has been detected. A load step contactor or relay is energised but no load is applied. No response from the load contactor or relays when load is requested.
E10 E11 E12 E13	Over temperature on sensor/circuit 0. Over temperature on sensor/circuit 1. Over temperature on sensor/circuit 2. Over temperature on sensor/circuit 3.	Load bank is over temperature. • Allow the load bank to cool, and then press Stop and Start buttons. • Ensure that the load bank ambient temperature is not exceeded and check that the hot air discharge is not recirculating. More than one over temperature trip may be fitted. These devices will automatically reset when they cool down.
E20	Fan supply rotation check failed	The fan supply phase rotation detection failed when starting the load bank Fan(s). • Check the fan supply for a missing phase or single phase connection. • Check the Fans and Controls Supply Selector switch is in the correct position.

Code	Description	Possible causes / actions
E24	Fan supply voltage and/or frequency limits exceeded on pressing the load bank start button.	Fan supply voltage or frequency is out of limits. • Check control voltage and frequency. If the generator rating is incorrect run the load bank from an external supply. • Check the Fans and Controls Supply Selector switch is in the correct position.
E25	Fan supply check shows phase missing.	Fan supply phase is missing. • Check control phases. If the generator rating is incorrect run the load bank from an external supply. • Check the fans and controls supply selector switch is in the correct position.
E26 E27 E28 E29	No running signal for Fan 0. No running signal for Fan 1. No running signal for Fan 2. No running signal for Fan 3.	Load bank cooling fan is not running or fan contactor not energising • Check the fan contactor is energising and the auxiliary contactor is operating.
E30 E31 E32 E33	Overload tripped on Fan 0. Overload tripped on Fan 1. Overload tripped on Fan 2. Overload tripped on Fan 3.	A Fan overload has tripped on over current. • Check the fan is not obstructed, the inlet is clear and is free to rotate. • Confirm the over load is set to the correct current setting by referring to the load bank drawings.
E34	Fan supply voltage and/or frequency limits exceeded.	Fan supply voltage or frequency is out of limits. • Check control voltage and frequency. If the generator rating is incorrect run the load bank from an external supply. • Check the Fans and Controls Supply Selector switch is in the correct position.
E40 E41 E42 E43	Air flow failure on sensor/circuit 0. Air flow failure on sensor/circuit 1. Air flow failure on sensor/circuit 2. Air flow failure on sensor/circuit 3.	No air flow detected when the load bank fans are running. • Check the fan or duct is not obstructed. • Verify the airflow direction - the air should exhaust from the elements., not from the fan. • Check the air flow sensor is operating correctly.
E44 E45 E46 E47	Cover closed on duct 0. Cover closed on duct 1. Louvre 0 failed to open. Louvre 1 failed to open.	The duct cover(s) or louvre(s) are closed. • Open the duct covers or louvres before pressing the load bank Start button. • Check the proximity detectors for correct operation.
E50	Supply-on-test failure while on load.	The Supply-on-Test failed whilst load was applied. Any load applied has been removed and the load bank has gone to an error state. This option can be enabled in the load bank to avoid re-starting a generator on load.
E51	Supply-on-test over voltage.	The Supply-on-Test voltage has exceed the load bank limits. • Check the Supply-on-Test voltage. Note that a low Supply-on-Test frequency may also cause an over voltage error. The maximum voltage is frequency dependant for resistive/reactive load banks. Check the load bank specification for voltage and frequency limits.

Code	Description	Possible causes / actions
E52	Supply-on-test incorrectly wired.	The Supply-on-Test is wired incorrectly when using remote Modbus load control. • Check the Supply-on-Test connection, possible phase rotation or phase missing.
E60 E61	Circuit breaker 0 tripped. Circuit breaker 1 tripped.	The load bank Supply-on-Test circuit breaker is tripped. • Ensure the circuit breaker is closed before pressing the load bank Start button. • If the load bank circuit breaker trips whilst on load, verify the cause before re-closing.
E90	No valid load bank setup.	
E91	Self test failed.	
E99	Unknown error.	

If you are unable to rectify the problem call Avtron on +44 (0) 1780 920 100 or email froment.support@avtronpower.com for assistance.

Appendices

The following pages contain additional information that may be useful but does not easily fit in with the rest of the text. This includes a specification for each of the 3000 SERIES load banks and a number of installation diagrams that show dimensions and space requirements for each unit.

3024 - Installation Diagram

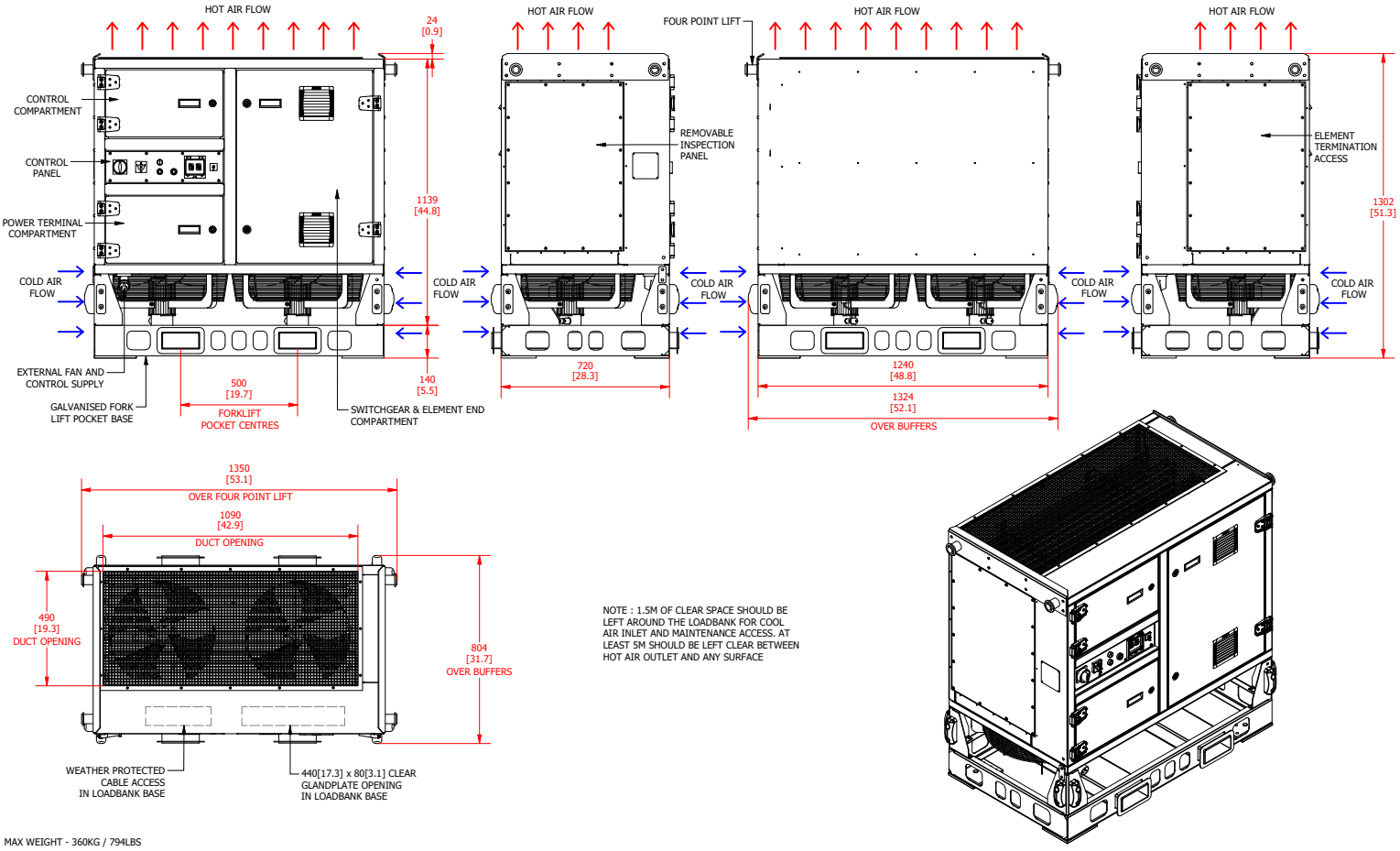


Figure A-1 3024 Load Bank General Arrangement

3044 - Installation Diagrams

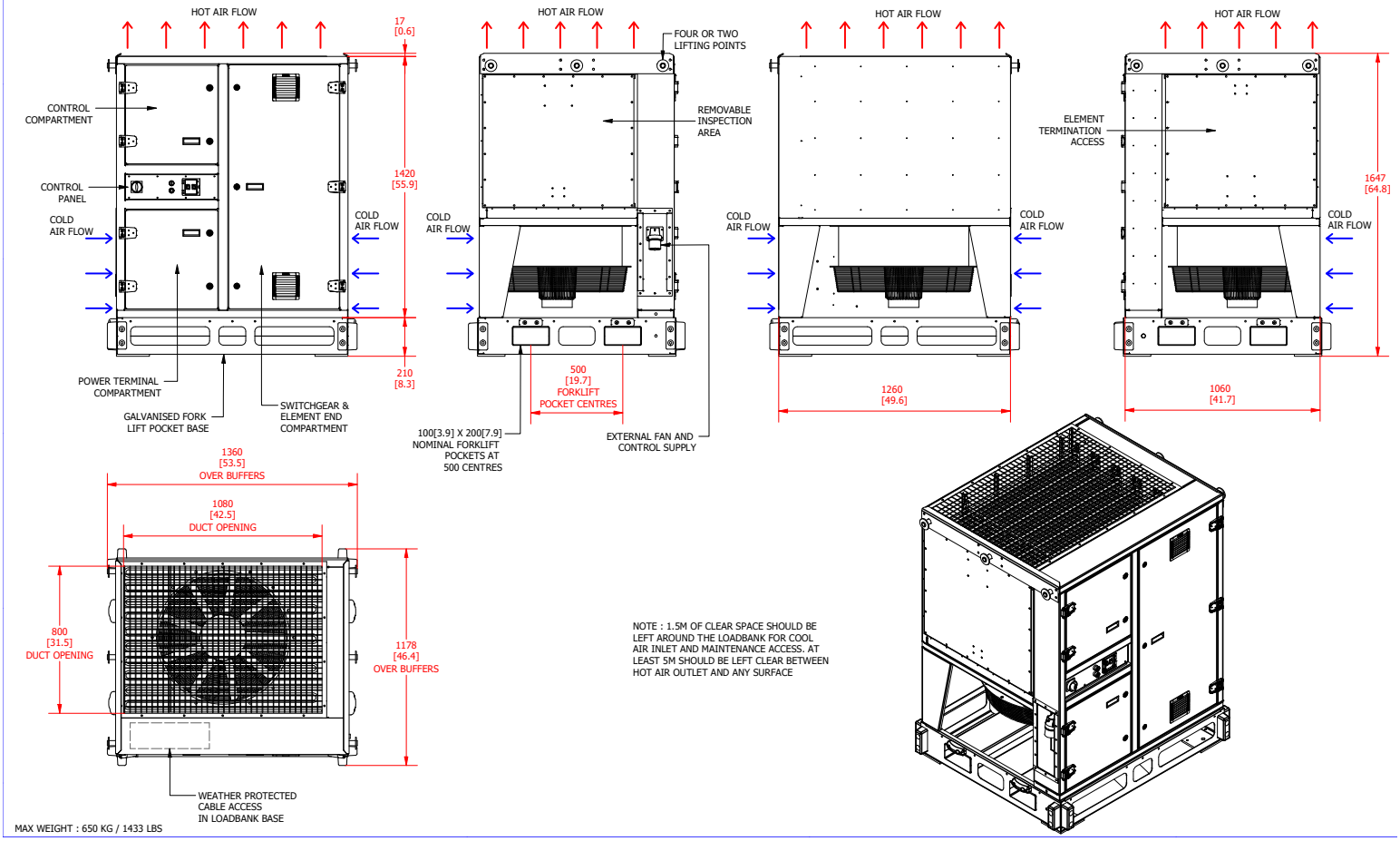


Figure A-2 3044 Load Bank General Arrangement

3066 - Installation Diagram

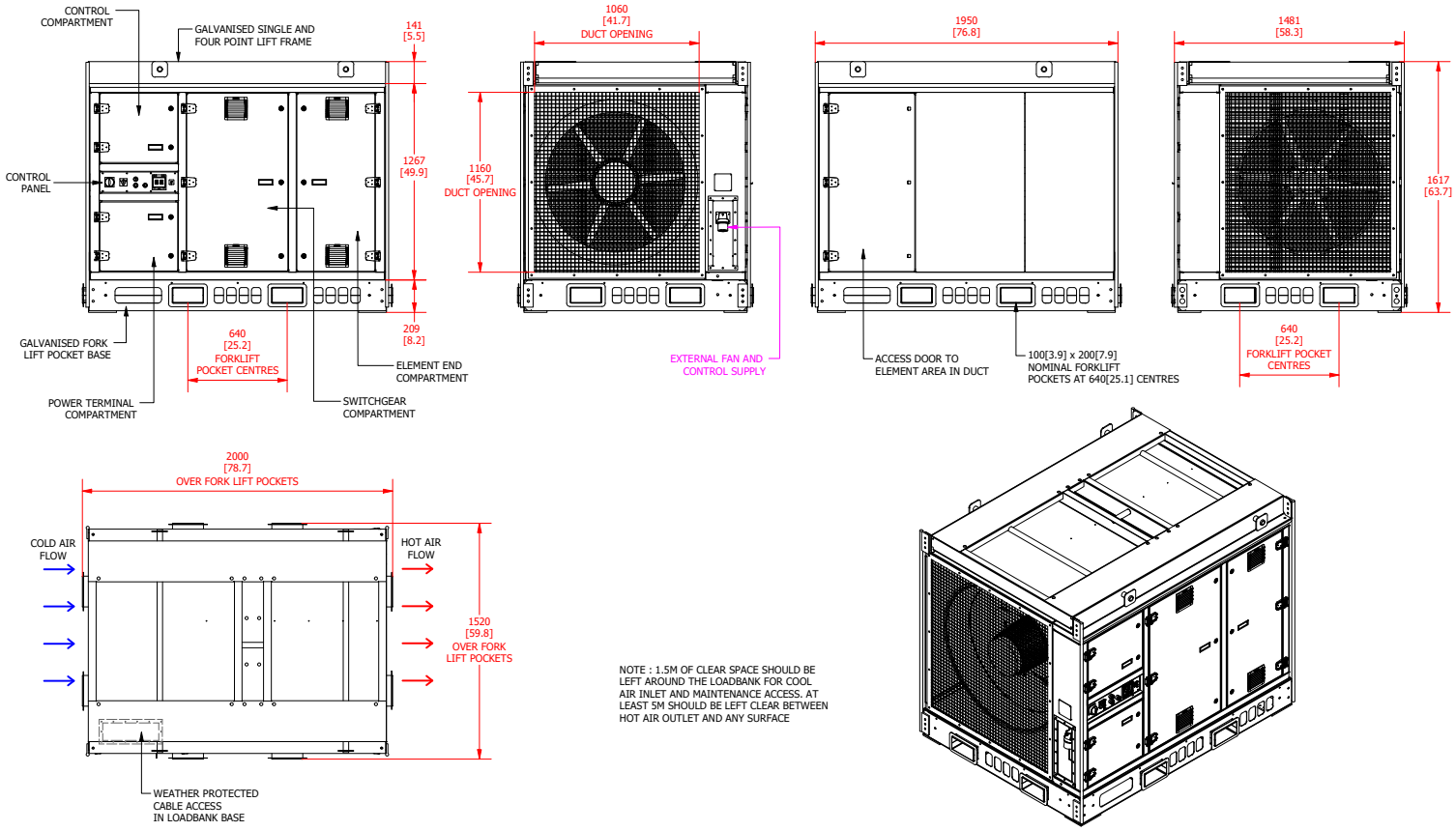


Figure A-3 3066 Load Bank General Arrangement

3103 - Installation Diagrams

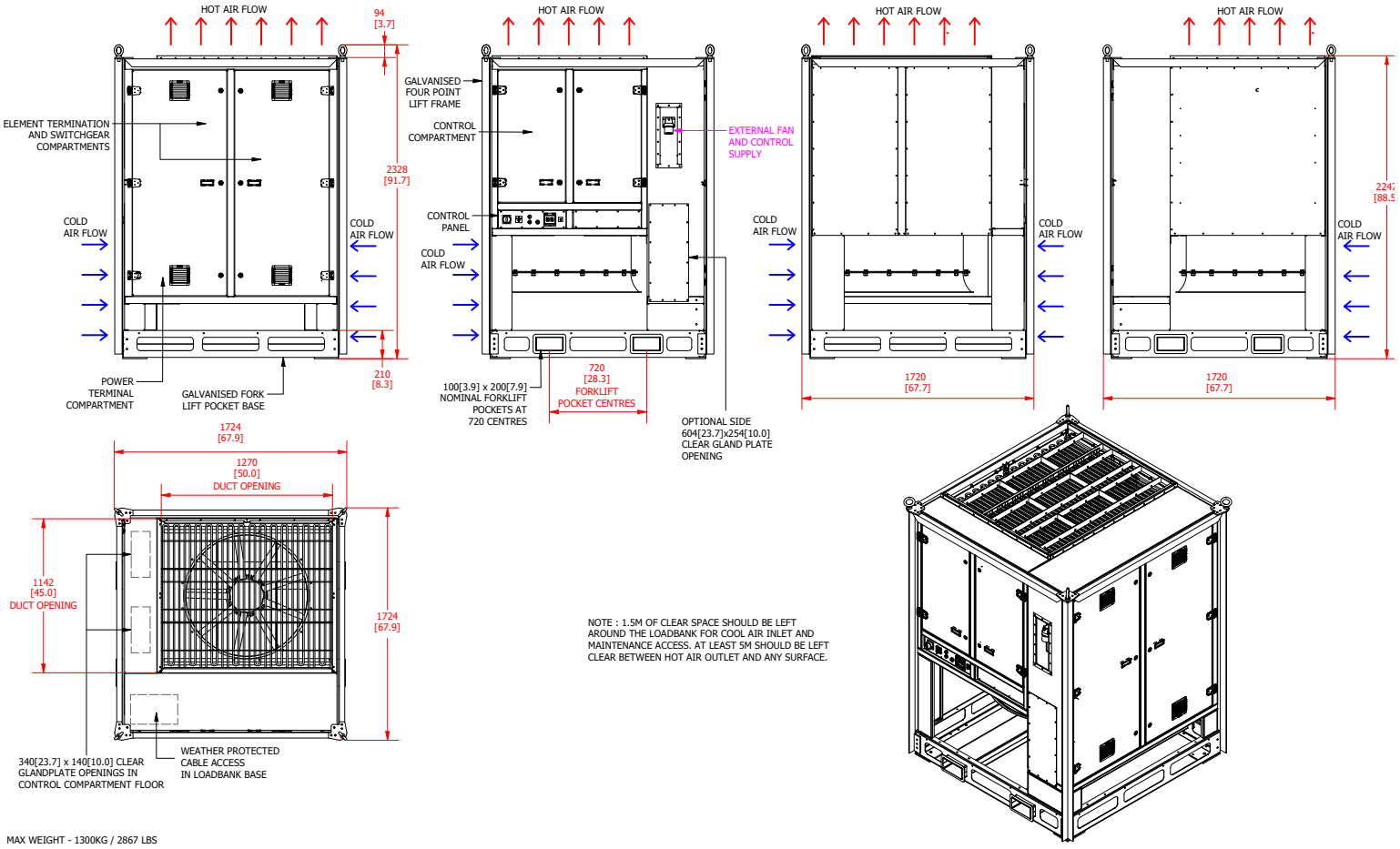


Figure A-4 3103 Load Bank General Arrangement

3110 - Installation Diagram

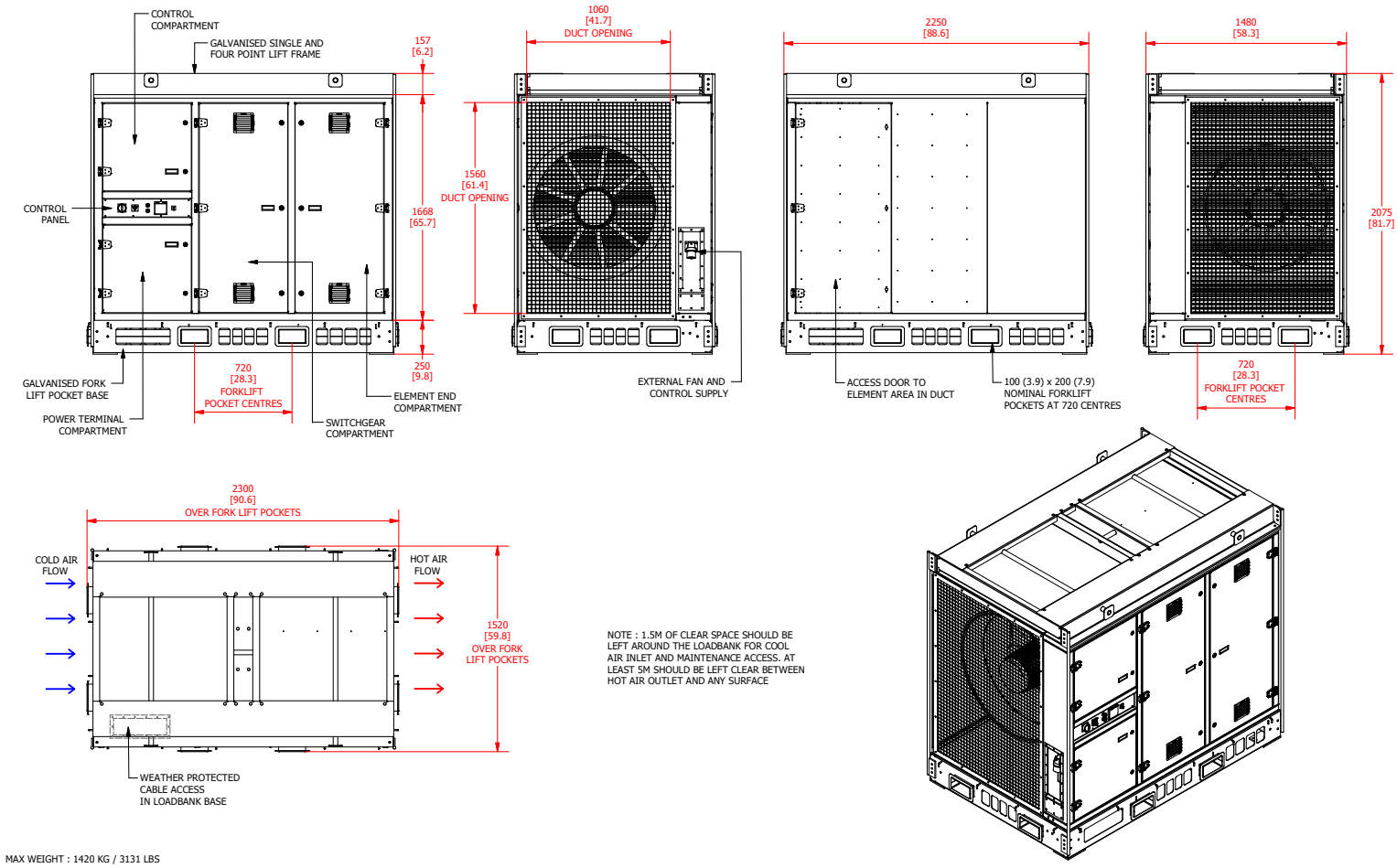


Figure A-5 3110 Load Bank General Arrangement

3164 - Installation Diagrams

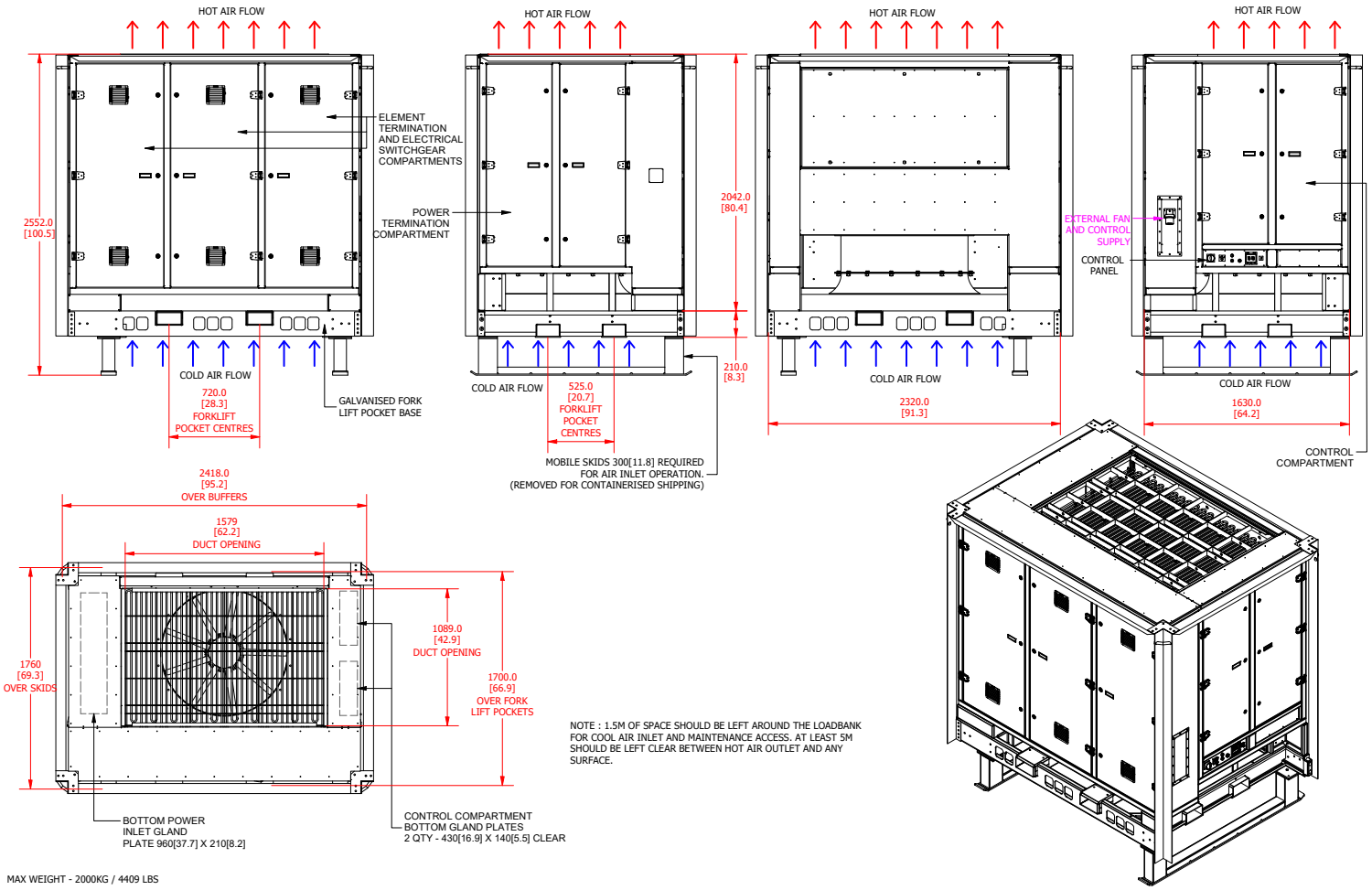


Figure A-6 3164 Load Bank General Arrangement

3220 - Installation Diagram

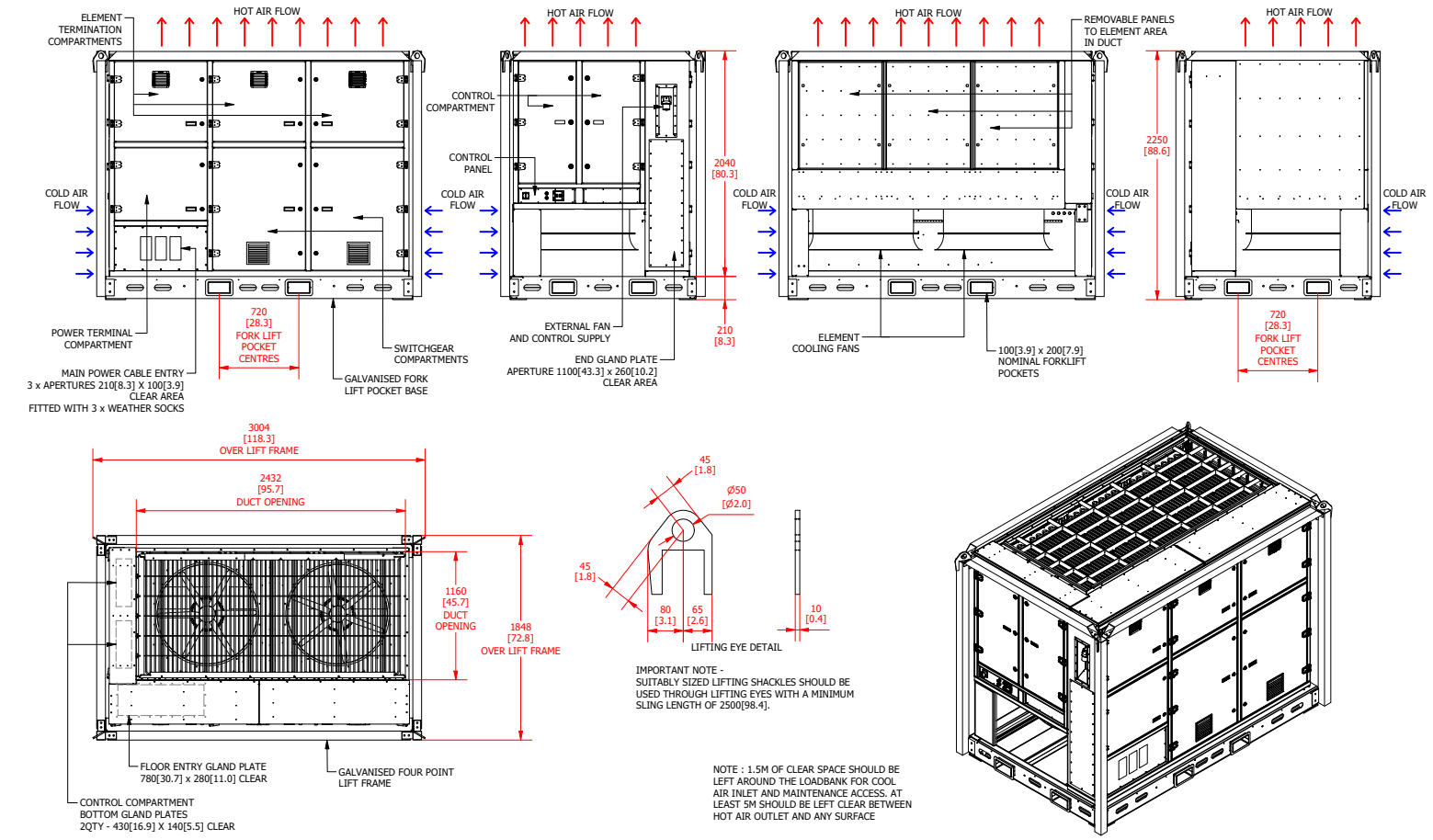


Figure A-7 3220 Load Bank General Arrangement

Certificate of Conformity - CE

AVTRON POWER SOLUTIONS

EU Declaration of Conformity

Product:	Load Bank
Name of Manufacturer:	N J Froment & Company Limited, Easton-on-the-Hill, STAMFORD, PE9 3NP, United Kingdom
Telephone	+44 (0) 1780 920 100
e-mail	support@avtronpower.com
Website	www.avtronpower.com
Country of Origin	United Kingdom

This declaration of conformity is issued under our sole responsibility of the manufacturer

Object of Declaration:	Load Bank Types:	3000 Series 6000 Series 8000 Series

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

2014/30/EC	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive
EU 2015/863	RoHS Directive – EEE Category 9.
EC 1907/2006	REACH

References to the relevant harmonised standards used or references to the other technical specifications in relation to which conformity is declared:

BS EN 60204-1:2018	Safety of Machinery. Electrical Equipment of Machines.
BS EN 61000-6-3:2001	Electromagnetic Compatibility. Generic Emission Standard.
BS EN 61000-6-2:2001	Electromagnetic Compatibility. Generic Immunity Standard.

Basis of self attestation:	**Quality Assurance to BS EN ISO 9001:2015** Registered Firm Certification No: FM 38927
Signed for and behalf of:	N J Froment & Company Limited
Place of Issue:	Easton-on-the-Hill, STAMFORD, UK
Date of Issue:	1st December 2022
Name & Position:	J. Clarke Director
Signature:	

CE

One copy of this declaration accompanies each load bank, for customer retention

Certificate of Conformity - UK CA

UK Declaration of Conformity

Product:	Load Bank
Name of Manufacturer:	N J Froment & Company Limited, Easton-on-the-Hill, STAMFORD, PE9 3NP, United Kingdom
Telephone	+44 (0) 1780 920 100
e-mail	support@avtronpower.com
Website	www.avtronpower.com
Country of Origin	United Kingdom

This declaration of conformity is issued under our sole responsibility of the manufacturer

Object of Declaration:	Load Bank Types:	3000 Series 6000 Series 8000 Series

The object of the declaration described above is in conformity with the relevant UK Statutory Instruments and their amendments:

2008 No 1597	The supply of Machinery (Safety) Regulations 2008
2016 No 1101	The Electrical Equipment Safety Regulations 2016
2016 No 1091	The Electromagnetic Compatibility Regulations 2016
2012 No 3032	The Restriction of the Use of Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

References to the relevant harmonised standards used or references to the other technical specifications in relation to which conformity is declared:

BS EN 60204-1:2018	Safety of Machinery. Electrical Equipment of Machines.
BS EN IEC 61000-6-3:2001	Electromagnetic Compatibility. Generic Emission Standard.
BS EN IEC 61000-6-2:2001	Electromagnetic Compatibility. Generic Immunity Standard.

Basis of self-attestation:	**Quality Assurance to BS EN ISO 9001:2015** Registered Firm Certification No: FM 38927
Signed for and behalf of:	N J Froment & Company Limited
Place of Issue:	Easton-on-the-Hill, STAMFORD, UK
Date of Issue:	1st December 2022
Name & Position:	J. Clarke Director
Signature:	

One copy of this declaration accompanies each load bank, for customer retention

Electromagnetic Compatibility

This equipment has been designed and constructed to comply with the European Community Directive 89/336/EEC. To ensure that the requirements of the Directive and related standards are satisfied it is essential that the equipment is used as intended and in full accordance with the operating instructions.

Immunity to external interference (EN 61000: Part 6-2:2001)

- This equipment will not suffer permanent damage, or become dangerous or unsafe as a result of electromagnetic interference at the levels set in the standards. Normally it will continue to operate as intended. Electrostatic discharges or breaks in the power supply may cause the equipment to shut down until it is manually re-set and re-started.
- Exposure to higher levels of electromagnetic disturbance, above the prescribed limits (for example by the operation of a hand-held transmitter close to the remote controller) may result in out-of-tolerance readings on the instrumentation.

Electromagnetic emissions (EN 61000: Part 6-3:2001)

- Electromagnetic disturbances generated by this equipment do not exceed the prescribed levels that could cause interference to radio, telecommunications or television reception apparatus. There will be no interference provided the reception equipment itself is constructed and used in accordance with the applicable standards, and its antenna is located more than 10 metres away.
- If highly susceptible apparatus is used nearby, particularly if its faulty operation could cause danger, then you must take additional measures to minimise the risks.
- This test equipment is intended to cause controlled changes in the load on an electrical power supply. Such tests may result in disturbances in the Supply-on-Test that are outside prescribed limits. If susceptible apparatus is connected to the Supply-on-Test, particularly if its faulty operation could cause danger, then it should be switched off, or disconnected, during the tests.

Useful Equations

Apparent Power (kVA)

$$kVA = \sqrt{kW^2 + kVAr^2}$$

$$kVA = \frac{V \times I \times \sqrt{3}}{1000}$$

$$kVA = \frac{kW}{pf}$$

$$kVA = \frac{kVAr}{\sqrt{1 - pf^2}}$$

Resistive Power (kW)

$$kW = kVA \times pf$$

$$kW = \frac{V \times I \times pf \times \sqrt{3}}{1000}$$

$$kW = \sqrt{kVA^2 - kVAr^2}$$

Reactive Power (kVAr)

$$kVAr = kVA \times \sqrt{1 - pf^2}$$

$$kVAr = \frac{V \times I \times \sqrt{1 - pf^2} \times \sqrt{3}}{1000}$$

$$kVAr = \sqrt{kVA^2 - kW^2}$$

Power Factor (pf)

$$pf = \cos\phi = \frac{kW}{kVA}$$

Current (A)

$$I = \frac{kVA \times 1000}{V \times \sqrt{3}}$$

$$I = \frac{kW \times 1000}{V \times pf \times \sqrt{3}}$$

De-rate from Nominal Voltage and Frequency

$$kW = \left(\frac{V}{V_{nom}}\right)^2 \times kW_{nom}$$

$$kVAr = \left(\frac{V}{V_{nom}}\right)^2 \times \frac{F_{nom}}{F} \times kVAr_{nom}$$

Note: All voltages are phase-to-phase values and assume a 3-phase system.

Avtron Power Solutions

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