MSC-3V

1000V Series

INSTRUCTION MANUAL

ZENER

VARIDRIVE SOLUTIONS

ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1976 Zener Electric has supplied many thousands of drives to industry. These drives have been installed into numerous applications resulting in a wealth of in house experience. The Zener MSC-3V AC variable speed controller is the culmination of this experience, modern technology and industrial application requirements. The Zener Quality Assurance program ensures that every MSC-3V manufactured has proven to operate correctly in the production test bay before dispatch.

SAFETY

Your MSC-3V must be applied, installed and operated in a safe manner. It is the responsibility of the user to ensure compliance with all regulations and practices covering the installation and wiring of your MSC-3V. The instruction manual should be completely read and understood before attempting to connect or operate the MSC-3V. Only skilled personnel should install this equipment. This equipment contains a number of components that are designated by their various manufacturers as “not for use in life support appliances, devices or systems where malfunction of the components can reasonably be expected to result in personal injury or death”. Customers using or selling Zener products for use in such applications do so at their own risk and agree to indemnify Zener for any damage resulting from improper use or sale.

THE CONTENTS OF THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE

Contents

Explanation of symbols

	WARNING	Indicates a condition or practice that, if the warning is not strictly observed, could result in personal injury or death.
	CAUTION	Indicates a condition or practice, if the caution is not strictly observed, could lead to damage or destruction of equipment or a significant impairment of proper operation.
	WARNING	This symbol is used to highlight an electrical hazard. Failure to strictly observe the warning could result in electrocution.
i		This symbol is used to highlight additional information on the product's capabilities or a common error in installation, commissioning or operation.

Warnings

Read all operating instructions before installing, wiring, operating, servicing or inspecting the MSC-3V.

Ensure that the instruction manual is made available to the final user of the product as well as all personnel involved in any aspect of installation, adjustment or maintenance. Your MSC-3V must be applied and installed by a suitably qualified and experienced personnel in accordance with this manual, good engineering practice and all local rules and regulations to the end use environment.

There are hazardous voltages inside the ZENER MSC-3V whenever it is connected to an electrical supply and for some time afterwards.

Before touching anything inside the ZENER MSC-3V enclosure or other equipment connected to the ZENER MSC-3V terminals, disconnect all sources of electrical power, wait at least 11 minutes for capacitors within the ZENER MSC-3V to discharge to less than 50VDC and then ensure, by measurement, that there is no hazardous AC or DC voltage present at any terminal.

The MSC-3V contains high energy circuits that may be hazardous. Do not operate MSC-3V with the door open or any part of the enclosure removed.

Do not touch the terminals of the MSC-3V or any associated motor and wiring when it is energised, even if the MSC-3V and motor are stopped. Electric shock may result.

Do not modify this equipment electrically, mechanically or otherwise. Modification may create safety hazards.

The MSC-3V is designed to drive an appropriately rated and otherwise suitable 3 phase induction motor. It is not suitable for single phase motors or other types of motor or non-motor load. Use with inappropriate load types may create a safety hazard.

Where the MSC-3V is used as a component part of another product, it is the purchaser's responsibility to ensure that the final product meets all of the necessary safety, EMC, regulatory, operational and other requirements for that product. Requirements for the purchaser's final product may be substantially different to the requirements for stand-alone inverters.

The MSC-3V is manufactured under strict quality control arrangements, however additional and independent safety equipment must be installed if the application is such that failure of the product may result in personal injury or property damage.

Ensure that electrical noise generated by the product and any associated equipment does not adversely affect the proper operation of other equipment or systems, particularly those that have a safety function.

Install emergency stop circuitry that removes power from the MSC-3V and does not depend on any feature of the product for proper and safe operation. Do not use the braking functions of the product for safety purposes.

The MSC-3V has features that may be used to cause an automatic restart in certain circumstances. The overall application (machine etc) must be designed such that automatic restart is not hazardous.

Do not install this equipment in locations where mechanical damage to the enclosure is possible. In particular, consider vehicles, vandalism and attack by insects or animals. Severe equipment damage and safety hazards may result.

Receiving

Inspect the MSC-3 for any shipping damage. If any damage is found, report it to the carrier immediately.

Do not attempt to operate the MSC-3V if any obvious damage exists.

After the initial inspection, the MSC-3V can be repacked and stored in a clean, dry location until it is required for use.

DO NOT store this equipment in an area where the ambient temperature will fall below -20°C or rise above 70°C. DO NOT store this equipment in areas that are subject to condensation or corrosive atmosphere. Proper storage is necessary to ensure satisfactory controller start up and performance.

Software

This manual applies to MSC-3V software revision 5.2.x. The software revision is displayed briefly at power up and may also be viewed in the service menu.

This manual provides basic control configuration information for the ZENER MSC-3V to suit more common applications. Please refer to the *ZENER 8000 Reference Manual IM00140* for a detailed explanation of each control feature, including communications protocols.

Installation

MSC-3V mounting location

The MSC-3V chassis is intended to be mounted in a switchboard style enclosure with the heatsink section protruding through the rear wall of the enclosure. The input and output line reactors provided as part of the MSC-3Vshould be mounted within the switchboard, adjacent to, or on the enclosure floor, below the MSC-3V module chassis. The control console is separate to the MSC-3V chassis and intended to be mounted on the front of the switchboard enclosure for convenient operation. Mechanical protection may be required to prevent damage to the heatsink section in some environments. The MSC-3V portion within the user's switchboard enclosure is designed for use in a pollution degree 2[1] environment. The system integrator and user are responsible for providing and maintaining this environment inside the switchboard enclosure under all circumstances for the lifetime of the equipment.

Installation Information

CAUTION

- The MSC-3V must be mounted in a vibration free situation with heatsink fins protruding through the wall of a switchboard type enclosure.
- Do not mount the MSC-3V where it is subject to heating by direct sunlight or other heat radiating sources.
- MSC-3V must be mounted vertically. No other mounting orientation is acceptable.
- The thermal design of the user's switchboard enclosure must be accommodate the total heat dissipation of the MSC-3V components together with the heat dissipation any other equipment in the same enclosure and maintain the internal ambient temperature within the range of 0 - 50°C without condensation.
- Attention is drawn to the potential for condensation in vulnerable environments. Additional precautions may be required for all enclosure types.
- All of the parts associated with a drive system using parallel modules must be installed in the same enclosure.
- The installation location and environment should provide for safe access and working conditions for maintenance personnel.
- The mechanical design of the enclosure should provide for the safe removal and replacement of drive modules and line reactors for maintenance purposes in a way that suits the circumstances of the final installation site.
- Do not drill holes in the MSC-3V module enclosure except in the gland plates.
- Remove the module gland plate before drilling cable holes.
- Do not allow metal shavings or any other conductive material to enter the MSC-3V module enclosure or line reactors. Serious damage may result.

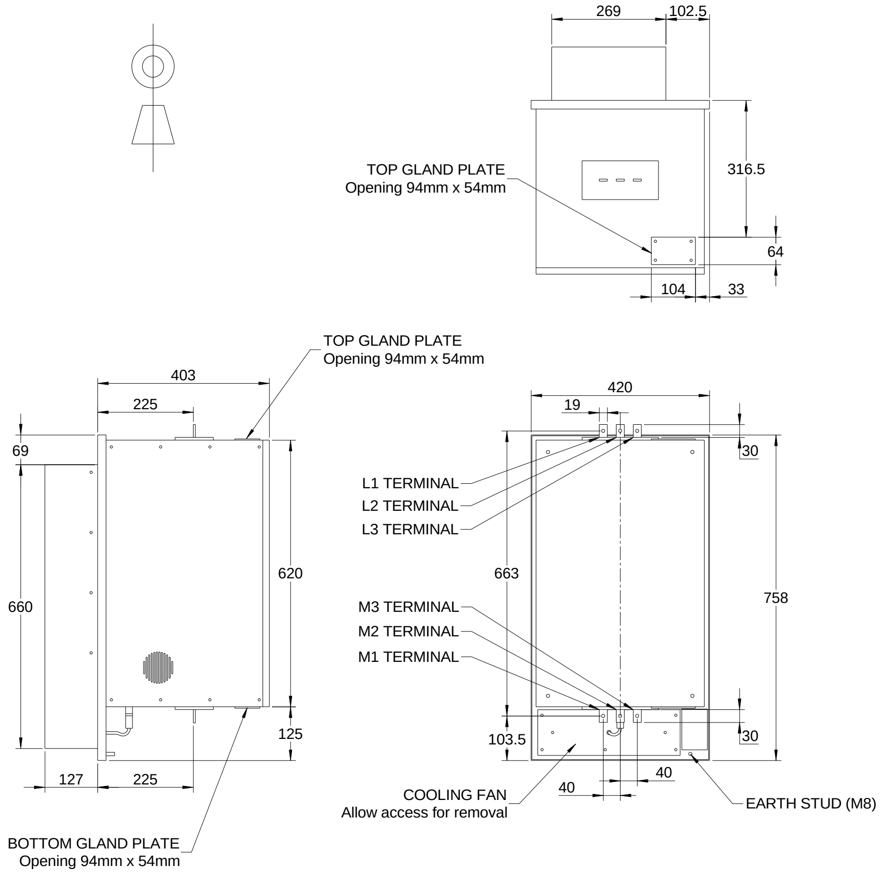
[1] Any pollution present is non-conductive

MSC-3V Mechanical Installation Information

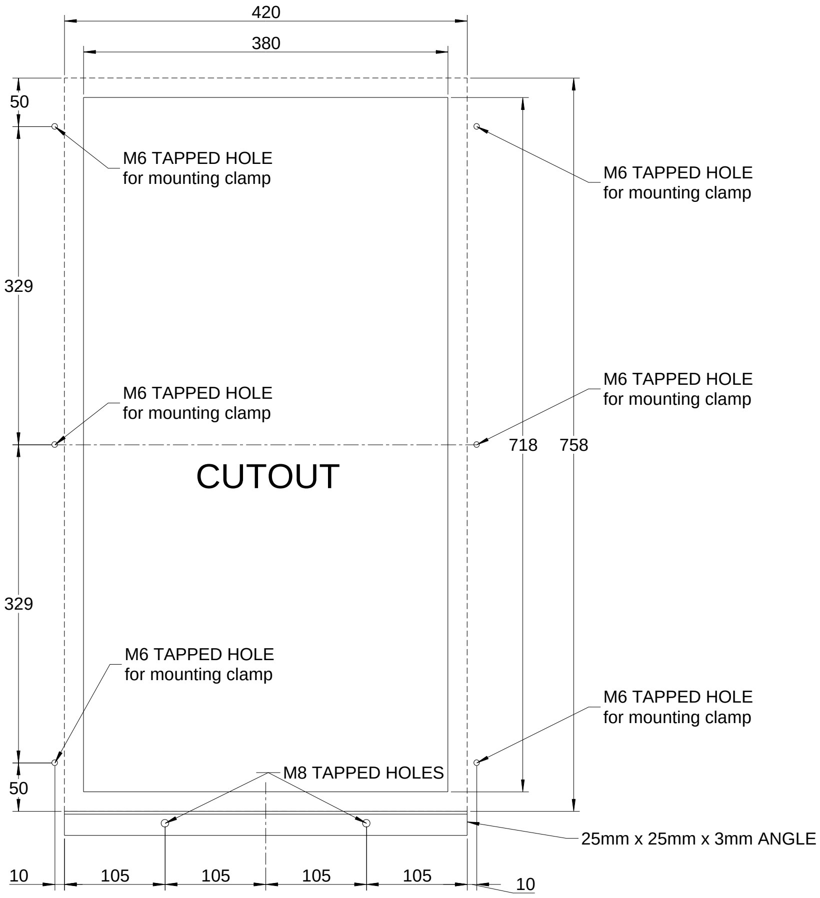
Each MSC-3V system consists of one module or a number of modules for connection in parallel. There are two physical sizes of module, V1 and V2, with a number of different electrical ratings available in each physical module size.

V1 Module

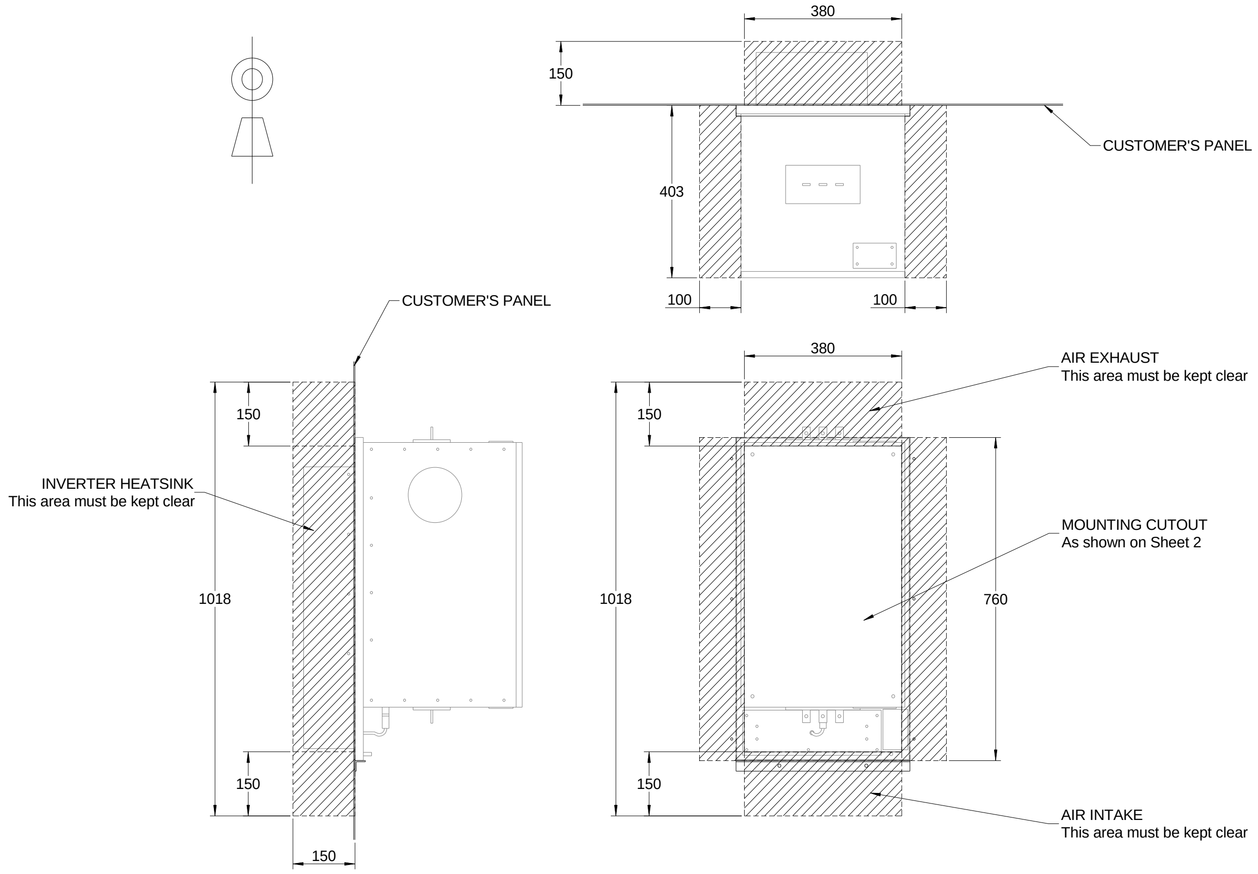
The inverter modules for ratings up to 66A are of V1 dimensions.



V1 Module dimensions



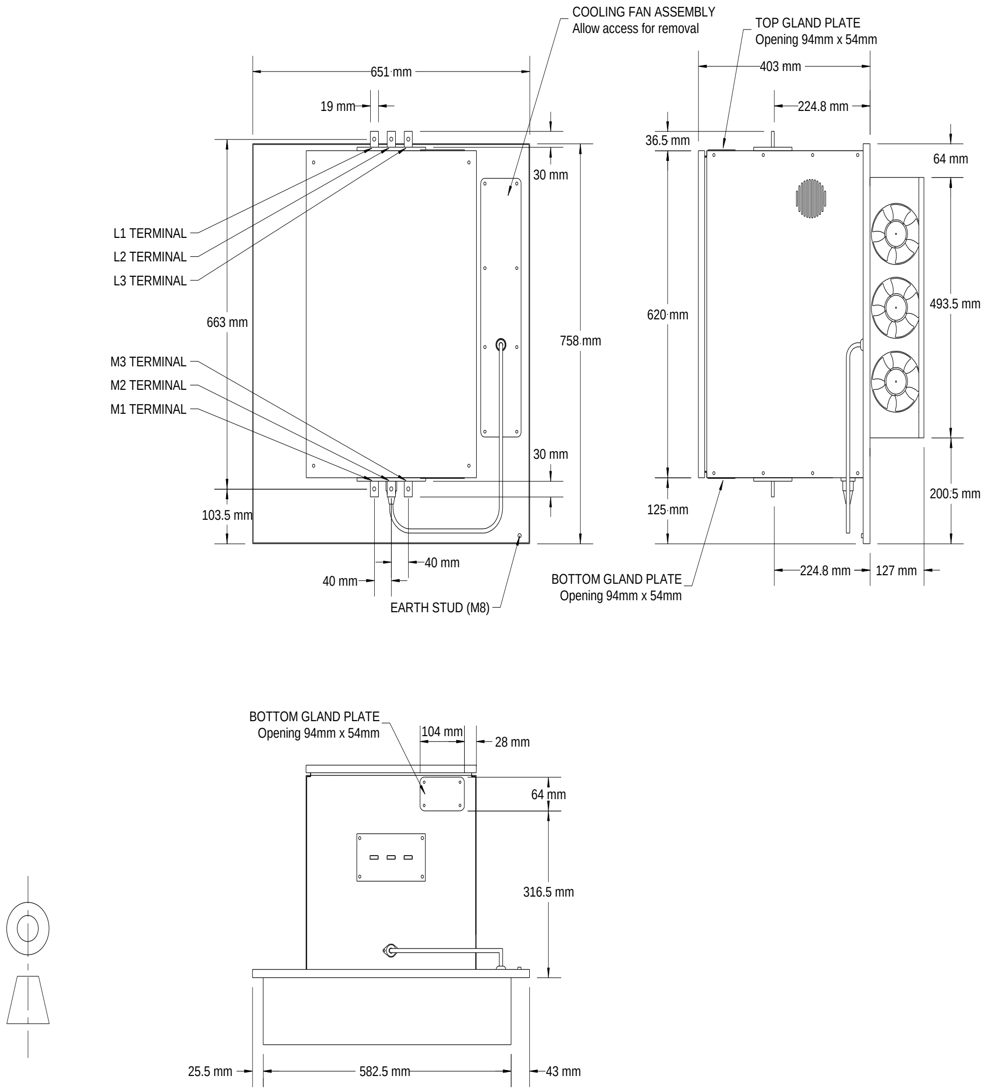
V1 Module mounting cut-out detail



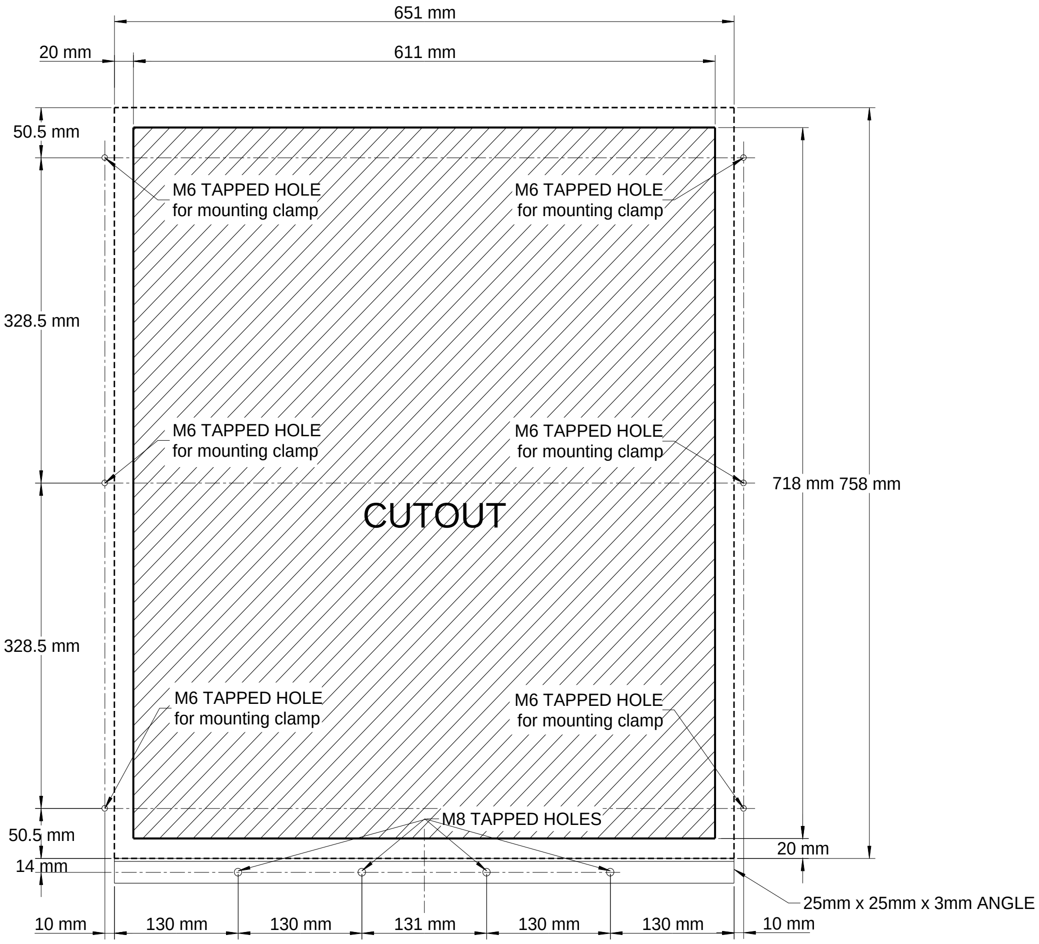
V1 Module mounting clearance requirements

V2 Module

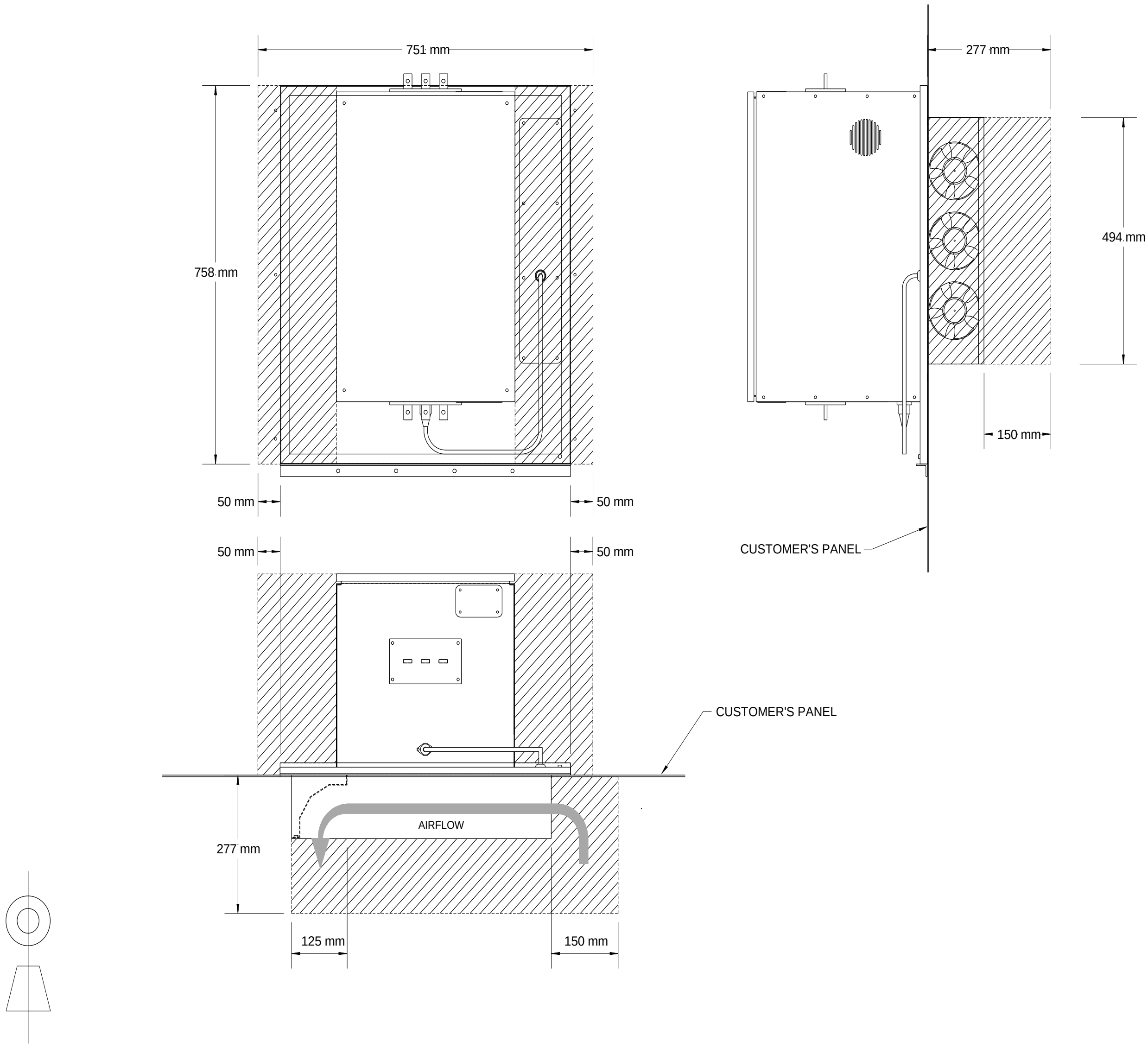
The inverter modules for ratings of 84A and above are of V2 dimensions.



V2 Module dimensions

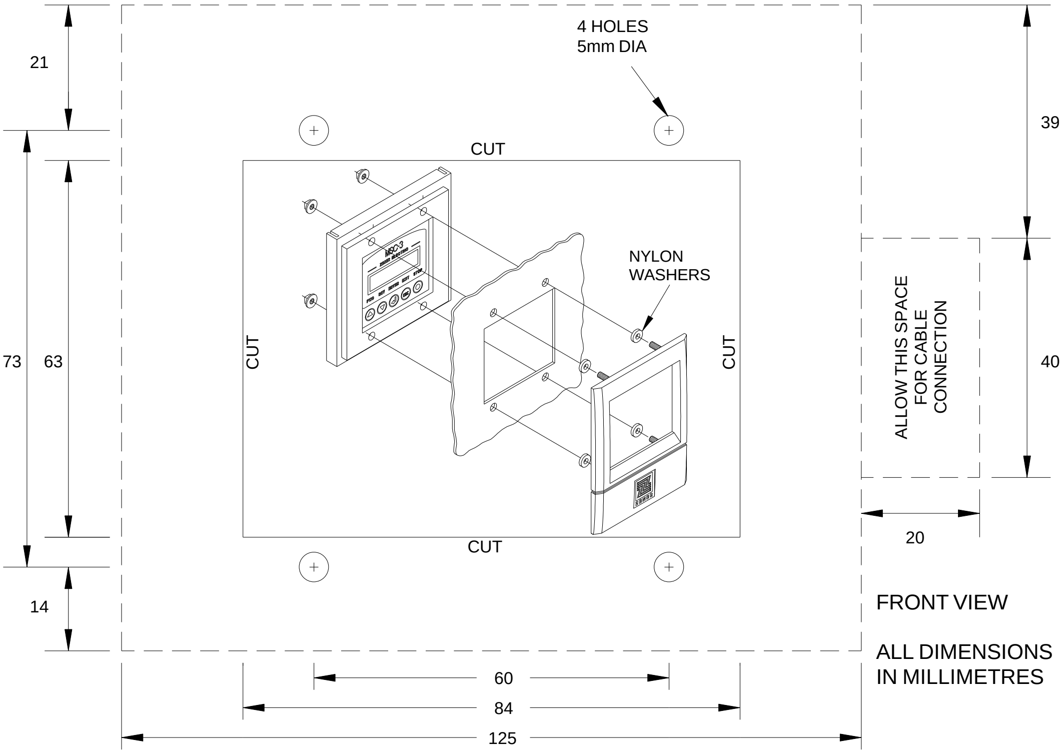


V2 Module mounting cut-out detail



For installations with inverter modules mounted side by side, the minimum mounting pitch horizontally is 751mm.

Systems that use parallel connected modules (ratings 200A and above) have the additional requirements that the modules be mounted in a horizontal row with a mounting pitch not exceeding 1100 mm.



Allow 70mm behind the panel to accommodate the depth of the remote console.

Remote console mounting

MSC-3V Power wiring

AC line overcurrent protection device

An overcurrent protection device is required in the AC supply to the MSC-3V. The purpose of this device is twofold:

- To provide thermal protection for the cables etc between the location of the overcurrent protective device (usually at the origin of the relevant supply sub-circuit) and the MSC-3V. This is predominantly a measure to prevent injury and property damage from melting and fire.
- To limit the energy available at the location of a short circuit or near short circuit in the unlikely, but possible, event of a major arcing fault in wiring or within the MSC-3V enclosure. This measure is to control the risk of personal injury and property damage due to arc flash, conductor erosion, explosion and the like.

The first requirement is relatively slow and normally provided by fuses or the timed (traditionally referred to as thermal) characteristic of a circuit breaker. Note that the protection offered by this device on the AC line side of the MSC-3V does not extend to the output (motor) side because the AC line side current may be considerably less than the MSC-3V output current when operating at less than full speed. This is a consequence of the high efficiency of the MSC-3V and the power required by the load being a product of torque and speed, the AC input power (and current) reduce with speed, even if the load torque remains high. The MSC-3V itself provides both timed overcurrent (I^2t) and instantaneous overcurrent protection for the output wiring and motor.

The second requirement may be met with either the instantaneous trip function of a circuit breaker or a fuse. The total amount of energy let through in the event of a short circuit or near short circuit event is usually the critical factor in determining the injury risk, extent of physical damage and consequently the time and expense involved in repair. The let through energy may be accessed in terms of the I^2t (time integral of current squared) let through the protective device in the process of interrupting the fault current. In order to minimise the I^2t let through and the associated risks of injury, property damage and downtime, we recommend the use of appropriately rated current limiting[2] type fuses. In some circumstances, the user's protection needs may be met by a suitably selected circuit breaker however, we strongly recommend that any such selection be based on detailed engineering evaluation and not simply a catalogue selection.

Coordination of supply circuit protection and switchgear

Either fuses or a circuit breaker must be connected as shown. The protective elements used and any upstream switchgear (contactors, isolation switches etc) must be selected with due regard for the prospective short circuit currents of the electrical supply and the requirements of your local electrical code. The selection should provide for “type II” (no damage) coordination as per IEC 60947 or Australian Standard AS 3947.

Cable sizes

Power cables between the various system components are the responsibility of the installer and the size and type to be used should be selected to suit the application and on the basis of the continuous current rating of the MSC-3V and a minimum temperature rating of 70C. Cables sizes should be selected according to local wiring rules using the currents given in the table on page 11. Note that the power terminals of the MSC-3V enclosure and the input/output line reactors are intended for use with cables terminated in crimp lugs with a single hole to match the diameter of the hole or bolt provided.

[2] “Current limiting” describes the ability of an overcurrent protective device (fuse or circuit breaker) to reduce the peak current that flows in a circuit, by opening and clearing the fault in a sub half-cycle time frame.

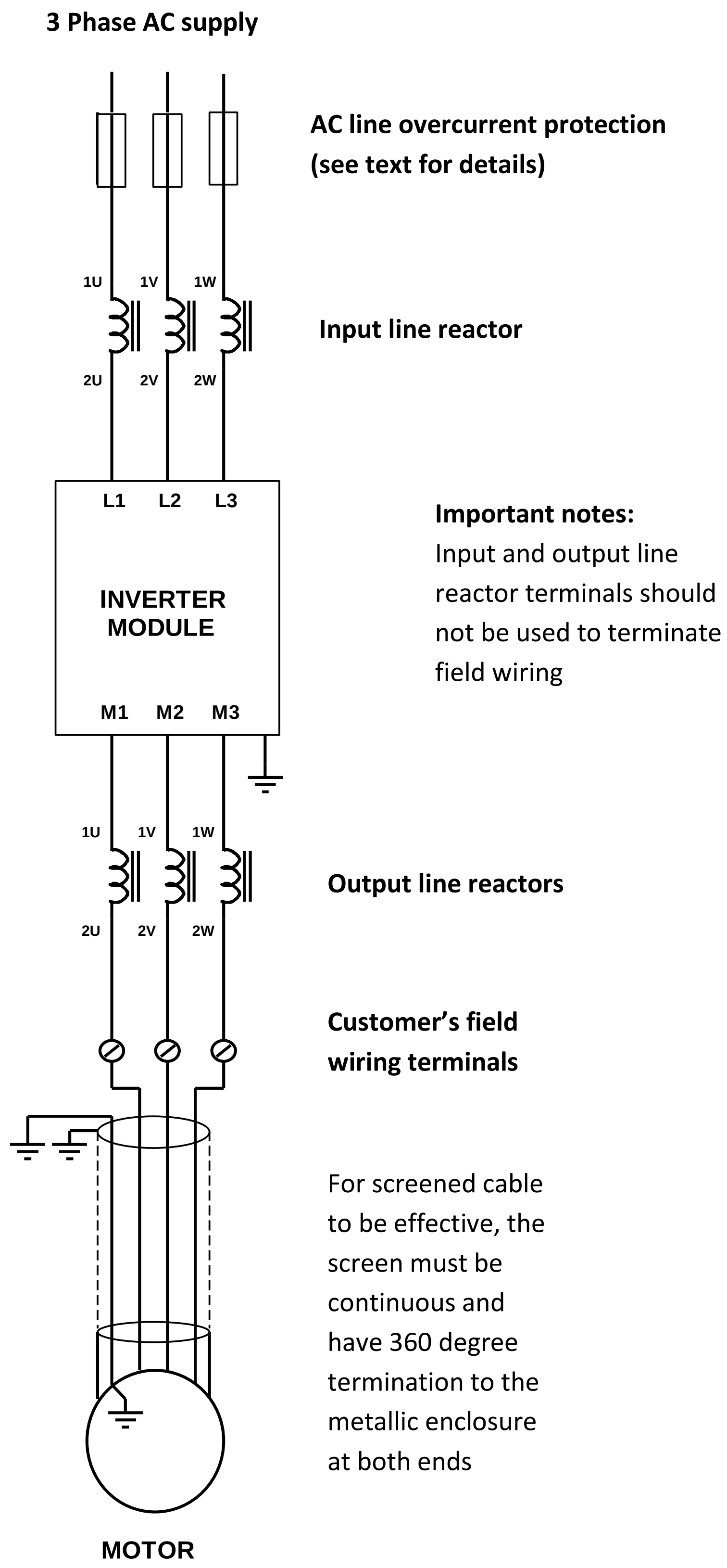
Electrical Isolation

A suitable means of isolating the MSC-3V from the electrical supply must be provided in accordance with your local electrical code. In the event that a second supply is connected to the relay contacts on the control terminal strip (or otherwise brought into the MSC-3V enclosure), suitable marking must be applied to the outside of the MSC-3V enclosure by the installer to indicate the dual supply arrangement in accordance with your local electrical code and other safety requirements. A means of isolating the second electrical supply source will also be required.

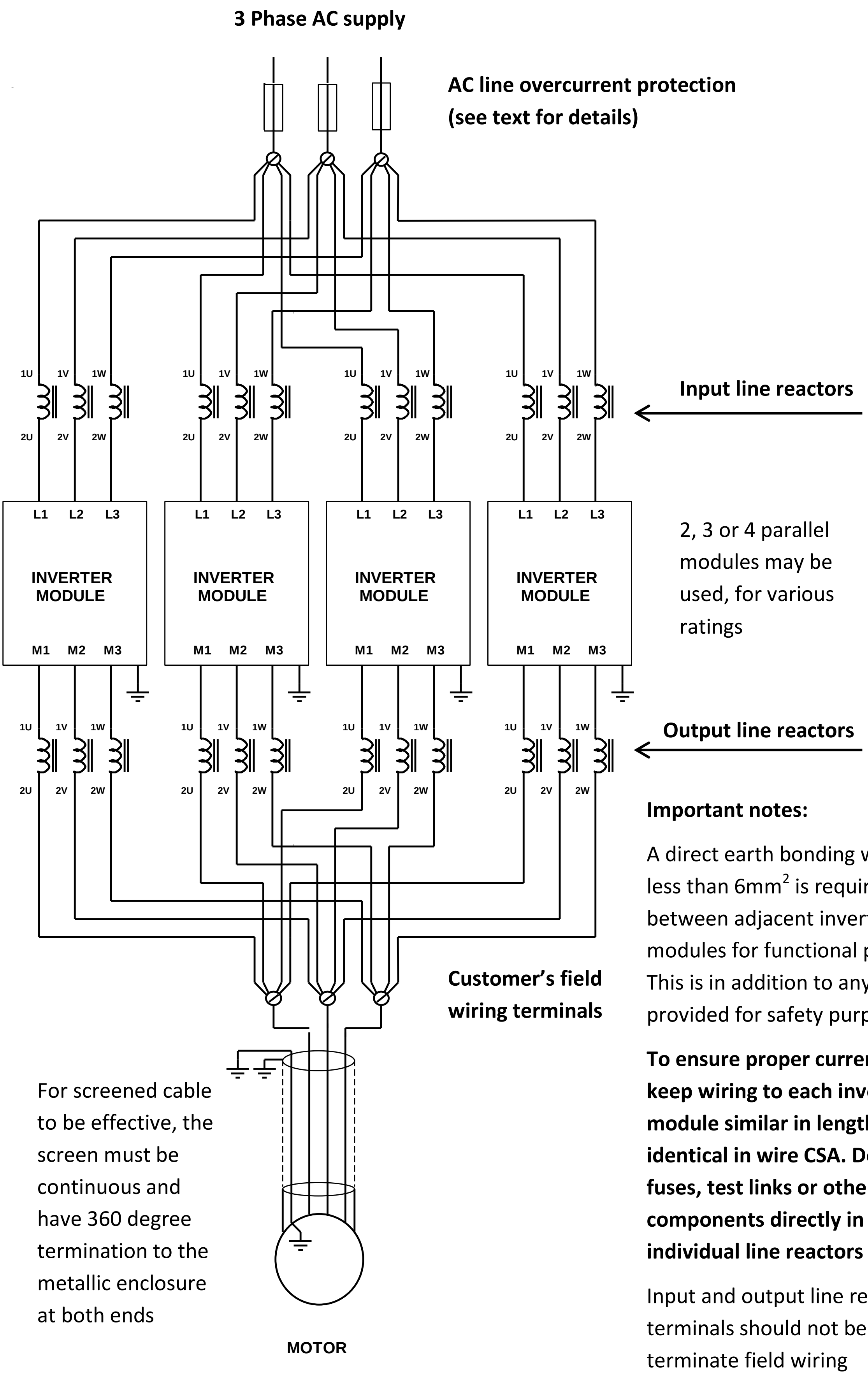
Motor thermal protection

The MSC-3V provides an electronic type thermal overload function that relies on the measured motor current to estimate the thermal conditions of the motor. For enhanced motor thermal protection, thermistors should be installed in the motor winding and wired to the appropriate trip relay. The MSC 3 Extended Features Option provides a thermistor relay function and other features.

Power Wiring for Single Units



Power Wiring for Parallel Units



For screened cable to be effective, the screen must be continuous and have 360 degree termination to the metallic enclosure at both ends

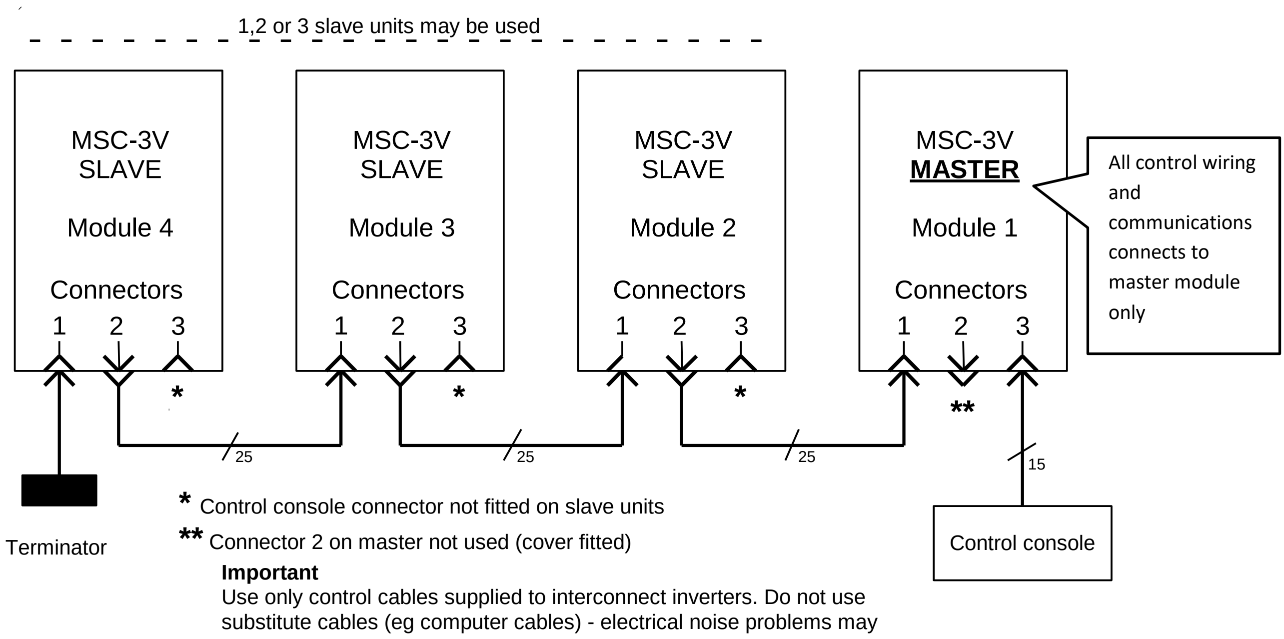
Important notes:

A direct earth bonding wire of not less than 6mm^2 is required between adjacent inverter modules for functional purposes. This is in addition to any earth wire provided for safety purposes.

To ensure proper current sharing, keep wiring to each inverter module similar in length and identical in wire CSA. Do not fit fuses, test links or other components directly in series with individual line reactors

Input and output line reactor terminals should not be used to terminate field wiring

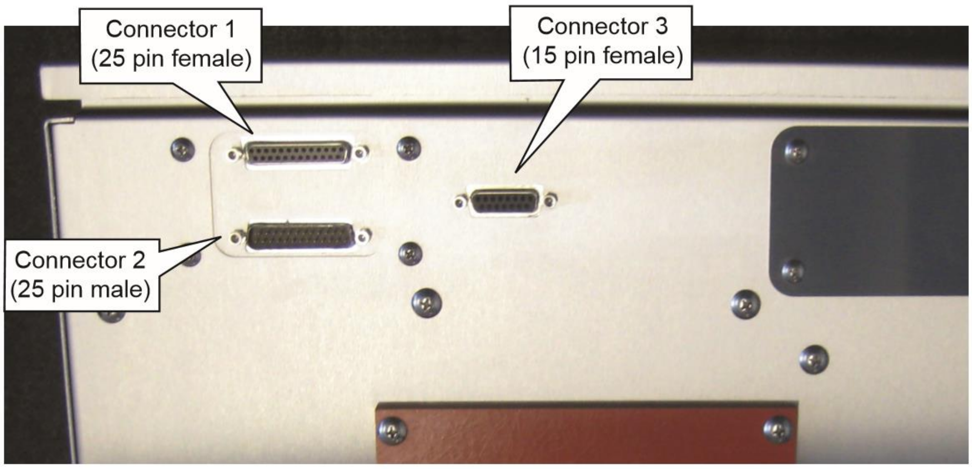
Control Interconnection for Parallel Units



Control Cable Diagram

A direct earth bonding wire of not less than 6mm^2 is required between adjacent inverter modules for functional purposes.

In addition, one (only one!) earth connection should be made from the master inverter module to the switchboard earth link. Do not use the inverter module earth connections to earth other components or cable screens etc. The reason for this requirement is to avoid possible earth currents from other sources flowing in the earth bonding wire between inverter modules. High frequency currents in the bonding connections may induce sufficient voltage between inverter modules to cause improper operation.



(Module viewed from below)

Control Connector Identification

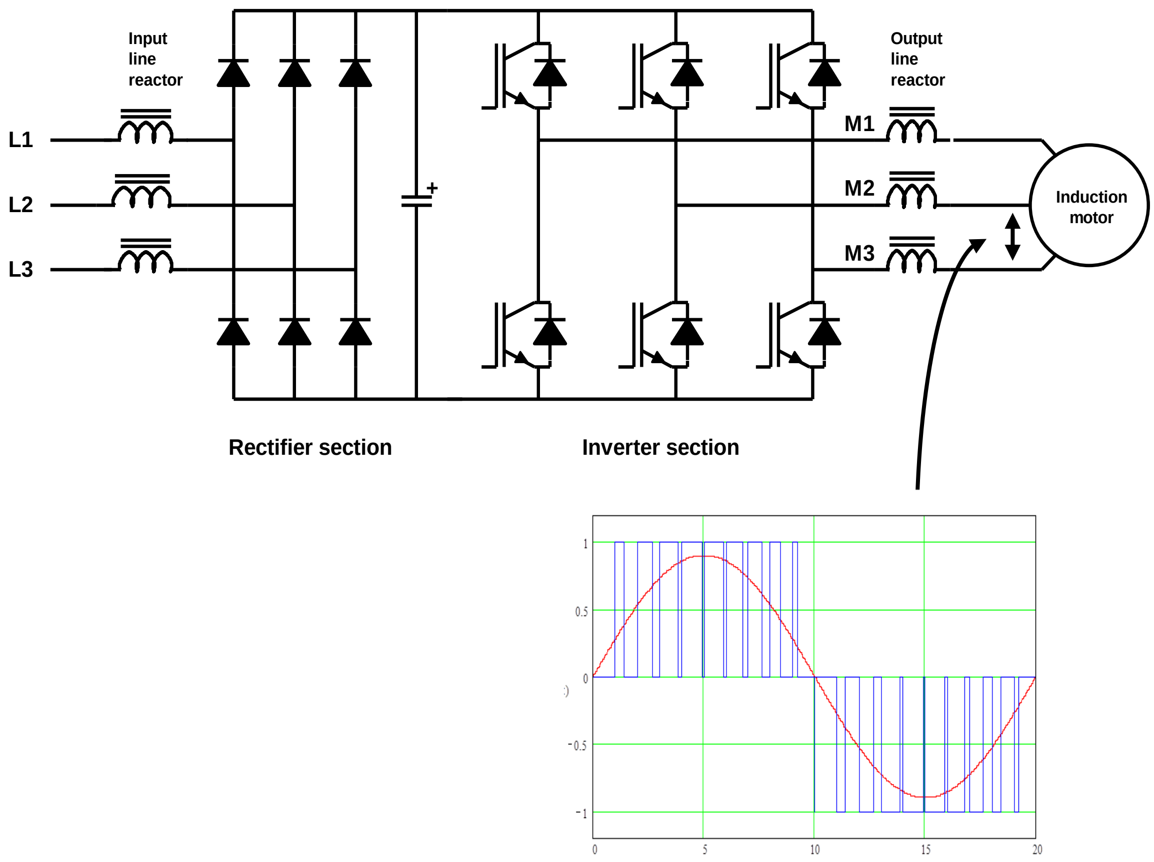
Earth leakage currents in IT supply system environments

These notes are provided to raise awareness of issues associated with capacitively coupled earth leakage currents in 1000V VSD installations using “IT” electrical supply systems. Typically these will be mining industry applications. These notes are general in nature and should not be considered in any way to represent an alternative to appropriate professional engineering advice.

A general explanation of “IT” and “TN” electrical distribution earthing systems is provided as an appendix.

Basic VSD power circuit

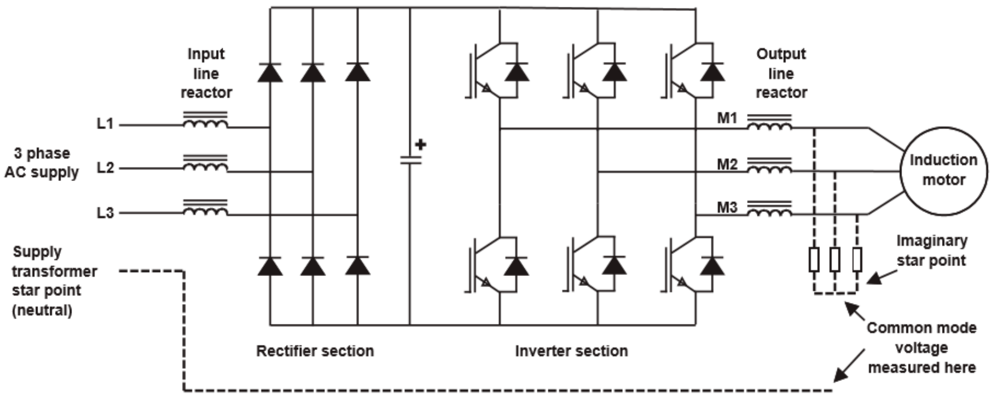
The MSC-3V rectifies the incoming AC line to produce a DC voltage that feeds and inverter stage consisting of 6 IGBT switches. The switches are operated to create a pulse width modulated (PWM) output voltage between the M1/M2/M3 output terminals. The voltage between the output terminals provides the necessary variable frequency and variable voltage power source to operate the motor over a wide speed range.



Voltage between phases

Common mode voltage and capacitive currents

A side effect of the PWM process is that there is also a voltage generated between an imaginary star point on the 3 phases feeding the motor (M1/M2/M3) and the star point of the incoming AC supply.



Single line diagram showing potential paths for capacitive leakage currents

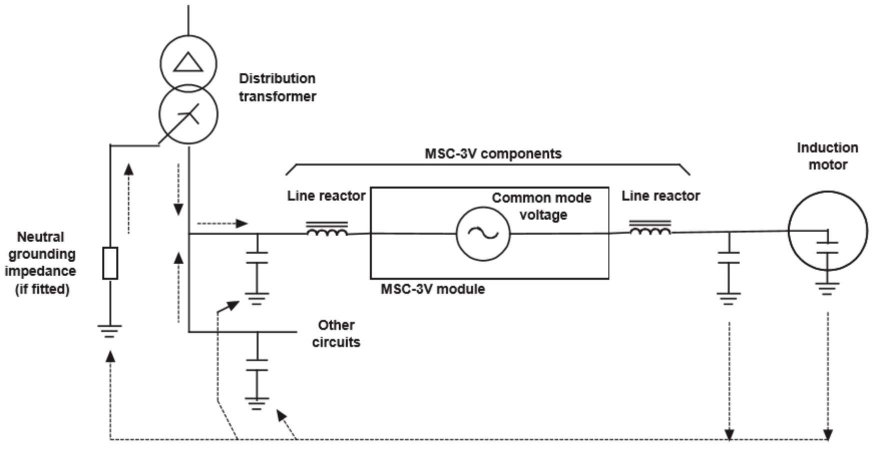
This so called “common mode” voltage is of little consequence from a power point of view because there is no “neutral” or “star point” connection on the output side of the inverter and therefore no path for current to flow except through the small capacitance that exists between the motor circuit and ground. This capacitance will be partly in the motor itself and partly in the associated cables. The current that is able to flow through this capacitive path is quite small relative to the equipment current rating, however the nature, path and magnitude needs to be considered in the design of a safe and reliable installation. There is a capacitive current path to any conductor in the vicinity of the motor circuit and this is particularly so for any additional conductor that is within or closely alongside the motor cable.

Nature of the capacitive leakage current

The capacitive leakage current takes the form of brief pulses. Each pulse is the result charging or discharging the stray capacitances of the motor and cables with each change of the common mode voltage.

Capacitive leakage current path

The single line diagram below gives a general indication of the paths that the capacitively conducted currents may typically take. Basic electrical circuit theory tells us that current flow will take the form of a loop. The key to understanding the path capacitive leakage currents and possible interactions with other equipment or instrumentation is to identify all of the elements of the loop.



Single line diagram showing potental paths for capicitive leakage currents

Note that all of the capacitors in this diagram are just "stray" capacitances incidental to cables, motors etc.

There are no intentionally installed capacitors here.

Magnitude of capacitive leakage currents

The magnitude of an AC current can be evaluated according to several different concepts. The appropriate choice is dictated by the intended application of the result (ie what it is that you want to know). Some of the possible methods and typical purposes are:

Concept / Method		Purpose	Notes
RMS	True RMS value	Heating effect of the current	This method widely applied by default for AC current measurement. It is not always the relevant interpretation!
RMS(300Hz LP)	True RMS value of the current after a 300Hz low-pass filter is applied	Approximation of the response of some earth leakage detectors/relays	Some earth leakage current relays incorporate a filter to reject high frequencies in order to reduce nuisance tripping
Ipk	Instantaneous peak value of the leakage current	Possible consideration of the potential to overload the input circuitry of instrumentation or disrupt operation in other ways	Depends on the design detail of the instrumentation involved.

The characteristics of earth leakage monitoring devices are closely specified in the relevant technical standards. In most instances, these standards consider leakage currents at 50/60Hz and leave the behaviour at higher frequencies such as a few kHz unspecified. The design of some, but certainly not all of these devices incorporates filtering to reduce sensitivity to frequencies higher than 200…300Hz in order to reduce the likelihood of nuisance tripping. The RMS(300Hz LP) evaluation concept is intended to reproduce this characteristic in a general sense rather than a formal specification. Please consult the manufacturer of the particular device regarding expected behaviour and suitability for your application.

The expected value of capacitive leakage current by the RMS(300Hz LP) method can be estimated as:

1.5mA RMS for each 1nF of total stray capacitance

For example, a system with a total motor and cable capacitance of 100nF could be expected to have a capacitive leakage current of 150mA evaluated by this method, under the given conditions.

Notes

1. The total stray capacitance is measured between all phases of the motor and motor cable connected together and ground.
2. This estimation is based on maximum DC bus voltage (as may occur during rapid deceleration), PWM switching frequency 1KHz and other conditions selected to maximise the RMS(300Hz LP) value.
3. The true RMS value of the capacitive leakage current will be **significantly higher** than the RMS(300Hz LP) value because the RMS(300Hz LP) evaluation excludes higher frequency components.
4. There are potentially a number of different reasons to evaluate the impact of earth leakage currents in an installation. The evaluation method selected each should be appropriate to that reason. It is unlikely that a single evaluation method will meet all requirements.

Contact Zener for additional information.

Earth leakage monitoring instruments / devices

The following notes may be of assistance in selecting appropriate devices:

1. The measurement bandwidth of the device will have a significant influence on the leakage current indicated because the actual capacitive leakage current will contain a wide range of frequencies. We suggest that the device bandwidth should be selected based on the particular risks to be managed.
2. Earth leakage monitoring instruments / devices are potentially exposed to all frequency components of the leakage current, not just those that pass through any internal low-pass filter. Check instrument / device suitability with the manufacturer.
3. An insulation fault between the inverter module DC link and earth, could in theory at least, produce an earth fault current with a DC component. The issue is that an earth fault with a DC component may not be recognised by, or might otherwise de-sensitise, an AC-only earth leakage monitoring device. The inverter module DC link is entirely internal to the inverter module and not connected to field wiring or available at any terminal of the inverter module to minimise the opportunity for such a fault. In view of this construction we believe the possibility of a fault of this nature to be remote. We understand that earth leakage monitoring devices that include a DC capability are available.

Q&A

This seems very different to 415V VFDs installations. Why?

The basic mechanism producing capacitive leakage currents is the same in both types of VFD.

In a 415V VFD intended for a TN supply network the path for the capacitive leakage current is managed by using a screened power cable between the VFD and motor together with substantial capacitors (integral to the VSD) connected between the AC input and ground. This combination contains a substantial portion of the capacitive leakage currents to a loop between the AC input of the VFD and the motor. Note that the major purpose of the shield incorporated into the motor cable is to provide a low impedance path for capacitive leakage currents back to the VFD chassis rather than preventing electromagnetic radiation as is often supposed.

In the case of 1000V VFDs for IT supply networks, connection of substantial components between the supply phases and earth is generally not allowed, so the mechanism used in the TN situation to confine most of the capacitively coupled leakage current to the loop between the VFD chassis and the motor is not available. This means that the capacitive leakage currents flow in a larger part of the installation. The protective relays and other system components need to be fit for purpose in this environment.

The actual capacitive leakage current associated with a particular amount of stray capacitance is proportional to the voltage applied, so the capacitive leakage currents in 1000V equipment are, in principle, about 2.5 times higher than those in 415V systems. This factor is independent of the IT or TN supply type.

Will using a screened motor cable reduce the capacitive earth leakage currents?

The stray capacitance of a screened motor cable is typically higher than a similarly sized unscreened cable, so it will increase rather than reduce the capacitive earth leakage current from the cable. Other benefits of using a screened motor cable may outweigh this consideration in some circumstances.

How can I minimise the capacitive earth leakage current and its impact on the installation?

- Recognise that a VFD in an IT supply system requires special attention to issues that would not normally be part of the experience of applying VFDs in TN supply systems.
- Include the topic of capacitively coupled earth leakage currents in the safety risk analysis at the design stage of the installation.
- Minimise drive to motor cable length to minimise total stray capacitance which, in turn, minimises the capacitive earth leakage current.
- Avoid placing other conductors in or adjacent to the inverter to motor cable. This cable should contain the 3 phase conductors and earth conductor(s) only.
- Review all protection relays and similar devices for correct and reliable operation with the expected capacitive leakage and other currents.
- Review other loads and their associated protection / instrumentation that might be connected to the same distribution transformer secondary for sensitivity to the portion of capacitive leakage current that may flow in that circuit.

Can I add an EMC filter on the AC line to the drive?

There is no issue from a drive point of view; however the majority of packaged EMC filters available in the market have substantial capacitors connected between the phase conductors and earth which is acceptable in a TN supply system, but likely to be problematic in an IT supply system. EMC filters for IT supply systems should be specifically designed for that environment.

What are the implications for touch potential around the installation?

The flow of leakage currents around the installation will naturally cause small voltage differences between the ends of conductor(s) involved. We suggest that these be checked against the requirements for the particular operating environment. General information on this topic is provided in AS/NZS 60479 *Effects of current on human beings and livestock* and AS/NZS 60990 *Methods of measurement of touch current and protective conductor current*

Can pilot earth circuits be used in cables associated with 1000V VFDs?

There is no inherent reason that prevents the use of pilot earth (AKA “earth check”) systems, however the electrical environment inside a VSD motor cable and to some extent associated AC line cables, is challenging from an interference point of view. Pilot earth relays designed without specific consideration of this environment are highly likely to be problematic.

What happens if the earth connection to the motor is disconnected?

In the event that earth connection to the motor frame is disconnected it is likely that the capacitive leakage currents between motor winding and motor frame will result in the motor frame being hazardous to touch.

Other potential hazards for consideration include being a possible source of ignition in hazardous area situations and hazards associated with capacitive leakage currents flowing in alternative circuits and / or structures.

The integrity of the motor frame earthing arrangement is an important safety consideration and should be specifically considered as part of the safety risk assessment of the installation design and included in ongoing maintenance / inspection arrangements.

Electromagnetic Compatibility (EMC)

Installation practices and EMC

Electromagnetic compatibility covers a wide range of phenomena including emission and immunity to harmonics, flicker, and conducted and radiated interference. The material presented in this section relates to the conducted and radiated interference aspects of EMC.

Technical limits for emissions and immunity to interference are specified in a number of local and international standards of which Australian Standard AS 61800 Adjustable speed electrical power drive systems, Part 3: EMC requirements and specific test methods is typical.

Clause 6.6 Engineering practice provides a methodology for dealing with C4 category equipment such as MSC-3V systems as well useful information on problems associated with applying the more usual kind of AC line filter employed in low voltage appliances to power systems with isolated or impedance grounded neutrals (IT-network).

Practical resolution of interference issues usually centres around conducted rather than radiated issues and especially paying close attention to the path of high frequency common mode currents around the installation. In many instances, the use of screened power cables will be of assistance.

In the case of a drive system in an "IT" supply system environment (ie a system where fitting a large capacitance between AC input and earth is not allowed) the principle benefits of a screened motor cable are:

- Substantial reduction in the capacitive leakage current between the motor cable phase conductors and nearby conductors such as cable trays, cable support hardware and other cables.
- Reduction in the high frequency voltage appearing between the ends of the motor cable earth wire by reducing the impedance of the earth connection between the inverter and motor. This reduces the opportunity for high frequency currents to flow in incidental paths between inverter and motor. Incidental paths may involve cables of other circuits or perhaps metal structures in the vicinity.

Screened power cables will generally have a higher stray capacitance between the phase conductors and the earth/screen than an unscreened cable. This difference will usually quite small comparted to the total stray capacitance of the motor and cable together. The benefits of a screened motor cable will generally outweigh this consideration.

Please note that this situation is significantly different to the case of "TN" supplied drive systems where substantial capacitors are fitted between the AC input and earth as part of an EMC filter. This arrangement, in conjunction with a properly installed screened motor cable, is very effective in isolating most of the capacitive leakage current effects from other parts of the installation.

In order to achieve the best electrical performance from a screened motor cable at high frequencies, it is essential that the screen of the cable has a 360° connection to both the gland plate of the metallic (typically switchboard) enclosure containing the MSC-3V and the motor terminal box. The correct type of metal cable gland to suit the screened cable should be used. The protective earth (PE) conductor should be terminated in the usual way to meet the local wiring codes.

Isolation switches wired between the MSC-3V and the motor should be in a metallic enclosure with the power cable screen properly terminated on both sides. Failure to properly terminate the screened power cable (or alternative metal sheath) will result in a severe degradation of the screened cables performance at high frequencies and increase the possibility of EMC problems. The screened motor cable should only contain the phase and earth (PE) conductors of one inverter and the associated motor. Do not include other conductors inside the screen.

Screened power cables and alternative materials

There is a wide variety of materials available as well as a degree of misunderstanding concerning the benefits of material without explicit EMC related specification. The following table seeks to summarise the situation.

	Category	Technical Data	Comment	
1	Screened cable material from reputable manufacturers	Technical data will be available to allow assessment of the performance of the material against specific criteria.	The manufacturer's claimed data can generally be relied on, provided that the proper installation and termination practices are strictly adhered to.	✓
2	Generic materials with well understood EMC properties For example, screwed steel conduit and MIMS cable	The technical performance of these materials is well understood by analysis from basic principles. Specific data has been reported in reputable engineering research journals.	These materials generally offer very high performance, provided that the proper installation and termination practices are strictly adhered to.	✓
3	Material without specific EMC performance data. Armoured cables and flexible conduit systems fall into this category when there is no EMC performance data provided. Note that there are high performance, fully EMC specified examples of these materials available which would make them part of category 1	None. Assessment of the likely performance by visual inspection is difficult and unreliable.	These materials represent a high risk category because the EMC performance is simply unknown. Apparently similar materials may have widely differing EMC performance. In general, there is no control of the EMC properties during design or manufacture because this is not the intended application.	✗

EIA/RS-485 Communications Wiring

The ZENER MSC-3V communications port is EIA/RS-485 compliant and is isolated from ground and other circuits. This communications port is used by BACnet MS/TP and Modbus RTU protocols.

The communications system (communications cable, ZENER MSC-3V and other devices) needs to operate reliably in a potentially electrically noisy environment. For best performance and to reduce the risk of network failure, we recommend the following:

Best practice

Best practice for EIA/RS-485 communications requires 3 conductors and a shield. It is frequently discussed in terms of being a two wire network, but this is not the case.

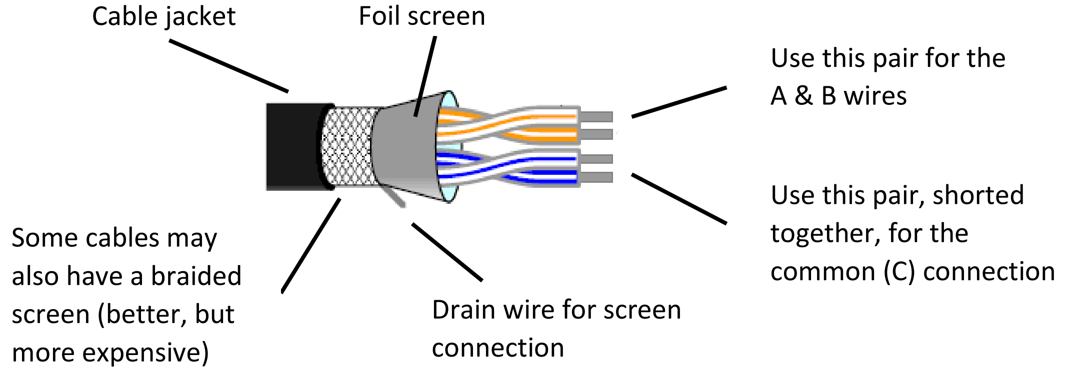
Two conductors are used to carry the EIA/RS-485 data as a differential voltage signal. These wires should ideally be twisted together so that any magnetically induced interference voltage will occur equally in both conductors and be rejected by the differential nature of the EIA/RS-485 interface circuit.

The third conductor is used to keep the common connection (marked as terminal "C" in ZENER MSC-3V) in all the communications interfaces at the same potential, that is, keep the common mode voltage at each interface within the limits specified by the standard.

The Shield is connected to earth/ground at one end[3] only and provides protection against capacitive coupling to nearby cables and other electrical noise sources.

One arrangement that meets these requirements using generic materials is as follows:

> Use a standard two pair shielded instrumentation cable. Internally, this will have a total of 4 conductors, physically arranged as two twisted pairs surrounded by an aluminium wrapper as a screen. A bare "drain wire", in contact with the aluminium wrapper, makes an electrical connection to the screen.
>
> One pair is used for the data signals. The other pair is used in parallel as the common wire. The screen (drain wire) is connected to ground at one end only.



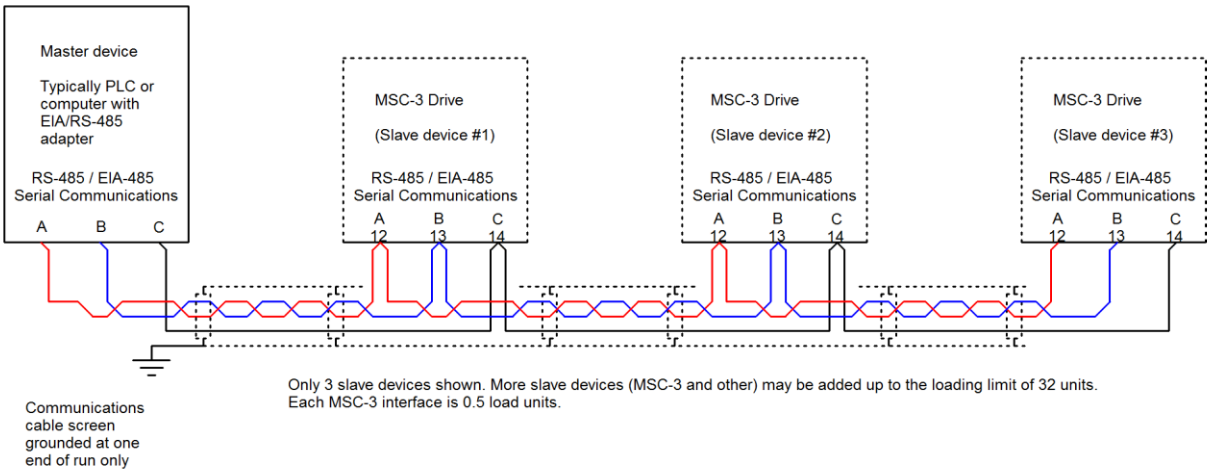
[3] Why one end only? Because there will be voltage differences between various ground points in an electrical installation that contain significant amounts of electrical noise and occasionally significant power frequency voltages during electrical fault events. We don't want these voltages to cause a current in the communications cable screen (because it would then induce a voltage in the cable conductors inside), so we ground the screen at one point only.

Terminating resistors

For best performance with long cable runs and high data rates a terminating resistor should be fitted at each end of the cable run. Values of 100 or 120 Ohms are commonly used, connected between the A and B terminals of the first and last devices on the cable run. For convenience, the ZENER MSC-3V

EIA/RS-485 interface incorporates a 120 Ohm terminating resistor that is controlled by menu item G167 TERMINATOR. Refer to the *ZENER 8000 Reference Manual IM00140* for details. A terminator should not be fitted to, or selected at, intermediate devices on the communications cable.

The purpose of the terminator is to supress electrical reflections (echo) that may occur on a long communications cable where the time for the signal to travel the length of the cable becomes significant compared to the rise time of the signalling pulses. In more compact installations, this will not be an issue and the system may benefit from the slightly higher signal levels that result from terminating resistors not being fitted.



Typical EIA/RS-485 wiring arrangement

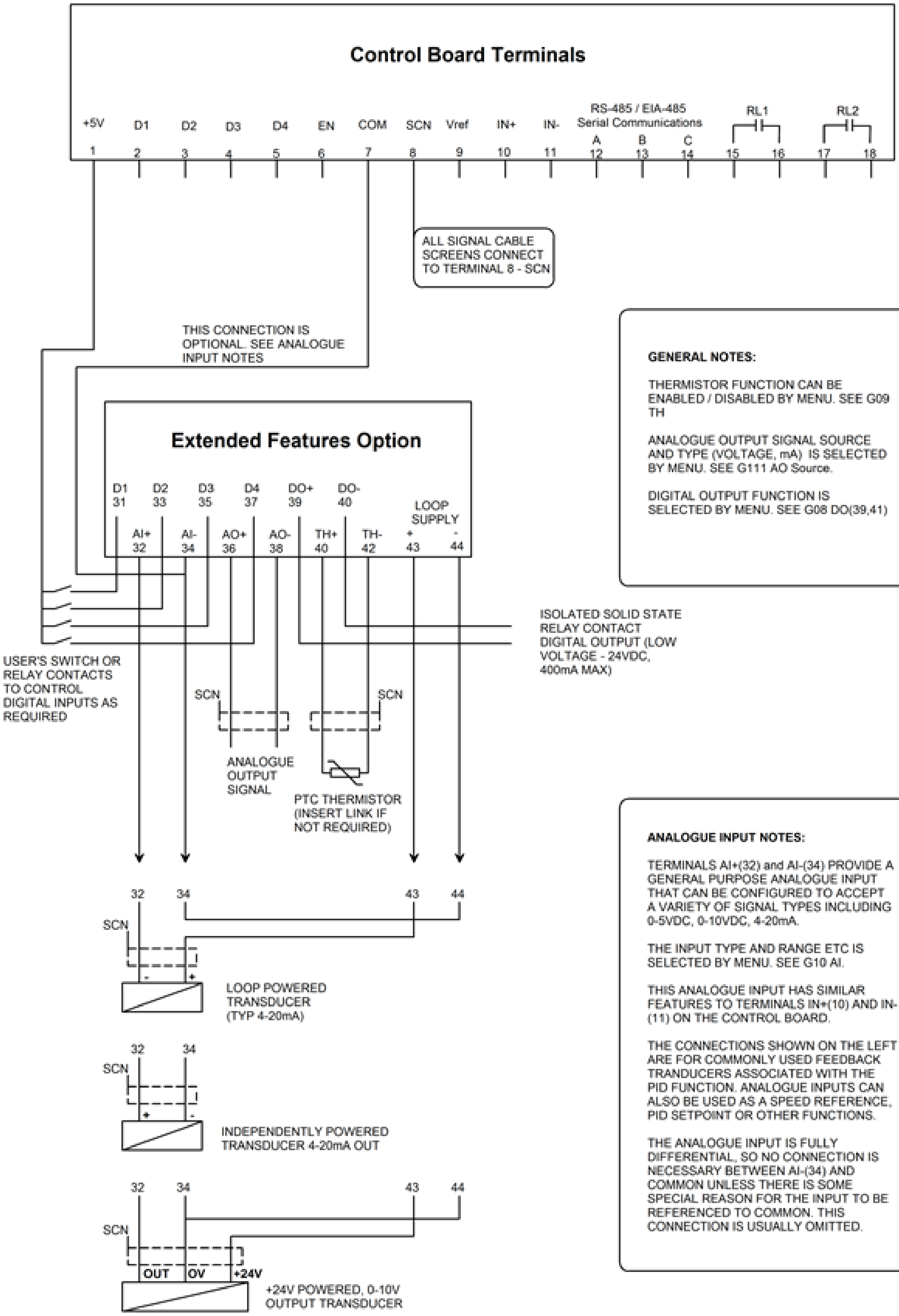
General

- Use twisted pair shielded communications cable.
- Connect EIA/RS-485 common terminals in addition to data conductors.
- A linear wiring scheme (daisy chain) is preferred over a star arrangement or one with stubs.
- The cable should have its shield connected to ground at one end only (earthing recommended at the computer / controller end).
- Avoid laying communication cables adjacent to power cabling and wiring. If not possible utilise the best separation of communication cabling and power cabling. Communication cables should cross power cables at right angles..
- The EIA/RS-485 standard allows a total of 32 standard load units on a network segment. Each ZENER MSC-3V interface is 0.5 standard load units, allowing a master device and at least 62 ZENER MSC-3V drives. Network loading for other equipment may vary – check with the equipment manufacturer.

Shortcuts

From time to time we are asked if all this is really necessary and perhaps pointing out some functional installation installed in some lesser way. Will it work? Can it be made to work? The short answer is basically yes, The downside is that compromise arrangements tend to be a source of frustration with issues like setups that work during a bench test but troublesome in the field. There is also some equipment that doesn’t have an accessible common connection. For these compromise situations – ask us – we can almost always find a creative solution!

Extended Features Option Wiring



GENERAL NOTES:

THERMISTOR FUNCTION CAN BE ENABLED / DISABLED BY MENU. SEE G09 TH

ANALOGUE OUTPUT SIGNAL SOURCE AND TYPE (VOLTAGE, mA) IS SELECTED BY MENU. SEE G111 AO Source.

DIGITAL OUTPUT FUNCTION IS SELECTED BY MENU. SEE G08 DO(39,41)

ANALOGUE INPUT NOTES:

TERMINALS AI+(32) and AI-(34) PROVIDE A GENERAL PURPOSE ANALOGUE INPUT THAT CAN BE CONFIGURED TO ACCEPT A VARIETY OF SIGNAL TYPES INCLUDING 0-5VDC, 0-10VDC, 4-20mA.

THE INPUT TYPE AND RANGE ETC IS SELECTED BY MENU. SEE G10 AI.

THIS ANALOGUE INPUT HAS SIMILAR FEATURES TO TERMINALS IN+(10) AND IN-(11) ON THE CONTROL BOARD.

THE CONNECTIONS SHOWN ON THE LEFT ARE FOR COMMONLY USED FEEDBACK TRANDUCERS ASSOCIATED WITH THE PID FUNCTION. ANALOGUE INPUTS CAN ALSO BE USED AS A SPEED REFERENCE, PID SETPOINT OR OTHER FUNCTIONS.

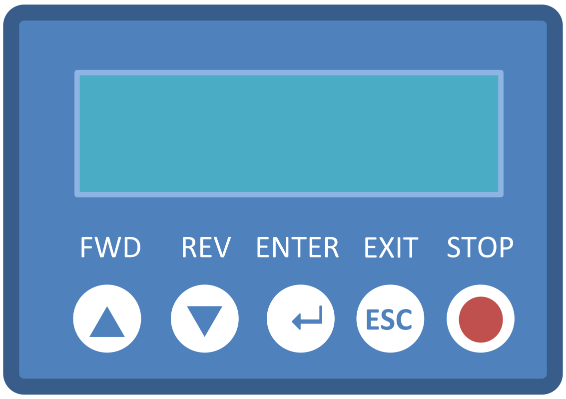
THE ANALOGUE INPUT IS FULLY DIFFERENTIAL, SO NO CONNECTION IS NECESSARY BETWEEN AI-(34) AND COMMON UNLESS THERE IS SOME SPECIAL REASON FOR THE INPUT TO BE REFERENCED TO COMMON. THIS CONNECTION IS USUALLY OMITTED.

MSC-3 Start Up

This manual provides basic control configuration information for the ZENER MSC-3V to suit more common applications. Please refer to the *ZENER 8000 Reference Manual IM00140* for a detailed explanation of each control feature, including communications protocols

Connect the input and motor power wiring in accordance with the installation information on pages 11 - 23. Select the terminal configuration you require. Connect the control wiring according to the appropriate Control Wiring Diagram or follow a quick setup. The ZENER MSC-3V is now ready to run. Before applying power ensure that rotation of the motor shaft will not cause injury or damage.

After applying power it is recommended that you at least go through the **B00 MOTOR**, **C00 PERFORMANCE** and **G00 INPUT/OUTPUT** menus to set up the ZENER MSC-3V before running the motor to prevent any unexpected motor operation. The ZENER MSC-3V is supplied with a link between the EN terminal and the +5V terminal. This link must always be made for the motor to run.



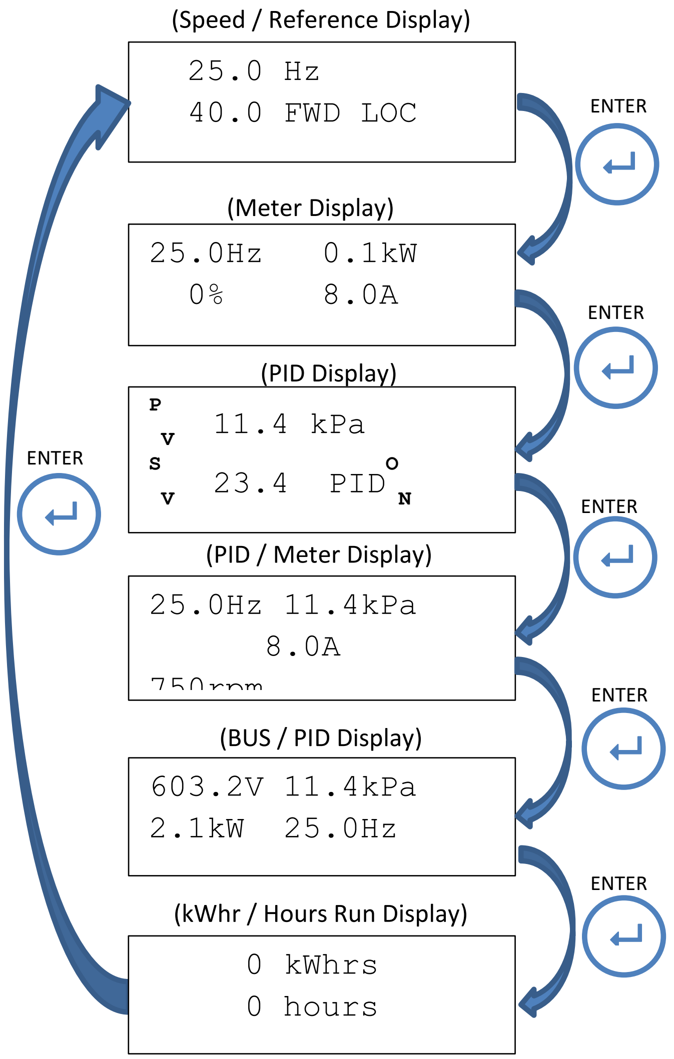
When the ZENER MSC-3V is first powered up, the drive model and version is displayed for approximately 2 seconds. An example of this display is:

V200

Ver 5.2.x

Operation Displays & Pushbuttons

The operational displays show the operating state of the ZENER MSC-3V. The six operational displays are: Speed / Reference Display, Meter Display, PID Display, PID / Meter Display and kWhr / Hours Run Display. Press ↵ (ENTER) to reveal each display.



Speed / Reference Display

The top line displays the operating output frequency and the second line displays the speed reference and the drive status

Meter Display

The top line displays the operating output frequency and power and the second line displays motor load and output current.

PID Display

The top line displays the process variable (PV) with its units and the second line displays set-point variable (SV) expressed with the same units.

PID / Meter Display

The top line displays the operating output frequency and process variable (PV) and the second line displays output current and motor speed.

BUS / PID Display

The top line displays the DC Bus voltage and process variable (PV) and the second line displays output power and output frequency.

kWhr / Hours Run Display

The top line displays the kWhrs consumed by the motor and the second line displays accumulated running time of the motor.

Local Mode Operation Example

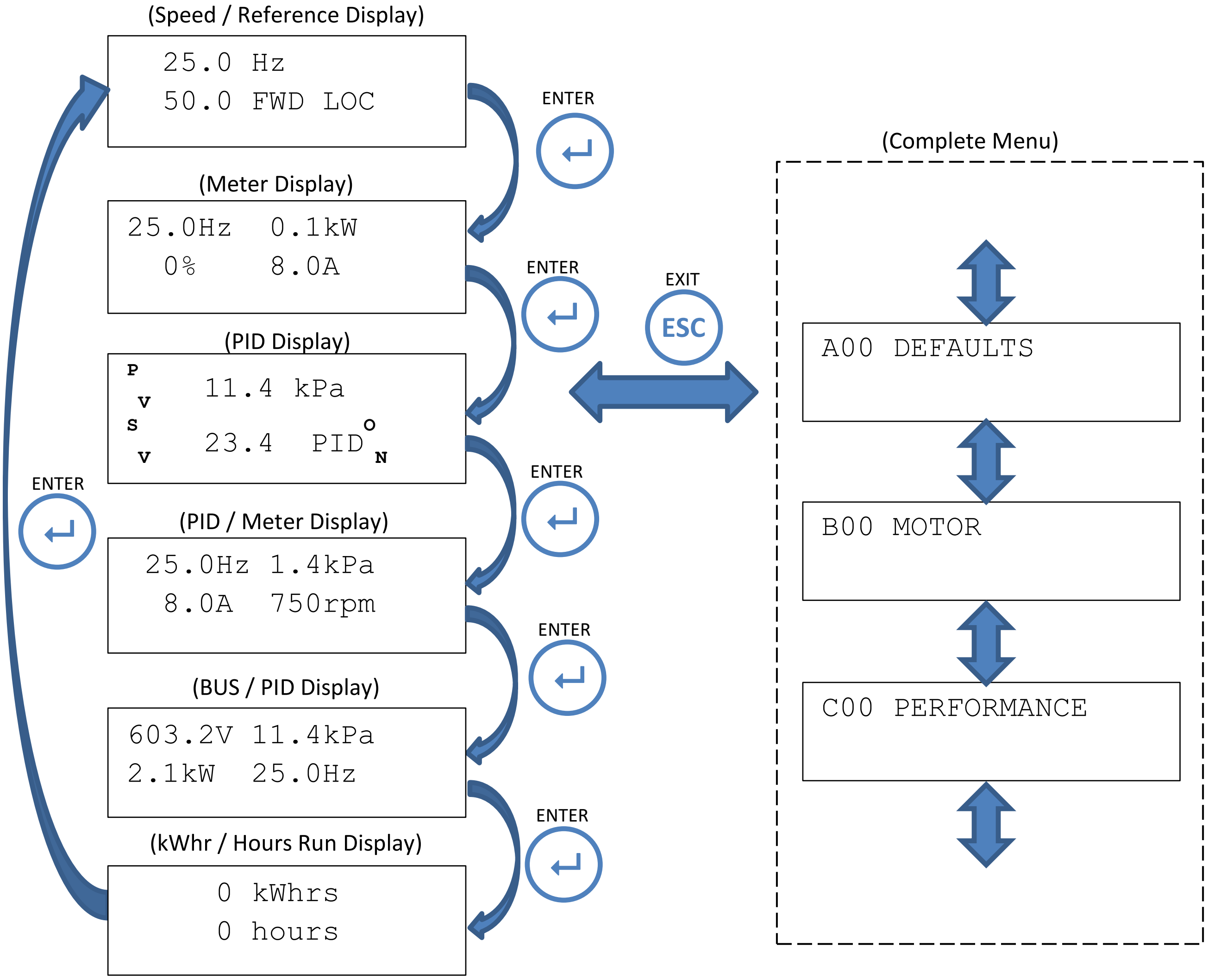
The Speed / Reference display above shows the desired output speed is 40 Hz and the motor is rotating at 25 Hz in the forward direction in local mode as indicated by the status “**FWD LOC**”. Some notes:

- The ZENER MSC-3V was started by pressing the ▲FWD button.
- The speed reference is increased by pressing the ▲ FWD button. The motor will accelerate to this speed.
- The speed reference is decreased by pressing the ▼ REV button. The motor will decelerate to this speed.
- The ZENER MSC-3V may be started in reverse by pressing ▼ REV button.
- Pressing STOP will stop the motor or reset any trip condition.
- Press ESC to access the configuration menus

IMPORTANT! If the motor shaft rotates in the wrong direction remove the input power, wait for the ZENER MSC-3V to discharge and swap any two motor phase wires. Re-apply input power and select a direction by pressing
▲ FWD or ▼ REV.

Complete Menu

The broad range of motor-drive solutions requires parametric configuration changes. To gain access to configuration parameters, press ESC to reveal either the "Complete Menu". With factory default parameters installed, pressing ESC will reveal the complete menu.



To move around the menu system, press:

- Press the ▲ FWD and ▼ REV buttons to display each menu item.
- Press the ↵ ENTER push button to enter a sub menu or change a parameter.
- Press ESC to abandon a parameter change or exit a sub menu.
- Press ESC several times in a row to return back to the operation displays.

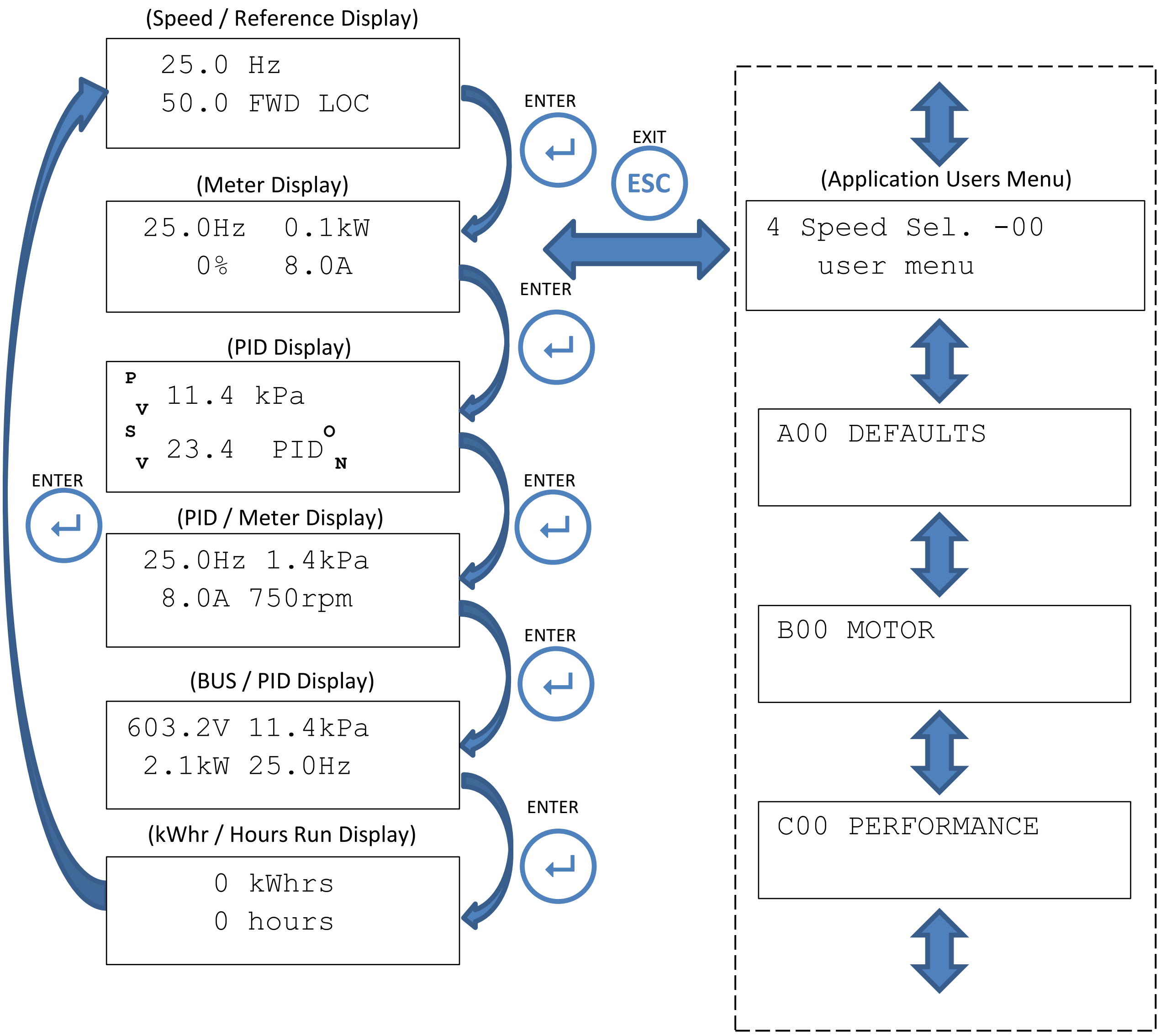
After applying power it is recommended that you at least go through the **B00 MOTOR**, **C00 PERFORMANCE** and **G00 INPUT/OUTPUT** menus to set up the ZENER MSC-3V before running the motor to prevent any unexpected motor operation. The ZENER MSC-3V is supplied with a link between the EN terminal and the +5V terminal. This link must always be made for the motor to run.

Application Menu

An “application” groups parameters together in one location creating a short menu to summarise all the relevant parameters necessary for your application.

The ZENER MSC-3V has several applications on offer ready for your selection and convenience. Some of the more common and simplest of applications will be described in the following sections. More sophisticated applications will have extra documentation detailing wiring and commissioning information.

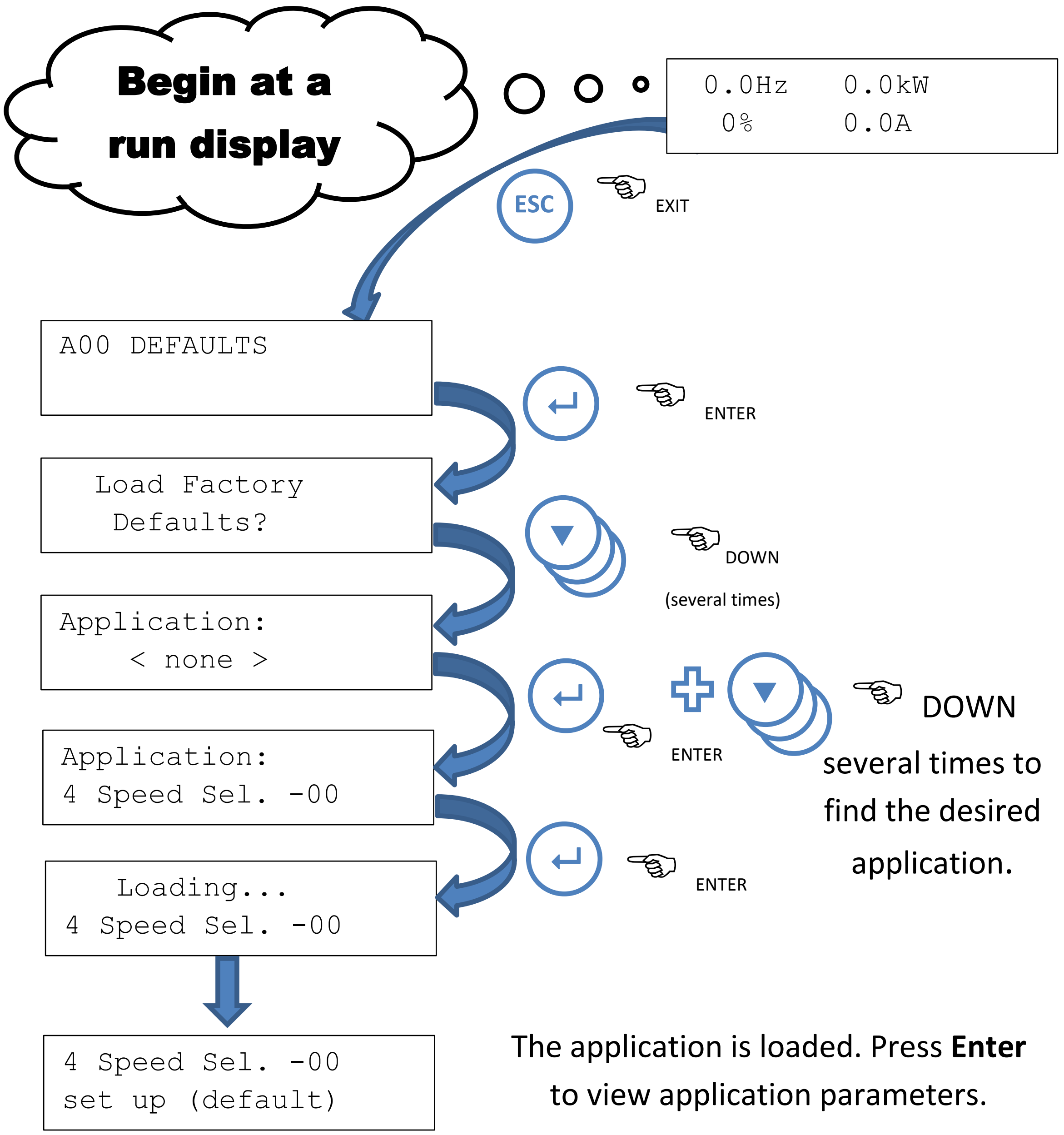
Once an application is installed, it becomes the first menu visible from the operational displays as shown below:



The diagram above is an example of the installed application: “4 Speed Sel. -00”. Pressing ESC once from an operational display reveals the “4 Speed Sel. -00” user menu which contains relevant parameters.

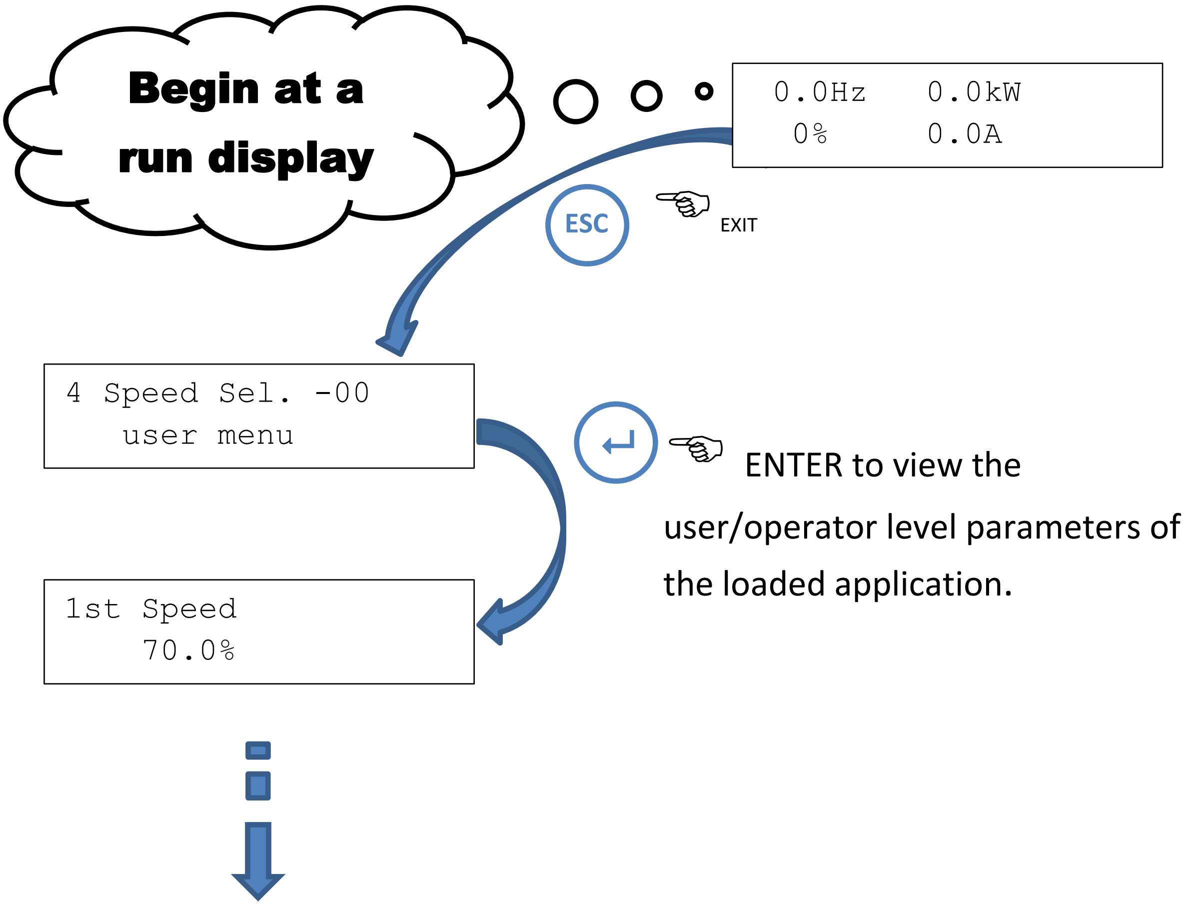
Loading an Application

Follow the diagram below to load an application. E.g. Loading the "4 Speed Sel. -00" application.



Application user menu

Once an application is loaded, parameters that a user/operator may change are available in the Application user menu. Continuing with the "`4 Speed Sel. -00`" application example, the diagram below shows how to access the Application user menu.



Changing an Application

There are 2 steps necessary to change an application:

1) Restore factory defaults:
    a. Go to the "Load Factory Defaults" menu, press **Enter**
    b. Follow the directions presented on the display.
2) Select a new application. See "Loading an Application" above.

Control connections and configuration

General

The purpose of selecting particular control connections and setting various configuration parameters is to select the required logical and speed control functions for the particular application. The configurable items can be grouped as follows:

Category	Description
Display	Customisation of the display in terms of what variable (speed, frequency, load, current, voltage etc) is displayed. Customisation of the output frequency display to show user defined units. Some housekeeping functions.
Motor	Information from the motor nameplate.
Performance	Maximum and minimum speeds, acceleration rates, motor flux adjustment etc.
Protection	Current limit settings, I2t (thermal overload) etc.
Stop / Start	Choices for stopping, automatic restart options etc.
References	Choice of speed signal source to be used in local and remote modes, jog speeds.
Input / Output	Assignment of particular control functions to terminals (inputs) and relays (status outputs). These can be selected individually.

The MSC-3 control terminals can be configured, on an individual terminal basis, to suit a wide variety of applications. This provides enormous flexibility.

Factory default settings

The factory default terminal configuration provides for single direction control from either the terminal strip or the front panel console, as selected by a local / remote input on the terminal strip. This is detailed as “Standard Industrial Terminals”, starting on page 37.

There is a menu function to restore the terminal configuration and all parameters to the factory default state should you wish to do so. See Load Factory Defaults.

Settings for your application

The function of each of the analogue inputs, digital inputs and status relays may be individually assigned from an extensive list. in addition, digital inputs may be assigned to be level or edge sensitive and there are additional internal functions including timers that are fully configurable. Many applications may be easily configured using one of the quick setup applications listed below.

Quick Setup

To assist with quick configuration of the most frequently encountered applications, there are a number of pre-defined applications. Terminal strip configuration and associated setup notes are provided.

Control Inputs

The ZENER MSC-3V is operated by a set of digital input functions designed to work with logical signals that originate external to the drive. The extensiveness of this set of functions is testament to variety of applications the ZENER MSC-3V can operate with. The list of functions includes:

- **I00 FWD&LATCH, I01 REV&LATCH, I02 ~STOP**
- **I03 FWD, I04 REV**
- **I05 UP, I06 DOWN**
- **I07 RESET**
- **I08 ESO**
- **I09 JOGFWD, I10 JOGREV**
- **I11 REMOTE**

Not all functions are necessary for a given application and unused functions may be turned "off". Functions that are necessary have assigned to them a physical input from the terminal strip. Review "Terminal Configurations" in the "Major Features" section of this document.

The menus within the "Digital Input Configurations" menu provide a way to map a finite set of physical digital inputs to the internal set of input functions. The simplest way to configure digital inputs is to utilise one of the pre-existing configurations from the **G01 DI config** menu. Otherwise a custom configuration can be organised where each function has a physical input terminal assigned to it. In most cases the inputs levels and edges are available for selection. For example digital input **D1** is found at terminal **2** and is identified as **D1(2)**. The choices are:

Selection	Input Truth
D1(2)	Active high level is selected
~D1(2)	Active low level is selected
/D1(2)	Active rising edge is selected
D1(2)	Active falling edge is selected

Selecting Standard Input Configuration

```
G01 DI config
>Standard Industrial
```

Available Choices: Standard Industrial
HVAC
Power up/start
Forward/Reverse
Machine drive 1
Machine drive 2
Machine drive 3
Custom

- Press ↵ once to begin configuration selection.
- Use the ▲/ ▼ buttons to view the choices.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

The **G01 DI config** menu permits the selection of all standard and custom configurations. The available choices are:

For each configuration the digital sources are:

	G01 DI config							
Function	Standard Industrial	HVAC	Power up/start	Forward/ Reverse	Machine drive 1	Machine drive 2	Machine drive 3	Custom
I00 FWD&LATCH	D3(4)	D2(3)	EN(6)	D2(3)	D2(3)	OFF	D2(3)	Not specific. Refer to each functional assignment
I01 REV& LATCH	OFF	OFF	OFF	D3(4)	OFF	OFF	OFF	
I02 ~STOP	D2(3)	D1(2)	EN(6)	D1(2)	D1(2)	OFF	D1(2)	
I03 FWD	OFF	OFF	OFF	OFF	OFF	D1(2)	OFF	
I04 REV	OFF	OFF	OFF	OFF	OFF	D2(3)	OFF	
IO5 UP	OFF	OFF	OFF	OFF	OFF	OFF	D3(4)	
I06 DOWN	OFF	OFF	OFF	OFF	OFF	OFF	D4(5)	
I07 RESET	D1(2)	OFF	EN(6)	OFF	OFF	OFF	OFF	
I08 ESO	OFF	D3(4)	OFF	OFF	OFF	OFF	OFF	
I09 JOGFWD	OFF	OFF	OFF	OFF	D3(4)	D3(4)	OFF	
I10 JOGREV	OFF	OFF	OFF	OFF	OFF	D4(5)	OFF	
I11 REMOTE	D4(5)	D4(5)	EN(6)	D4(5)	D4(5)	EN(6)	EN(6)	

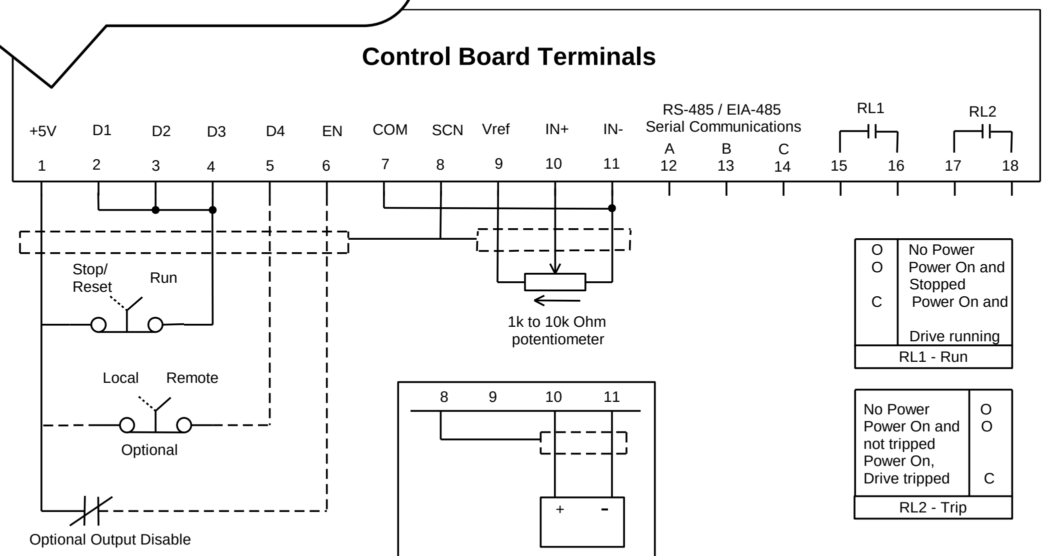
Standard Industrial Terminals

Typical Connections

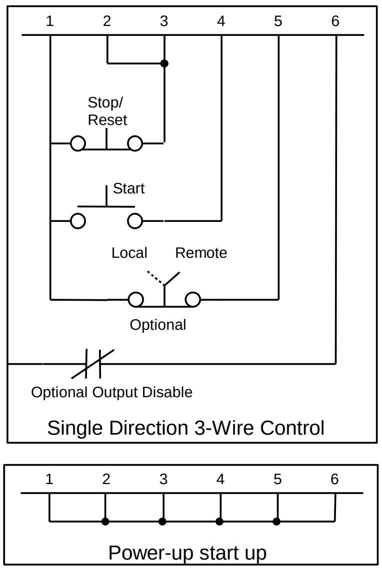
This section shows the typical configurations applicable to a wide range of industrial applications. The motor speed may be controlled from the local console on the MSC-3 or a remote signal source. Switching between local and remote operation is controlled by a contact closure. This terminal configuration is the factory default. Several alternative arrangements for starting and stopping are shown.

i The functions of terminals D1…4 are programmable. In the default configuration, the following functions are assigned to the terminals:

I07	RESET	D1
I02	~STOP	D2
I00	FWD & LATCH	D3
I11	REMOTE	D4



Single Direction 2-Wire Control



Optional Wiring

If selection between local and remote is not required, place a link between terminals 1 and 5. If the output disable is not required place link between terminals 1 and 6

Local / Remote

In "local" the MSC-3 is controlled from the front panel console. In "remote" the MSC-3 is controlled from the terminal strip

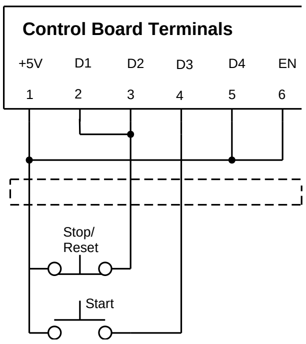
Setup Guide

Features Single direction operation, Select between local (console) and Remote (wiring to terminal strip) control

Procedure

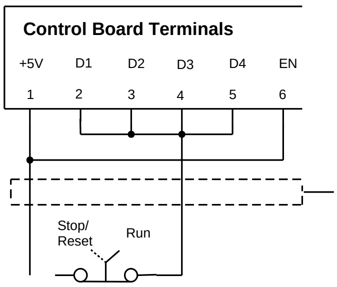
STEP 1. Complete the power wiring according to the instructions on pages 9 to 18

STEP 2. Choose your own control method from one of the following. Connect your control wiring as shown.



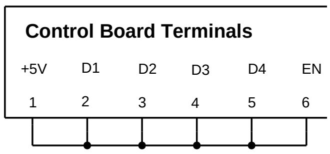
Push button control

(3 – wire control)



Switch or contact control

(2 – wire control)



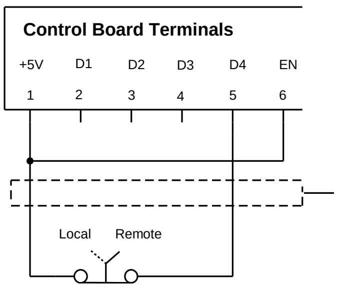
Power up start

Drive will start as soon as power is applied

Local / Remote Selection

The Local/Remote Selection can be used in conjunction with any of the above circuits. Wire terminals 5 and 6 as shown. The Local/Remote selection can be overridden from the control console. See Remote Override Operation on page 102.

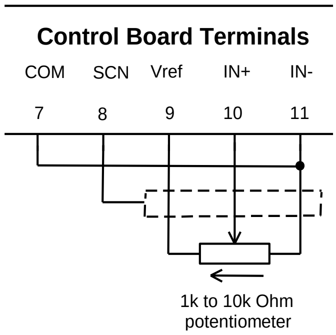
In "local" the MSC-3 is stopped and started from the front panel console. In "remote", the MSC-3 stop / start is controlled from the terminal strip. The source of the speed reference in both modes may be independently configured to come from a wide variety of sources including the terminal strip, console up/down buttons, preset values and the output of optional features such as the PID controller and networked communications.



STEP 3. Choose your speed reference and connect it as shown.

Speed control from an external potentiometer

This is typically used for simple manual speed control. See also Console Reference below.



Speed control from an external signal

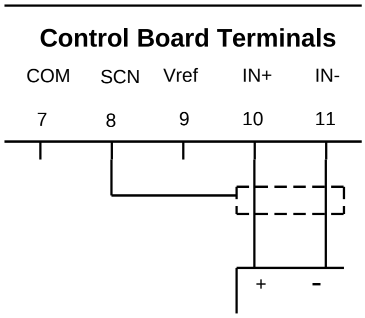
Go to the F00 REFERENCES menu and select

F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when AI(10,11) is displayed. Press ESC

Go to the G00 INPUT/OUTPUT menu and select

G02 AI(10,11). Set G028 for the type of input signal (0-10V, 0-5V, 4-20mA or Custom).

See the Reference Manual for more information.



Preset speed

This provides a single fixed speed.

Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when F100 PRESET 1 is displayed. Press Enter again. Now set your desired preset speed. Press Enter. No speed reference wiring is necessary.

Console reference

This uses the Up and Down arrows on the front panel to control the speed.

Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary

STEP 4. Follow the instructions on page 47 for MSC-3 start up, setting the parameters according to the table below. Alternative values may be used to suit the application.

Menu	Menu Item	Suggested Setting
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I00 FWD & LATCH = D3(4) (default)
		I02 ~STOP = D2(3) (default)
		I07 RESET = D1(2) (default)
		I11 REMOTE = D4(5) (default)
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)
	G04 Rl2	G040 RL2 Signal = TRIP (default)
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage
	B02 MOTOR AMPS	Motor nameplate amps
	B03 MOTOR HZ	Motor nameplate frequency
	B04 MOTOR RPM	Motor nameplate RPM
D00 PROTECTION	D01 CURRENT LIM M	Motor nameplate current +10%
	D02 I2t Thermal overload	Motor nameplate current
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5
	E04 Reset by PF	ENABLED
F00 REFERENCES	F01 REMOTE REF	AI(10,11) or PRESET or CONSOLE as selected in Step 3
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec
		C031 DECEL TIME = 10 sec

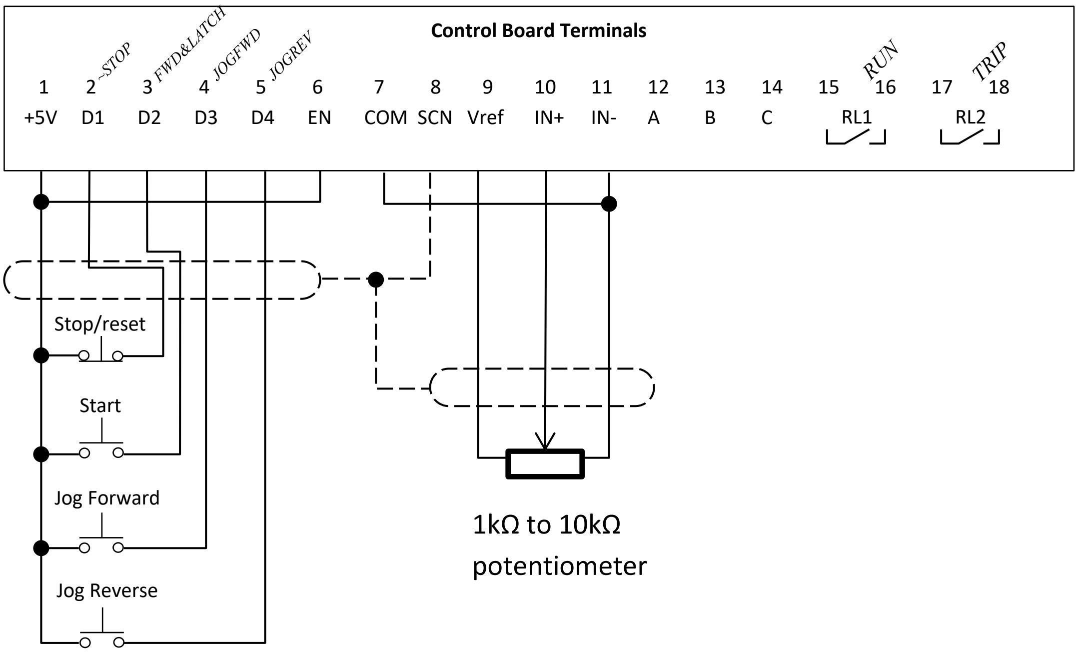
End of procedure

APPLICATION: Machine Drive, Start/Stop, Jog Forward & Reverse

This application is for a typical industrial process that requires start/stop with the ability to jog the machinery in both directions. A roll forming machine may be controlled this way. Features include but not limited to:

- Individual jog forward and jog reverse speed references.
- Remote potentiometer normal operating speed reference.
- Relays configured for RUN and TRIP operation.
- The full range of ZENER MSC-3V features and functions remain available.

Expected Wiring



One Time Installation/Application choice

Load the "**Machine/JOG -00**" application (Refer to "**Loading an Application**", page 32).

Application Parameters

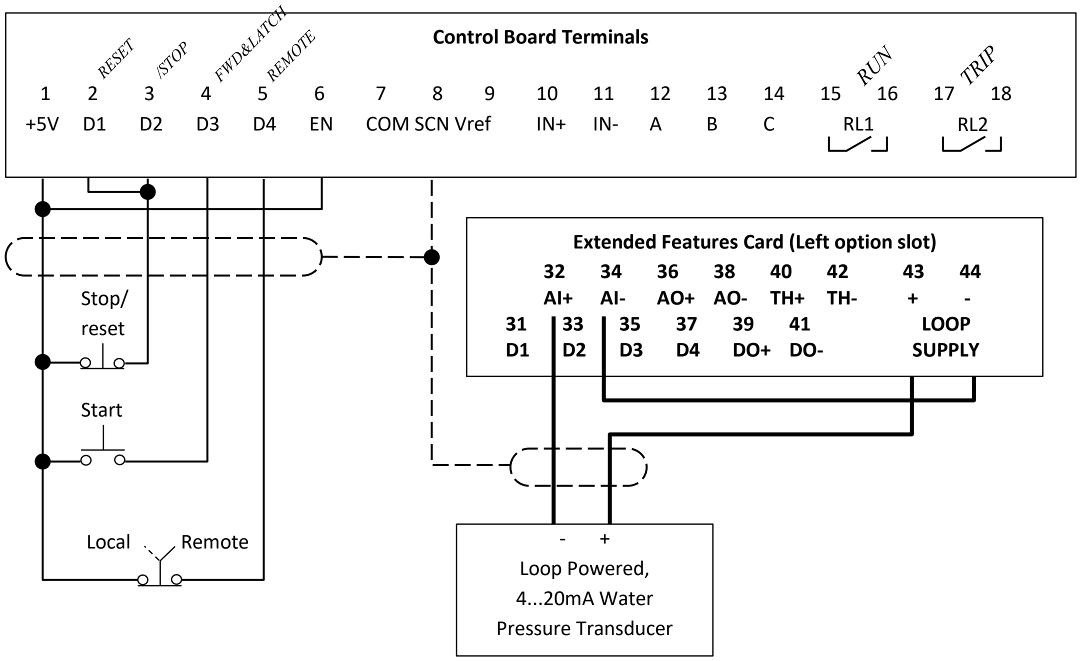
Jog fwd speed 5.0 Hz	This screen displays the preset jog forward speed required for the machine.
Jog rev speed 5.0 Hz	This screen displays the preset jog reverse speed required for the machine.
Rated Motor Amps 40.0 A	This screen displays the value of the motor's name plate current. Note the default value is model size dependent.
Overload Amps 40.0 A	This screen displays the value of the overload current setting for the motor. Note the default value is model size dependent.

APPLICATION: Water Pumping With Automatic Pressure Control

Intended use is for a centrifugal pump with 4 to 20mA outlet pressure transducer feedback. Pressure control by internal PID controller. Features include but not limited to:

- Water pressure control
- 4 to 20mA analogue input for pressure feedback with loop supply.
- Factory Default RUN/LOCAL-REMOTE logic
- Dual Ramp Logic
- The full range of ZENER MSC-3V features and functions remain available.

Expected Wiring



One Time Installation/Application choice

Load the “**`Pressure Ctl-00`**” application (Refer to “**Loading an Application**”, page 32).

Operation

To operate the pump manually:

- Set the Local/Remote switch to **Local**
- Press the **UP** push button to start pumping. The motor is accelerated to the minimum speed.
- Press and hold the **UP** push button on the console to increase the speed beyond the minimum speed. Release the **UP** push button at the desired output frequency.
- Press and hold the **DOWN** push button on the console to decrease the output speed. Release the **DOWN** push button at the desired output frequency.
- Press the **STOP** push button on the console to stop pumping.

To operate the pump with pressure control:

- Set the Local/Remote switch to **Remote**
- Press the **START** push button to start auto pressure control. The motor will run to the minimum speed.
- The motor speed is adjusted continually to find the speed necessary to yield the required pressure given the current water load conditions.
- Press the **STOP/RESET** push button to stop pressure control pumping.

To change the required pressure:

- Press the **ESC** push button on the console to reveal the application menu.

```
Pressure Ctl-00
   user menu
```

- Press **ENTER** to view the first application parameter.

```
Reqd Pressure
   500.0 kPa
```

- Press **UP** or **DOWN** to view other parameters.
- Press **ENTER** again to edit the displayed parameter.
    - Press **UP** or **DOWN** to adjust the value, **ENTER** to accept the value or **ESC** to abandon changes

Application Parameters

Screen	Description
Reqd Pressure 500.0 kPa	This screen displays the preset pressure reference required for the pump.
Min frequency 30 Hz	This screen displays the minimum output frequency setting of operation.
Pressure Units kPa	This screen allows for the selection of pressure units for display.
Pressure scale 1000.0 kPa	This screen allows for the full scale of pressure to be entered. The full scale is used for live displays
Rated Motor Amps 40.0 A	This screen displays the value of the motor's name plate current. Note the default value is model size dependent
Overload Amps 40.0 A	This screen displays the value of the overload current setting for the motor. Note the default value is model size dependent.

Pressure Control Performance

Observation	Corrective Actions
In closed loop the pressure does not match the desired operating pressure	• Verify the analogue input reading matches the transducer output signal. • A steady state error may be present. Go to **H00 PID Control → PID-A,** decrease **H02 Integ. time**. A smaller value will reduce steady state error but may increase overshoots.
In closed loop operation the pressure is not stable	Go to **H00 PID Control → PID-A**, increase the **H01 PROP. BAND** or decrease **H03 Diff time**.
The pressure responds too slowly	Go to **H00 PID Control → PID-A**, decrease the **H01 PROP. BAND** or decrease the **H02 Integ. time**.
The pressure overshoots or oscillates momentarily	• Go to **H00 PID Control → PID-A**, increase the **H01 PROP. BAND** or decrease the **H03 Diff time**. • Ensure the **C030 ACCEL TIME** and **C031 DECEL TIME** is similar to the **H02 Integ. time**.

Additional detailed information

This manual provides basic control configuration information for the ZENER MSC-3V to suit more common applications. Please refer to the *ZENER 8000 Reference Manual IM00140* for a detailed explanation of each control feature, including communications protocols

Communications Protocols

Please refer to the *ZENER 8000 Reference Manual IM00140* for details of the communications protocols supported.

Transport considerations

The overall enclosure structure containing the MSC-3V inverter modules and associated line reactors needs to withstand the stresses of transportation without damage.

Design of mounting arrangements should include consideration of mechanical shock loading that may occur during handling and transport of the completed switchboard assembly.

Maintenance considerations

Inverter modules incorporate heatsink cooling fans that are replaceable as modular assembly accessible from the clean (switchboard interior) side of the equipment. Please ensure that other equipment located in the switchboard does not obstruct access to the fan modules.

The inverter modules are not field-repairable and require removal and transport to Zener in Sydney for repair or refurbishment.

Access and lifting arrangements to enable inverter modules and line reactors to be removed / replaced safely and taking account of the end use environment should be considered as part of the switchboard enclosure design.

Spare parts

Spare parts holding should be appropriate to the skill levels of the maintenance personnel available to the end user. Contact ZENER for recommendations.

Packing for transport

Drive components for shipment to Zener need to be suitably packed for the chosen mode of transport to avoid damage. Shipping equipment on open pallets or otherwise without appropriate physical protection generally results in significant transport damage and we strongly recommend against this arrangement.

Display Messages

The ZENER MSC-3V displays a variety of messages to indicate its status. These message displays may be divided into two types: Fault messages and Status messages

Fault Messages

The ZENER MSC-3V will protect itself against a variety of fault conditions. When one or more of these conditions occur, the ZENER MSC-3V will trip, shut down the motor and display one or more fault messages on the top line of the console display. The messages will be displayed until the fault is cleared and a reset signal is asserted. Fault messages include:

Fault Message	Description
UA1: ALARM	User defined trip alarm. Refer to **G233 Alarm text** for message customisation.
UA2: ALARM	User defined trip alarm. Refer to **G243 Alarm text** for message customisation.
UA3: ALARM	User defined trip alarm. Refer to **G253 Alarm text** for message customisation.
UA4: ALARM	User defined trip alarm. Refer to **G263 Alarm text** for message customisation.
THERMISTOR HOT	The thermistor wired to the Extended features card indicates the motor is over heated
THERMISTOR SHORT	The thermistor wired to the Extended features card is short circuit
SUPPLY FAIL	There is a problem with the input power supply. One phase is partially missing and motor operation will be impaired
BRAKE SHORT	Either an Over Current or a Ground Fault has been detected on the dynamic brake resistor terminals
EARTH FAULT	An earth leakage fault has been detected
I2t OVERLOAD	An I2t overload trip has occurred
CHARGE FAULT	A rectifier failure has been detected
DC BUS LOW	The DC bus voltage has fallen below its minimum threshold
POWER FAILURE	All phases on the input power supply are either low or missing
OVER CURRENT	The output current has exceeded the ZENER MSC-3V's intermittent output current rating
IMBALANCE OC	One inverter module is conducting too much current. (Parallel systems only)
RELAY OPEN	The internal bus charge relay has failed to operate correctly
OVER VOLTAGE	The DC bus voltage has exceeded its maximum value
OUTPUT SHORT	An output short circuit has been detected. This is caused by either an Over Current or Ground fault on the motor terminals
Tj OVER TEMP	The ZENER MSC-3V has determined a power device Junction is too hot
HOT INTERNAL AIR	The internal air temperature has risen beyond the protection rating of the ZENER MSC-3V
Ths OVER TEMP	The internal heat sink temperature has risen beyond the protection rating of the ZENER MSC-3V
Tefct OVER TEMP	The earth fault current transformer temperature has risen beyond the protection rating of the ZENER MSC-3V
T1 OVER TEMP	The temperature of sensor T1 has risen beyond the protection rating of the ZENER MSC-3V

Fault Message	Description
T2 OVER TEMP	The temperature of sensor T2 has risen beyond the protection rating of the ZENER MSC-3V
T3 OVER TEMP	The temperature of sensor T3 has risen beyond the protection rating of the ZENER MSC-3V
T4 OVER TEMP	The temperature of sensor T4 has risen beyond the protection rating of the ZENER MSC-3V
T5 OVER TEMP	The temperature of sensor T5 has risen beyond the protection rating of the ZENER MSC-3V
T6 OVER TEMP	The temperature of sensor T6 has risen beyond the protection rating of the ZENER MSC-3V
T7 OVER TEMP	The temperature of sensor T7 has risen beyond the protection rating of the ZENER MSC-3V
T8 OVER TEMP	The temperature of sensor T8 has risen beyond the protection rating of the ZENER MSC-3V
MODULE 1	Parallel inverter trip detected in inverter module No. 1 (paralleled inverter systems only).
MODULE 2	Parallel inverter trip detected in inverter module No. 2 (paralleled inverter systems only).
MODULE 3	Parallel inverter trip detected in inverter module No. 3(paralleled inverter systems only).
MODULE 4	Parallel inverter trip detected in inverter module No. 4 (paralleled inverter systems only).

Status Messages

The prevailing operating conditions are indicated with a status message on the bottom right of the console display. The status messages include:

Status Message	Description
U MODE 1	Remote user mode 1 message. Refer to **F0122 MODE1 text** for message customisation.
U MODE 2	Remote user mode 2 message. Refer to **F0132 MODE2 text** for message customisation.
-<UW1>-	User defined warning message. Refer to **G272 Warning txt** for message customisation.
-<UW2>-	User defined warning message. Refer to **G282 Warning txt** for message customisation.
-<UW3>-	User defined warning message. Refer to **G292 Warning txt** for message customisation.
-<UW4>-	User defined warning message. Refer to **G302 Warning txt** for message customisation.
V LIMIT	The motor is regenerating or the input voltage is too high
C LIMIT	The motor is drawing its maximum overload current
P LIMIT	The motor's absorbed power exceeds the ZENER MSC-3V rating when operating from a single phase supply
ESO FWD	The ZENER MSC-3V is operating in Essential Services Override mode with forward rotation
ESO REV	The ZENER MSC-3V is operating in Essential Services Override mode with reverse rotation
OFF LINE	The ZENER MSC-3V has not been given a terminal strip run command in line contactor mode
NO AC	The ZENER MSC-3V has been given a terminal strip run command in line contactor mode but has detected no AC input voltage supply
CHARGING	The ZENER MSC-3V is waiting for the DC bus capacitors to be fully charged before running the motor
NOT EN	The ZENER MSC-3V is on but has no enable signal so it is unable to turn a motor
IDLE REM	The ZENER MSC-3V is idle in remote mode

Status Message	Description
FWD REM	The ZENER MSC-3V is running in the forward direction in remote mode
REV REM	The ZENER MSC-3V is running in the reverse direction in remote mode
EN REM	The ZENER MSC-3V has an enable signal but no direction is selected in remote mode
IDLE LOC	The ZENER MSC-3V is idle in local mode
FWD LOC	The ZENER MSC-3V is running in the forward direction in local mode
REV LOC	The ZENER MSC-3V is running in the reverse direction in local mode
EN LOC	The ZENER MSC-3V has an enable signal but no direction is selected in local mode
PID OFF	The PID block is ready to operate but no run command is given
FILLING	The pipe fill function is activated and pipe filling is underway
PID-A $^{O}{}_{N}$	The PID-A block is operating and the ZENER MSC-3V is part of a closed loop feedback system
PID-B $^{O}{}_{N}$	The PID-B block is operating and the ZENER MSC-3V is part of a closed loop feedback system
BOOSTING	The ZENER MSC-3V is applying a boost to the process variable before the ZENER MSC-3V enters the idle mode
PV-A OOR	An external condition exists that prevents PID-A controller from regulating properly
PV-B OOR	An external condition exists that prevents PID-B controller from regulating properly
PBNS	“Power Board Not Supported” – the detected model details cannot be found
MODEL?	The installed model details do not match the detected model.

Specifications

Input Supply	
Voltage	950 to 1100Vac, 3Ø -15% to +10%
Frequency	48 to 62 Hz
Output	
Voltage	0 to 1100Vac, 3Ø The output voltage cannot be higher than the input voltage.
Frequency Range	0 to 100Hz
Resolution:	0.1%
Linearity:	0.2% of maximum frequency
Environmental	
Enclosure Rating	IP66 Heatsink area IP00 Front section inside user's cabinet
Storage Temperature	-20 to +70ºC
Operating Temperature	0 to 50ºC
Relative Humidity	5 to 95%, Non Condensing
Altitude	0 to 1000m
Standards Compliance	
Models marked with this symbol comply with the Australian EMC Framework requirements	
The I2t function complies with IEC 60947-4-1 Ed. 2.0B (2000) and AS/NZS 3947.4.1:2001: Low voltage switchgear and control gear - Contactors and motor starters - Electromechanical contactors and motor starters thermal overload specification class 10A.	
Local Controls	
Console buttons	Up, Down, Enter, Escape, Stop/Reset
Terminal Strip Functions	
Digital Inputs	+5V and COM 5Vdc Supply 40mA max current D1 to D4 and EN Digital Inputs Logic High 3 to 5Vdc Logic Low 0 to 2Vdc
Analog Input	Vref and COM +5Vdc Supply 5mA max current IN+ and IN Differential Input 0 to 5V range 0 to 10V range 0 to 20mA range 4 to 20mA range Common mode range ± 25 Vdc to COM
Relay Outputs	2 Form A Outputs (single pole normally open contacts) Contact Rating (Resistive load) 5A@250Vac 5A@30Vdc Contact Rating (Inductive load) 2A@250Vac 2A@30Vdc
User Parameters	
Motor Voltage	900 to 1100V The output voltage cannot exceed the input voltage
Motor Current	25 to 180% of continuous general purpose rating
Motor Frequency	30 to 200Hz
Motor Speed	500 to 60 x Motor Frequency in rpm
Minimum Frequency	0 to 195Hz
Maximum Frequency	5 to 200Hz
Acceleration time	0.5 to 600s

Deceleration time	0.5 to 600s
S time	0.01 to 40s
Flux Plus	0 to 200%
Slip Comp	0 to 150% of slip speed
Audible Frequency[4]	2 to 16kHz
Current Limit	18 to 100% of overload current rating
I2t	18 to 100% of max cont current
I2t Zero Hz	18 to 100% of max cont current
I2t cnr Hz	2 to 200Hz
Drive Stopping	Ramp to stop Coast to stop
Auto Restart	
Number of restarts	0 to 20
Reset time	0.1 to 20 minutes
References	Analog Input Console Reference Preset Motorised Potentiometer
The following functions can be enabled or disabled	Menu Protect Reverse Direction High Speed Flux Plus Reset by Power Failure Remote override

[4] This is the frequency apparent in motor acoustic noise. The audible frequency is automatically reduced according to heat sink temperature and load current.

Output Current Specifications

Model	Continuous Current (A)	Overload Current[5]
MSC-3V030	30	45
MSC-3V044	44	66
MSC-3V058	58	87
MSC-3V066	66	99
MSC-3V084	84	126
MSC-3V100	100	150
MSC-3V132	132	198
MSC-3V168	168	252
MSC-3V200	200	300
MSC-3V300	300	450
MSC-3V400	400	600

Troubleshooting guide

Symptom	Cause	Remedy
Front Display does not illuminate.	Input power wiring not connected properly. Input voltage not within specification.	Check input power wiring, refer to the MSC-3 Electrical Installation Diagram. Measure the input voltage at the MSC-3 input terminals. Check with specifications.
Motor does not rotate when UP button on the Console is pressed.	Enable signal is not active.	Check that the EN terminal is connected to +5V. Check that the ENABLED message is displayed.
	MSC-3 is in REMOTE	Check that if you have a remote terminal it is not at +5V with respect to COM.
	Speed is set to minimum	Increase speed by holding down the UP button.
Motor does not rotate when remote START signal is activated.	Incorrect control signal wiring.	Check control wiring to terminals and the terminal functions assigned. Refer to Control Wiring Diagrams and Terminal Configurations.
	Enable signal is not active.	Check that the EN terminal is connected to +5V. Check that the ENABLED message is displayed.
	MSC-3 is in LOCAL	Check that your remote terminal is at +5V with respect to DIG COM
	A direction has not been selected.	Check that either a FWD or a REV terminal has been assigned and that it is at +5V with respect to DIG

[5] 60 second rating

Symptom	Cause	Remedy
		COM. If the reverse direction is selected ensure that reverse is enabled from the Protection menu.
	Speed signal is not correctly connected.	Check the REMOTE speed source in the References menu. Ensure that this source is not at zero.
Motor does not accelerate in the time set by the ACCEL ramp and C LIMIT message appears .	Current limit circuit is operating.	This is a normal operating mode for the MSC-3V. When the load is being accelerated too fast, the MSC-3V limits current drawn by the motor by extending the acceleration ramp time. A faster Accel time is not possible with this Current Limit setting. Increase the ACCEL time until the C LIMIT message disappears
	CURRENT LIM set too low.	Increase CURRENT LIM value so that the MSC-3 is not prematurely limiting current. Check that the motor does not overheat with the new setting.
C LIMIT message appears continuously	Motor mechanically overloaded.	Check the actual load is within the motor's capacity at the required speed.
	Motor shaft jammed.	Check the mechanical drive system.
	Fault in motor or motor wiring.	Check that motor is wired correctly
	Incorrect motor voltage selected.	Enter correct MOTOR VOLTAGE from the MOTOR menu
	Incorrect motor frequency selected.	Enter correct MOTOR FREQUENCY from the MOTOR menu.
	FLUX PLUS is set too high.	Reduce the FLUX PLUS setting.
Motor does not decelerate in the time set by the DECEL ramp and V LIMIT message appears.	Voltage limit circuit is operating.	This is a normal operating mode for the MSC-3. When the load is being decelerated too fast, the MSC-3 limits the voltage regenerated by the motor by extending the deceleration ramp time. Increase the DECEL time to make this message disappear.
V LIMIT message appears continuously.	Input voltage has exceeded maximum rating.	See MSC-3V General Specifications for input voltage ratings.
OUTPUT SHORT message appears	Short circuit on motor terminals.	Check wiring to motor terminals.
	Earth Fault on motor terminals	Check wiring to motor terminals.
OVER CURRENT message appears	Motor current was greater than the MSC-3's maximum current.	Check drive and motor current ratings.

Symptom	Cause	Remedy
OVER VOLTAGE message appears.	Input voltage has exceeded maximum ratings.	See general specification and check the input is within ratings. Check input supply for voltage transients. Fix the external source.
	Motor is overhauling.	Ensure load cannot overdrive the motor.
Any of these messages appear: Tj OVERTEMP HOT INTERNAL AIR Ths OVERTEMP T* OVERTEMP (* is any digit 1..8)	Ventilation problem.	Ensure operating ambient temperature is within specification. Check fans are rotating freely and there is no build-up of dust or debris in blades. Visually examine the heatsink fins for build-up of dust and debris.
	Drive is constantly overloaded.	Check the MSC-3 continuous current and ambient temperature rating.
Motor is unstable.	SLIP COMP is set too high.	Check that MOTOR NAMEPLATE RPM setting is equal to the motor rated speed. Check that NAMEPLATE CURRENT setting is equal to the motor nameplate current. Reduce SLIP COMP setting.
	FLUX PLUS set too high.	Reduce FLUX PLUS setting.
	Incorrect motor voltage selected.	Enter correct MOTOR VOLTAGE from the MOTOR menu.
	Incorrect motor frequency selected.	Enter correct MOTOR FREQUENCY from the MOTOR menu.
	CURRENT LIMIT is set too low.	Increase CURRENT LIMIT setting.
Excessive Motor Heating.	Motor is running at low speeds for long times.	Do not run the motor heavily loaded at low speeds for long periods unless the motor has been suitably de-rated or is force cooled.
	Motor damaged or incorrectly wired.	Check the motor and motor wiring for faults.
	Incorrect motor voltage selected.	Enter correct MOTOR VOLTAGE from the MOTOR menu.
	Incorrect motor frequency selected.	Enter correct MOTOR FREQUENCY from the MOTOR menu.

Your MSC-3 Setup Notes

Copy this page or complete in pencil

Date: ……………………………………

Site designator: ……………………………………………..

Serial No: ……………….……………

Parameter	User	Default
A06 Application:		<none>
B01 MOTOR VOLTS		*
B02 MOTOR AMPS		*
B03 MOTOR Hz		*
B04 MOTOR RPM		*
C01 MIN Hz		0
C02 MAX Hz		*
C030 ACCEL TIME		10.0 secs
C031 DECEL TIME		10.0 secs
C032 S TIME		0.01secs
C033 DUAL RAMP		DISABLED
C040 FLUX PLUS		0.00%
C041 HiSpd Flux+		DISABLED
C05 SLIP COMP %		0.00%
C06 AUDIBLE FREQ		AUTO
D01 CURRENT LIM		*
D020 I2t		*
D021 I2t zero Hz		*
D022 I2t CNR Hz		10.0 Hz
D03 REVERSE		DISABLED
D04 DC INPUT		DISABLED
D05 1 Phase Inpt		DISABLED
D060 SKIP SPEED		30 Hz
D061 SKIP RANGE		0 Hz
E01 COAST STOP		DISABLED
E02 DYNAMIC BRK		DISABLED
E030 ARs ALLOWED		0
E031 AR CLR TIME		1200 secs
E04 Reset by PF		DISABLED
E05 Motor Resync		DISABLED
E06 LC CONTROL		DISABLED
E0701 SOLAR FXN		DISABLED
E070 RUN MODE		OFF
E071 Restart DC		550V
E072 Restart DLY		60 secs
E073 Lo Radiance		530V
E074 Hi Radiance		CONSOLE
E075 Vmp Volts		550V
E076 Display var		PV-A
E077 Lo Solar t		0 secs

Parameter	User	Default
E078 SFC time		1 sec
E079 SFC Ext sel		OFF
F010 REMOTE REF		AI(10,11)
F011 REMOTE Inpt[6]	(see I11)	D4(5)
F0120 MODE1 REF		AI(10,11)
F0121 MODE1 Inpt		OFF
F0122 MODE1 text		"U MODE 1"
F0123 MODE1 cfg		Reference only
F0130 MODE2 REF		AI(10,11)
F0131 MODE2 Inpt		OFF
F0132 MODE2 text		"U MODE 2"
F0133 MODE2 cfg		Reference only
F02 LOCAL		CONSOLE
F030 ESO REF		F105 Preset 6
F031 ESO Input[6]	(see I08)	OFF
F032 ESO RAMP		10.0 secs
F040 JOGFWD REF		F105 Preset 6
F041 JOGFWD Inpt[6]	(see I09)	OFF
F050 JOGREV REF		F105 Preset 6
F051 JOGREV Inpt[6]	(see I10)	OFF
F060 Sel Method		Multiplexed
F061 USER REF 1		AI(10,11)
F062 USER REF 2		CONSOLE
F0630 Selector 1		OFF
F0631 Selector 2		OFF
F0632 Selector 3		OFF
F0633 Selector 4		OFF
F0634 Selector 5		OFF
F0635 Selector 6		OFF
F0636 Selector 7		OFF
F0637 Selector 8		OFF
F070 AI Function		Average fxn
F071 AI in 0 sel		ZERO_REF
F072 AI in 1 sel		ZERO_REF
F073 AI in 2 sel		ZERO_REF
F080 PERSISTENT		DISABLED
F081 STOP RESET		DISABLED
F09 COMMS PRESET		60.00%
F1001 PRESET1 units		%

[6] Alias name for the parameter

Parameter	User	Default
F100 PRESET1		10.00%
F1001 PRESET2 units		%
F101 PRESET2		20.00%
F1011 PRESET3 units		%
F102 PRESET3		30.00%
F1021 PRESET4 units		%
F103 PRESET4		40.00%
F1031 PRESET5 units		%
F104 PRESET5		50.00%
F1041 PRESET6 units		%
F105 PRESET6		60.00%
F1051 PRESET7 units		%
F106 PRESET7		70.00%
F1061 PRESET8 units		%
F107 PRESET8		80.00%
G01 DI config		Standard Indust
G020 Input Type		Volts
G021 MIN Input		0.0 V
G022 MAX Input		10.0 V
G023 Ref @MIN in		0.00%
G024 Ref @MAX in		100.00%
G025 Hi Compare Level		8 V
G026 Lo Compare Level		2 V
G027 Hysteresis		2.00%
G028 AI config		0 to 10V
G030 RL1 Signal		RUN
G031 RL1 Sense		DIRECT
G032 RL1 TON		0 secs
G033 RL1 TOFF		0 secs
G040 RL Function		TRIP
G041 RL Sense		DIRECT
G042 ON Delay		0 secs
G043 OFF Delay		0 secs
G050 UNDER SPEED		20.00%
G051 OVER SPEED		80.00%
G053 %LOAD UNDER		10%
G054 %LOAD OVER		100%
G070 T1 Interval		1 secs
G071 T1 mode		Delay ON
G0720 T1 Input 1		OFF
G0721 T1 Input 2		OFF
G0722 T1 Reset		OFF
G0723 T1 Logic		Standard
T1 IN1,2,3 m0:7 IN:		LLLLLLHL
T1 IN1,2,3 m0:7 Reset:		LHLHLHLH
G073 T2 Interval		1 secs
G074 T2 mode		Delay ON

Parameter	User	Default
G0750 T2 Input 1		OFF
G0751 T2 Input 2		OFF
G0752 T2 Reset		OFF
G0753 T1 Logic		Standard
T2 IN1,2,3 m0:7 IN:		LLLLLLHL
T2 IN1,2,3 m0:7 Reset:		LHLHLHLH
G080 DO Function		RUN
G081 DO Sense		DIRECT
G082 DO TON		0 secs
G083 DO TOFF		0 secs
G09 TH(37,38)		DISABLED
G100 Input Type		Volts
G101 MIN Input		0.0V
G102 MAX Input		10.0V
G103 Ref @MIN in		0.00%
G104 Ref @MAX in		100.00%
G105 Hi Compare Level		8V
G106 Lo Compare Level		2V
G107 Hysteresis		2.00%
G108 AI config		0 to 10V
G110 Output Type		Volts
G111 AO Source		FREQUENCY
G112 Signal min		0.0Hz
G113 Signal max		50.0Hz
G114 MIN Output		0.0V
G115 MAX Output		5.0V
G116 AO config		0 to 5V
G120 DO Function		RUN
G121 DO Sense		DIRECT
G122 DO TON		0sec
G123 DO TOFF		0sec
G13 TH(37,38)		DISABLED
G140 Input Type		Volts
G141 MIN Input		0.0V
G142 MAX Input		10.0V
G143 Ref @ MIN in		0.00%
G144 Ref @ MAX in		100.00%
G145 Hi Compare Level		8V
G146 Lo Compare Level		2V
G147 Hysteresis		2.00%
G148 AI config		0 to 10V
G150 Output Type		Volts
G151 AO Source		FREQUENCY
G152 Signal min		0.0Hz
G153 Signal max		50.0Hz
G154 MIN Output		0.0V
G155 MAX Output		5.0V

Parameter	User	Default
G156 AO config		0 to 5V
G160 Protocol		none
G161 bits/sec		19200
G162 Parity		Even parity
G163 MAC/Dev ID		1
G1630 IP address		192.168.0.180
G1631 IP mask		255.255.255.0
G164 Dev Inst.		1
G165 Max Masters		127 masters
G166 RUN SIGNALS		FROM TERMINALS
G167 Terminator		DISABLED
G168 Comms Lost Time		10sec
G169 Serial No.		G1000000
G170 RLY Signal		RUN
G171 RLY Sense		DIRECT
G172 RLY TON		0sec
G173 RLY TOFF		0sec
G180 RLY Signal		RUN
G181 RLY Sense		DIRECT
G182 RLY TON		0sec
G183 RLY TOFF		0sec
G190 RLY Signal		RUN
G191 RLY Sense		DIRECT
G192 RLY TON		0sec
G193 RLY TOFF		0sec
G200 RLY Signal		RUN
G201 RLY Sense		DIRECT
G202 RLY TON		0sec
G203 RLY TOFF		0sec
G21 TH(46,47)		DISABLED
G22 TH(66,67)		DISABLED
G230 Alarm mode		ALWAYS
G231 Alarm input		OFF
G232 Alarm delay		1 sec
G233 Alarm text		UA1: ALARM
G240 Alarm mode		ALWAYS
G241 Alarm input		OFF
G242 Alarm delay		1 sec
G243 Alarm text		UA2: ALARM
G250 Alarm mode		ALWAYS
G251 Alarm input		OFF
G252 Alarm delay		1 sec
G253 Alarm text		UA3: ALARM
G260 Alarm mode		ALWAYS
G261 Alarm input		OFF
G262 Alarm delay		1 sec
G263 Alarm text		UA4: ALARM

Parameter	User	Default
G270 Warn mode		ALWAYS
G271 Warn input		OFF
G272 Warn text		-<UW1>-
G280 Warn mode		ALWAYS
G281 Warn input		OFF
G282 Warn text		-<UW2>-
G290 Warn mode		ALWAYS
G291 Warn input		OFF
G292 Warn text		-<UW3>-
G300 Warn mode		ALWAYS
G301 Warn input		OFF
G302 Warn text		-<UW4>-
G400 CMP Signal		FREQUENCY
G401 CMP Scale		50 Hz
G402 CMP Ref		F100 Preset 1
G403 Threshold 1		20%
G404 Threshold 2		40%
G405 Threshold 3		60%
G406 Threshold 4		820%
G407 CMP mode		WINDOW
H01 Prop. Band		300.00%
H02 Integ. time		2.00 sec
H03 Diff time		0.00 sec
H04 +Opt clamp		100
H05 –Opt clamp		0
H06 SV choice		CONSOLE
H07 PV choice		AI(10,11)
H08 PID Units (selection)		%
H081 PID Units		%
H09 PID Scale		100.00%
H100 IDLE %LOAD		0%
H101 IDLE DELAY		0 secs
H102 RESUME		By speed ref
H103 RESUME Hz		0 Hz
H104 RESUME @PV		10% below SV
H105 IDLE boost		100% of SV
H106 Boost time		0 secs
H107 No Flow Sel		OFF
H110 PV LO value		20%
H111 PV HI value		80%
H120 Fill Mode		OFF
H121 Fill Time		0 secs
H122 Fill Threshold		0%
H123 Fill Ref		0 Hz
H131 OOR Thresh		10.0%
H132 OOR Time		5 secs
H21 Prop. Band		300.00%

Parameter	User	Default
H22 Integ. time		2.00 sec
H23 Diff time		0.00 sec
H24 +Opt clamp		100
H25 –Opt clamp		0
H26 SV choice		CONSOLE
H27 PV choice		AI(10,11)
H28 PID Units (selection)		%
H281 PID Units		%
H29 PID Scale		100.00%
H30 PV LO value		20%
H31 PV HI value		80%
H321 OOR Thresh		10.0%
H322 OOR Time		5 secs
I00 FWD & LATCH		D3(4)
I01 REV & LATCH		OFF
I02 ~STOP		D2(3)
I03 FWD		OFF
I04 REV		OFF
I05 UP		OFF
I06 DOWN		OFF
I07 RESET		D1(2)
I08 ESO		OFF
I09 JOGFWD		OFF
I10 JOGREV		OFF
I11 REMOTE		D4(5)
I200 LB1 Input 1		OFF
I201 LB1 Input 2		OFF
I202 LB1 Input 3		OFF
I203 LB1 m0:7		LLLLLLLL
I210 LB2 Input 1		OFF
I211 LB2 Input 2		OFF
I212 LB2 Input 3		OFF
I213 LB2 m0:7		LLLLLLLL
I220 LB3 Input 1		OFF
I221 LB3 Input 2		OFF
I222 LB3 Input 3		OFF
I223 LB3 m0:7		LLLLLLLL
I230 LB4 Input 1		OFF
I231 LB4 Input 2		OFF
I232 LB4 Input 3		OFF
I233 LB4 m0:7		LLLLLLLL
J01 Menu Lock		UNLOCKED
J02 Def. Display		SPEED-REF DISP
J030 Run Display Format		999.9
J031 Run Display Scale		50
J032 Run Display Units		Hz
J04 REMOTE OVRD		DISABLED

Parameter	User	Default
J05 LOCAL RUN EN		ON
S04 FAN OVERRIDE		DISABLED
S05 PF & UV MASK		DISABLED
S06 PWR UP ENTRY		ENABLED
S10 Load comp BW		default

Appendix A - Electrical distribution earthing systems

Electrical earthing

"Earthing" is the connection of the exposed-conductive parts of an electrical installation by means of protective conductors to an electrode in contact with the earth's surface.

Earthing is provided for both safety (protective) and functional purposes

Protective earthing

Protective earthing avoids electric shock hazards by keeping the exposed conductive parts of electrical equipment close to earth potential during a fault condition. In the event of a fault, a current is allowed to flow to earth via the earthing system. The fault current is utilised in various ways to disconnect the electrical supply thereby protecting the circuit and removing any fault-induced voltages from exposed conductive parts of the installation in a timely manner. The details of the arrangements used for the detection of fault currents vary according to both the electrical earthing system employed and special requirements of the industry/application.

Functional earthing

A functional earth connection is one provided for purposes other than safety. Applications that require functional earth connections include surge suppressors and electromagnetic interference filters.

Electrical supply earthing arrangements

Some kind of earth reference point is required in the electrical supply system to enable a fault current to flow in the event of an accidental (at the “fault”) connection between a live electrical conductor and objects connected to earth in some way.

There are a number of different arrangements in use. Two systems in common use are:

TN system

In this system the neutral conductor of the supply is directly connected to an earth electrode. In the event of a fault, either between the various power conductors or between a power conductor and ground, a high fault current flows. This fault current directly operates fuses or circuit breakers to disconnect the electrical supply. This is the system in common use in Australia for domestic and industrial installations operating on 240/415VAC.

IT system

In this system the neutral conductor of the supply (typically the star point of the secondary of the distribution transformer) is either isolated completely from earth or a connection to earth provided by a relatively high impedance component, typically a resistor. In both cases, the fault current flowing in the event of fault between power conductors and earth will be quite small (or near non-existent in a fully isolated system), so special relay devices are required to provide overall protection.

In general, there are two reasons for adopting an IT supply earthing arrangement:

(a) An IT system with a fully isolated neutral offers the possibility to allow the system to continue to operate in the presence of a single earth fault. This feature is desirable in some continuous process applications. In this case, the earth fault detecting device simply provides an indication that there is a fault in need of repair, rather than disconnecting the electrical supply immediately. A second earth fault occurring while the first remains unrepaired would result in a high fault current and disconnection of the electrical supply by means of over-current protective devices (fuses or circuit breakers).

(b) To take advantage of the limited fault current available in the event of an earth fault in an IT system with impedance earthed neutral. This arrangement is widely used in the mining industry on the basis that a substantial proportion of electrical faults, particularly associated with cables, which might begin as earth faults and otherwise progress to a major high current faults with considerable potential for personal injury and equipment damage.

A considerable amount of the literature on the topic of IT supply systems, including a number of International Standards, is written around the first reason above and is a source of confusion if read with the second reason in mind.

Glossary

~STOP	The logical inverse of STOP. This circuit must be closed for the ZENER MSC-3V to run.
2-wire control	Control of the stop / start function by a simple contact closure (eg a start / run switch contact).
3-wire control	Control of the stop / start function by momentary contacts, typically separate start and stop pushbuttons. This arrangement has the advantage of preventing an inadvertent re-start following a power outage.
COM	The common terminal to which all inputs on the ZENER MSC-3V are referenced.
AWG	American Wire Gauge
Console	The pushbuttons and LCD display on the front of the ZENER MSC-3V
Constant Torque	A load characteristic in which the driving torque requirement is largely independent of speed. e.g. a horizontal conveyor
DC Bus Choke	An inductor connected in series with the DC bus inside the ZENER MSC-3V. This provides several benefits including reducing the harmonic content of the AC line current.
EMC	Electromagnetic Compatibility. The arrangement of emission and immunity levels to achieve functional coexistence between various items of equipment in a given environment.
EN	The enable input on the ZENER MSC-3V.
ESO	Essential Services Override. A mode of operation that disables certain protection features in order to allow the ZENER MSC-3V and/or the motor to run to destruction in certain circumstances, for example clearing smoke from a building.
HVAC	Heating, Ventilation and Air Conditioning [industry]
IEC	International Electrotechnical Commission, publisher of many standards related to electrical / electronics technology.
IN+, IN-	These are the designations of differential analogue inputs on the ZENER MSC-3V. The ZENER MSC-3V will respond to the difference between the two inputs, rather than the voltage between either input and AN COM.
JOG	A control input that causes motion only while it is active (ie non-latched) that is usually used to manually operate equipment for the purposes of setting up or alignment prior to continuous operation.
LATCH	A feature of a control input that requires only a momentary signal (e.g. contact closure) to provide sustained (latched) operation.
Local	Operation of the ZENER MSC-3V from the console pushbuttons on the enclosure.

NEMA	[The American] National Electrical Manufacturer's Association, publishers of various NEMA standards.
PF	Power factor. The ratio of real (active or in-phase) current to the total current in an AC circuit.
PID	A type of automatic controller that seeks to drive a measured value (e.g. temperature, pressure etc) to a preset value by means of a control effort (e.g. motor speed) determined by proportional, integral, and derivative functions. PID, reverse acting A PID control system in which an increase in control effort (e.g. motor speed) results in a decrease in the measures variable (e.g. temperature). A common example is a cooling tower where an increase in fan speed causes a reduction in water temperature.
Ramp	A control function within the ZENER MSC-3V that controls the rate at which the motor speed can increase or decrease.
Remote	Operation of the ZENER MSC-3V via connections made to the control board terminal strip.
RMS	Technically, Root-Mean-Square. A method of measuring an AC voltage or current that gives the same numerical result as a DC voltage or current would on the basis of heating effect.
RMS line current	AC input current measured in a way that reflects the true heating value of the current.
SCN	The terminal on the ZENER MSC-3V for the connection of the screen of all cabled associated with analogue and digital control functions.
UL	Underwriters Laboratories Inc. An American organization involved in product safety standards and certification.
Variable Torque	A load characteristic in which the driving torque requirement is significantly influenced by speed. This term is most often used to describe the load characteristic of centrifugal fans and pumps.
VRef	A reference voltage (5.0V) available on the ZENER MSC-3V control terminal strip to assist in generating a speed reference voltage etc.

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