MSC-3V

FS2 Firmware

Instruction Manual

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

ZENER is a registered trademark of Zener Electric Pty Limited


ZENER


AC DRIVE
50.0Hz 12.6A
4 %L 6.2kW
FWD REV ENTER EXIT STOP
ESC
ZENER

A Zener Drive for Every Application

The ZENER MSC-3V series Variable Speed Drive is suitable for all types of loads, producing greater motor torque over the full speed range with ZENER's unique 'Flux Plus' control algorithm.

Variable Torque Loads

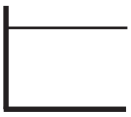
Typically Pumps and Fans

- 110% full overload capacity from 0-200Hz
- Controlled ramp from 0.1 sec to 1min
- Able to start into a high inertia load rotating at full speed without damage
- PID control for automatic process control
- Energy savings with speed reduction
- Soft Stop to reduce water hammer problems

Constant Torque Loads

Typically Conveyors,

Machines



- Flux plus for torque maximisation
- 150% - 175% full overload capacity from 0-200Hz
- Automatic Boost and slip compensation for fluctuating loads
- Dynamic Braking for rapid deceleration of high inertia loads (optional)
- Configurable Analog & Digital I/O

A Zener Drive for Different Environments

ZENER also offers a range of enclosure types to suit different environmental conditions, for improved life expectancy and reliability. Ratings at 40°C, 45°C and a 50°C rating are available.

IP30 ENCLOSED

Painted enclosure with IP30 rating for mounting within an enclosure or Switch Board.

Up to 490Amps

IP54 ENCLOSED

Painted enclosure with a dual compartment, self-contained, forced ventilated IP54 enclosure. All electronic components are housed in a totally enclosed compartment separate from the heatsink.

175 - 490Amps

IP66 ENCLOSED

Painted enclosure with a dual compartment, self-contained, forced ventilated IP66 enclosure providing added protection against the ingress of dust and water without the use of air filters. All electronic components are housed in a totally enclosed compartment separate from the heatsink and ventilation fan compartment.

Up to 140Amps

IP66 STAINLESS STEEL

Stainless Steel 304 with a dual compartment, self-contained, forced ventilated IP66 enclosure providing added protection against the ingress of dust and water without the use of air filters. All electronic components are housed in a totally enclosed compartment separate from the heatsink and ventilation fan compartment.

Up to 109Amps

Zener MSC-3 Options

SUPPLY VOLTAGE

The ZENER MSC-3 is available to operate from the following types of power supplies;

Supply Voltage	Supply Phase	Tolerance	Model
380 to 480Vac	3 Phase	-15, , +10%	MSC-3R
208 to 240Vac	3 Phase	-15, , +10%	MSC-3L
440 to 600Vac	3 Phase	-15, , +10%	MSC-3J
380 to 480Vac	1 Phase*	-15, , +10%	MSC-3R
208 to 240Vac	1 Phase*	-15, , +10%	MSC-3L
950 to 1100Vac	3 Phase	-15, , +10%	MSC-3V

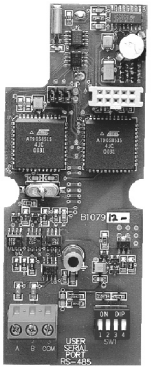
* Derating required for single phase operation.

REMOTE DISPLAY PANEL

Remote Display Kit which allows remote access to programming menu and drive controls. An IP66 rating applies if fitted correctly.

Available in 2m, 5m or 10m kits. Cable lengths greater than 10m may required screened cable and/or additional power supply.

A remote display panel is supplied as standard with MSC-3 (1100V) models.



OPTION BOARDS

The ZENER MSC-3 provides 2 expansion slots located on the control board to accept up to 2 option boards.

AQ03001	Extended Features; PID controller, Analogue Output, 2nd Analogue Input, Thermistor input, Speed Reference Select, Additional Relay output, 24VDC 20 mA power supply
AQ03004	Communication; Modbus
AQ03005	Communication; Metasys
AQ03078	Communication; Lonworks

Check with your authorised Zener Distributor for other communications protocols.

All Communication Option Boards include; Run, kWh log, Trip log, battery backed real time clock.

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.
		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 electrical tradesperson in accordance with this manual, good engineering practice and all local rules and regulations

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

Before touching anything inside the MSC-3V enclosure or other equipment connected to the MSC-3V terminals, disconnect all sources of electrical power, wait at least 11 minutes for capacitors within the 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 the 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 intended for use only in fixed wiring applications.

Mount the MSC-3V on a vertical, incombustible surface such as metal or masonry. Do not place combustible or flammable material near the MSC-3V. Failure to observe these precautions may create a fire hazard.

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-3V for any shipping damage. If any damage is found, report it to the carrier immediately. Access the inside of the controller and visually check for any damage.

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 -20ºC (-4ºF) or rise above 70ºC (158ºF). 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.

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-3V should be mounted within the switchboard adjacent to, or on the enclosure floor, below the MSC-3V 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 is deigned 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 for the lifetime of the equipment.

CAUTION Installation Information

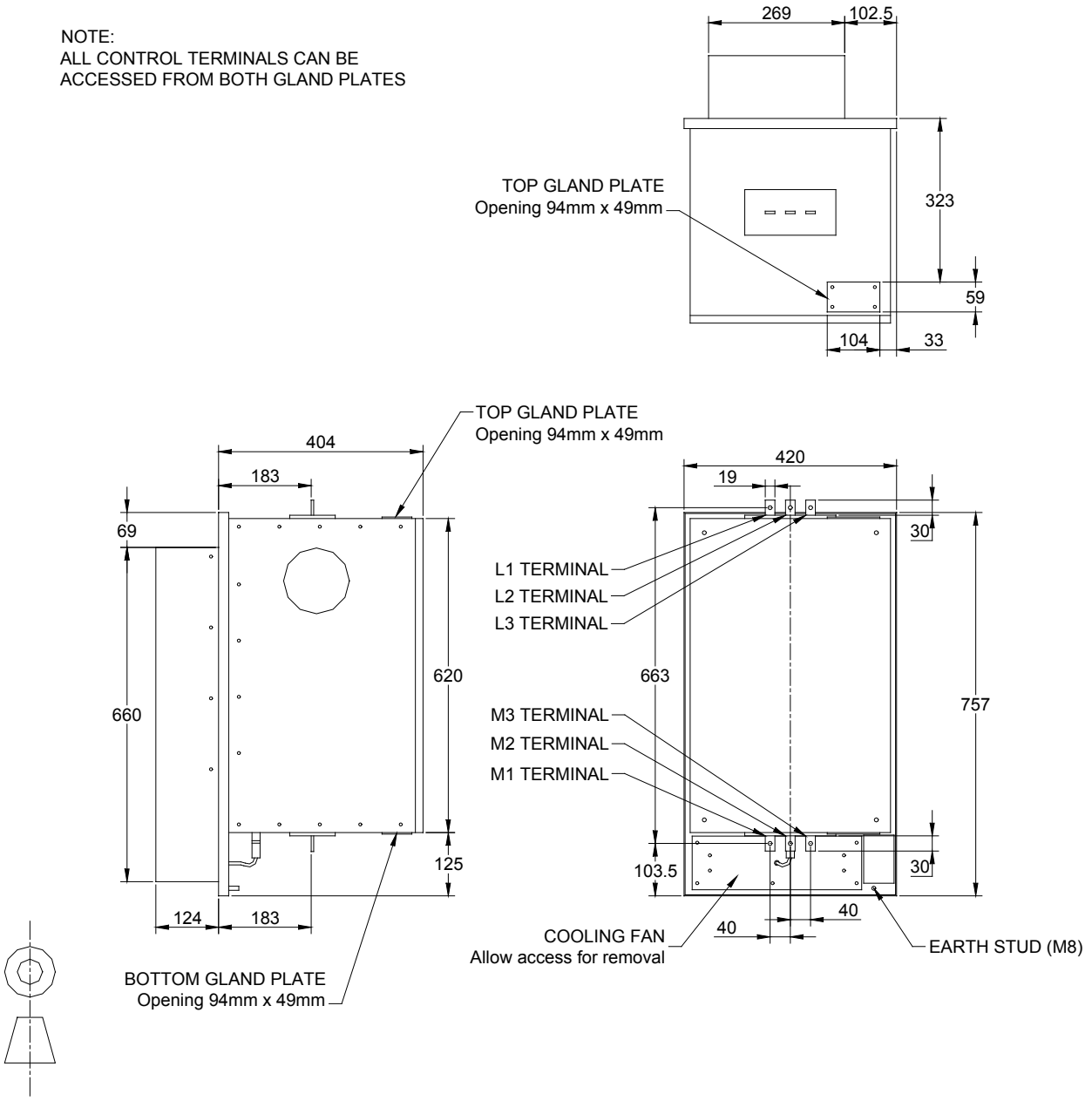
- The MSC-3V must be mounted on a vibration free vertical surface, away from heat radiating sources. Do not mount the MSC-3V in direct sunlight or on a hot surface.
- The MSC-3V must be mounted vertically. No other mounting orientation is acceptable.
- If the MSC-3V is mounted inside another enclosure, the total heat dissipation and resulting temperature rise in the enclosure must be allowed for.
- Attention is drawn to the potential for condensation in vulnerable environments. Additional precautions may be required for all enclosure types.
- The installation location and environment should provide for safe access and working conditions for service personnel. Do not mount the MSC-3V in “confined spaces” [2]
- Do not drill holes in the enclosure except in the gland plate.
- Remove the gland plate before drilling cable holes.
- Do not allow metal shavings or any other conductive material to enter the enclosure or damage may result.

[1] Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the equipment is out of operation.

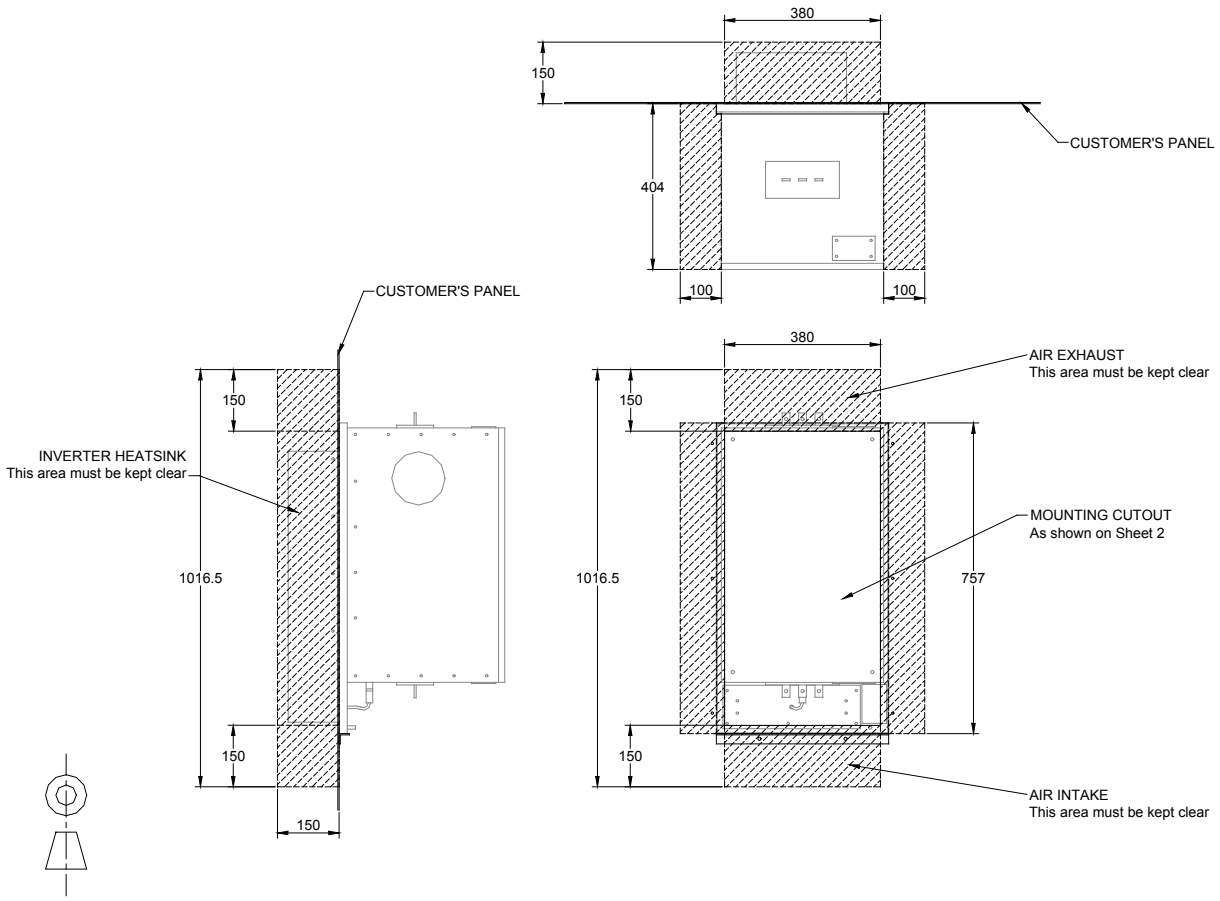
[2] Confined spaces are generally defined in Occupational Health and Safety (OH&S) regulations to mean spaces where special precautions are necessary to ensure a safe breathing atmosphere, or there is limited access for escape/rescue in case of emergency.

MSC-3V Mechanical Installation Information

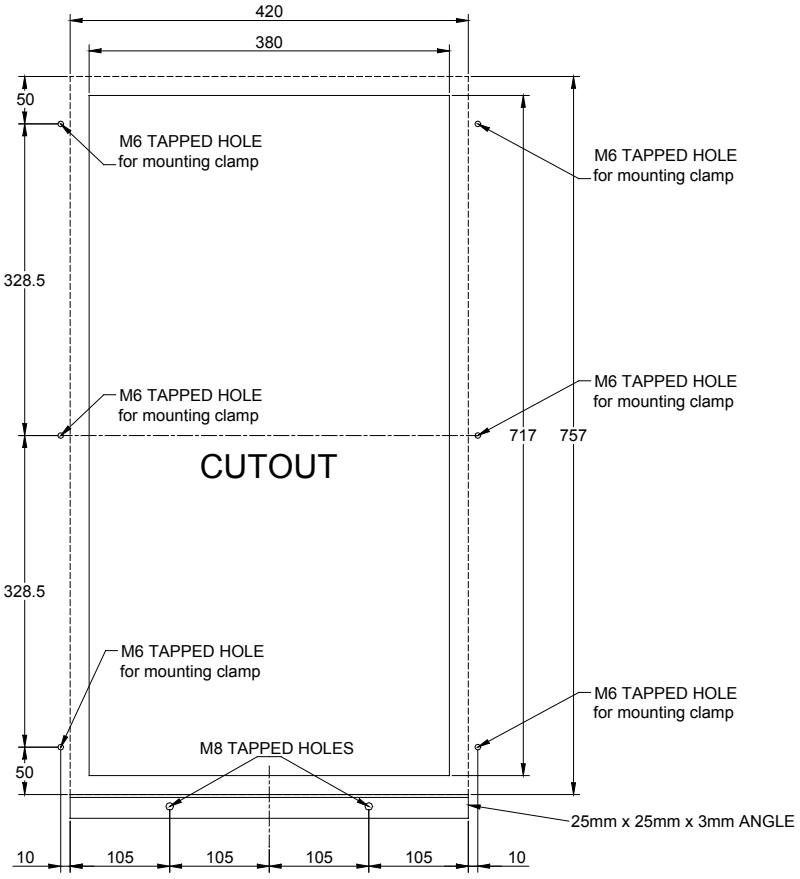
Each MSC-3V system consists of one module or a number of modules for connection in parallel. There are two physical sizes of module, V1 and V2, with a number of different electrical ratings available in each physical module size.



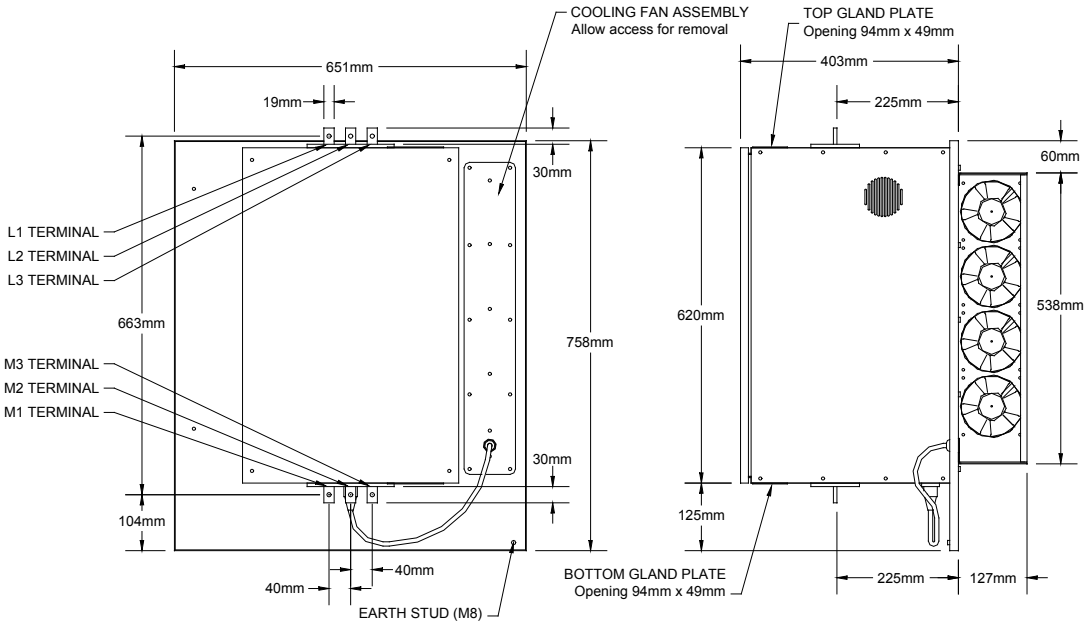
Outline Dimensions V1 Module

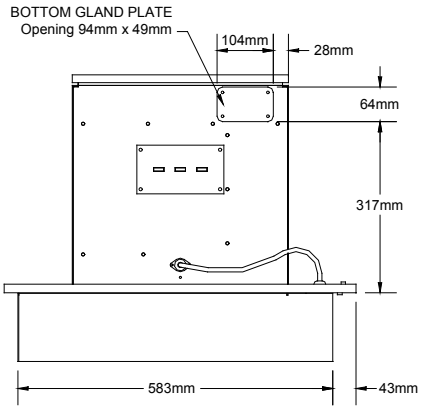


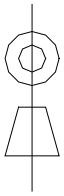
Installation Clearances V1 Module



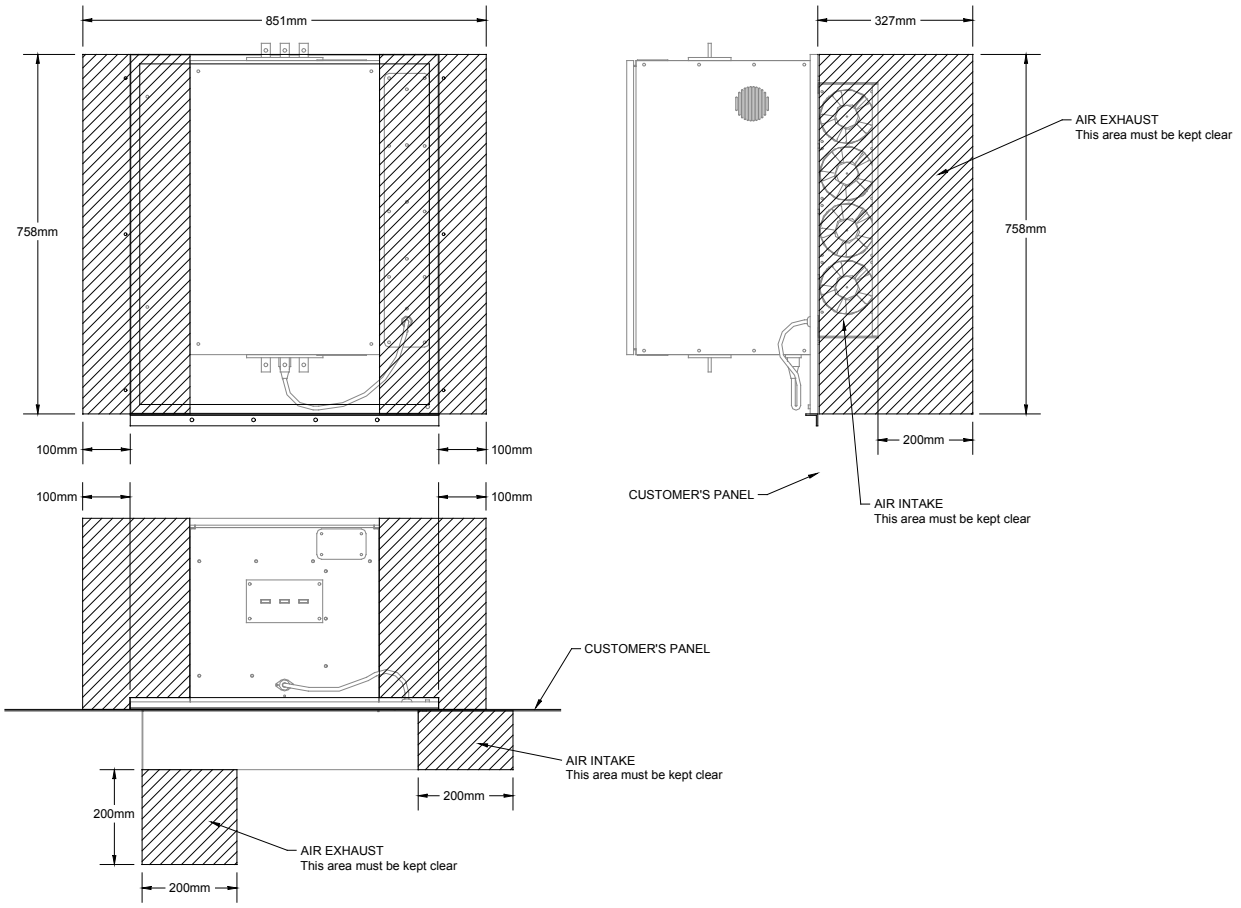
Mounting Cutout V1 Module



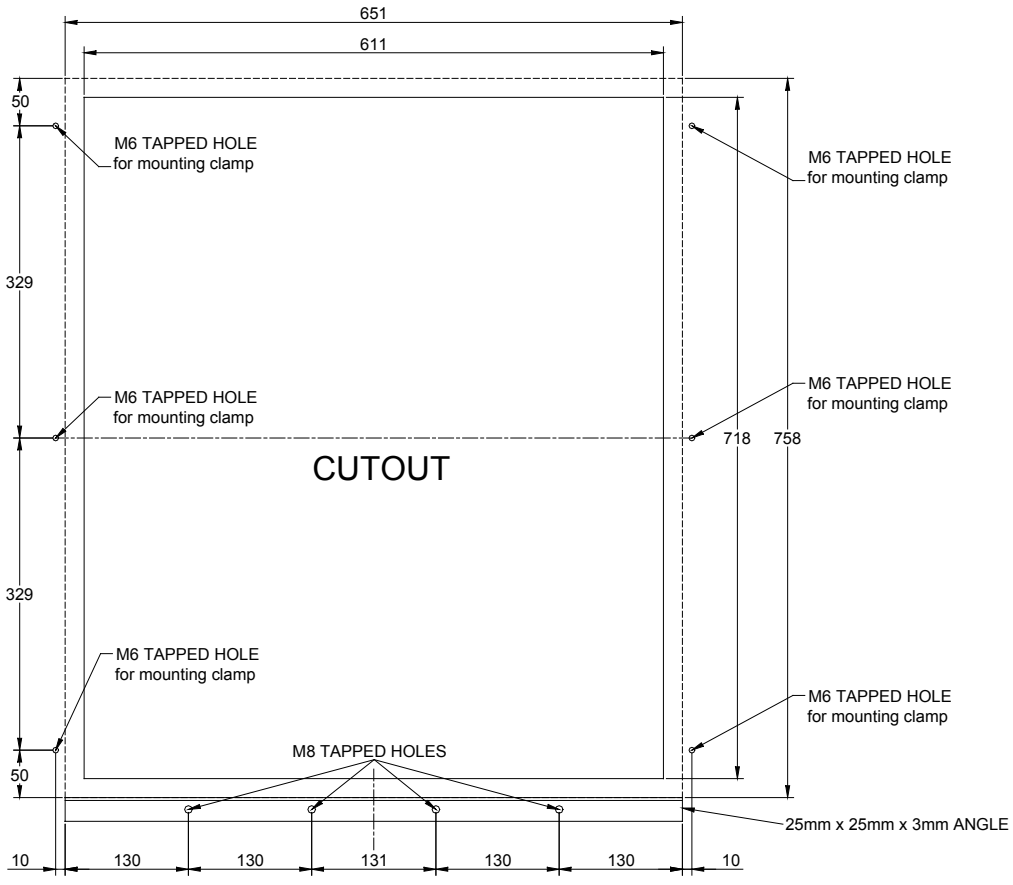




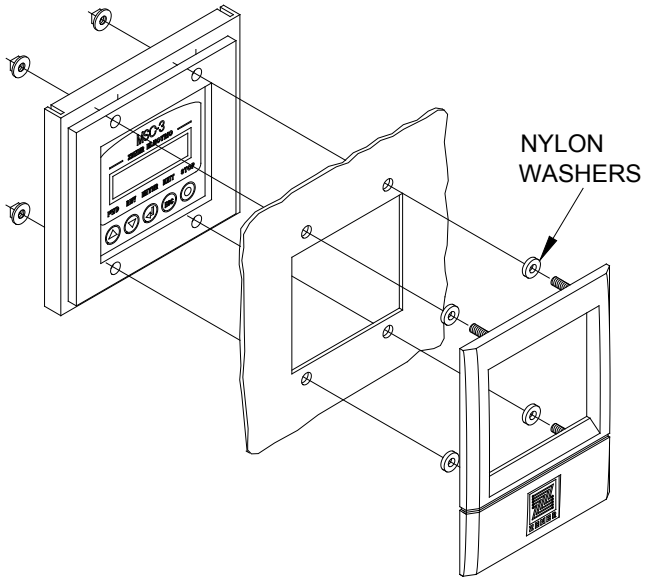
Outline Dimensions V2 Module



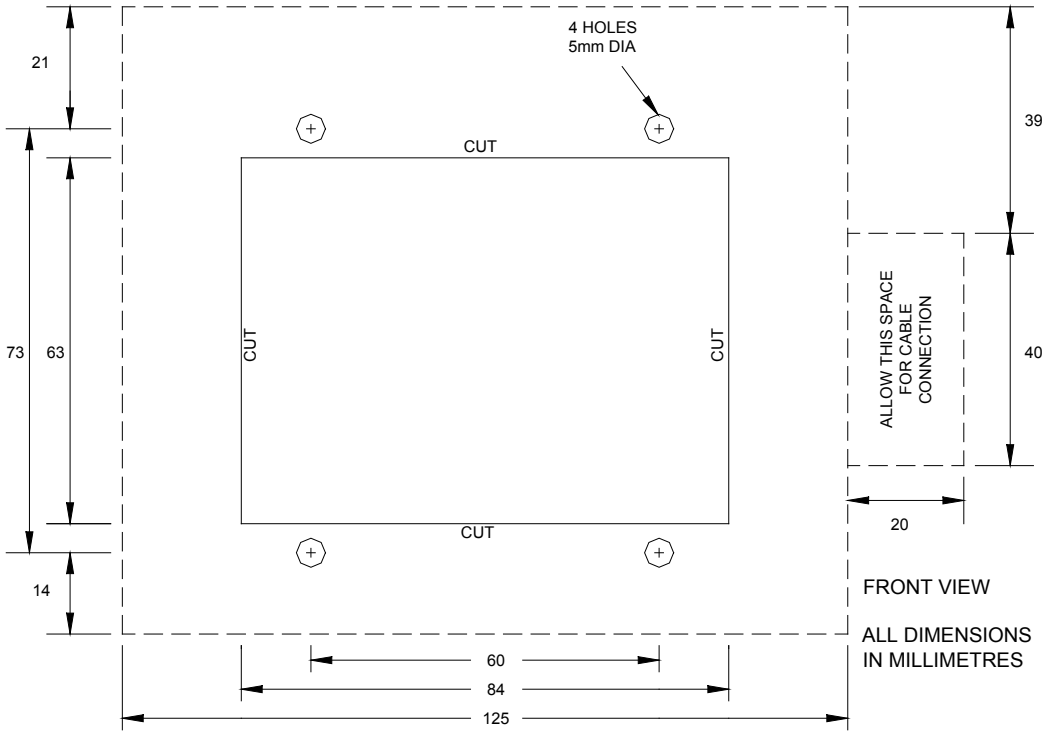
Installation Clearances V2 Module



Mounting Cutout V2 Module



Control Console Assembly



IMPORTANT:

Allow at least 70mm behind the panel for console mounting

Control Console Mounting Cutout

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 I2t (time integral of current squared) let through the protective device in the process of interrupting the fault current. In order to minimise the I2t let through and the associated risks of injury, property damage and downtime, we recommend the use of appropriately rated current limiting[3] 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 81. 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.

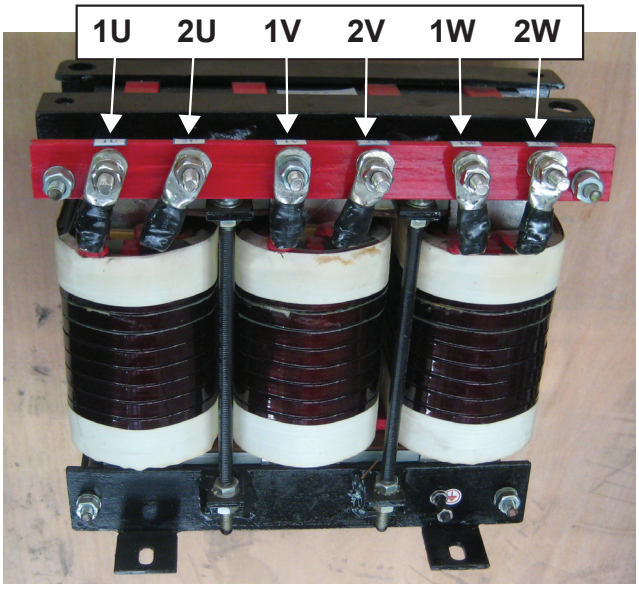
[3] "Current limiting" describes the ability of an overcurrent protective device (fuse or circuit breaker) to reduce the peak current that flows in a circuit, by opening and clearing the fault in a sub half-cycle time frame.

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.

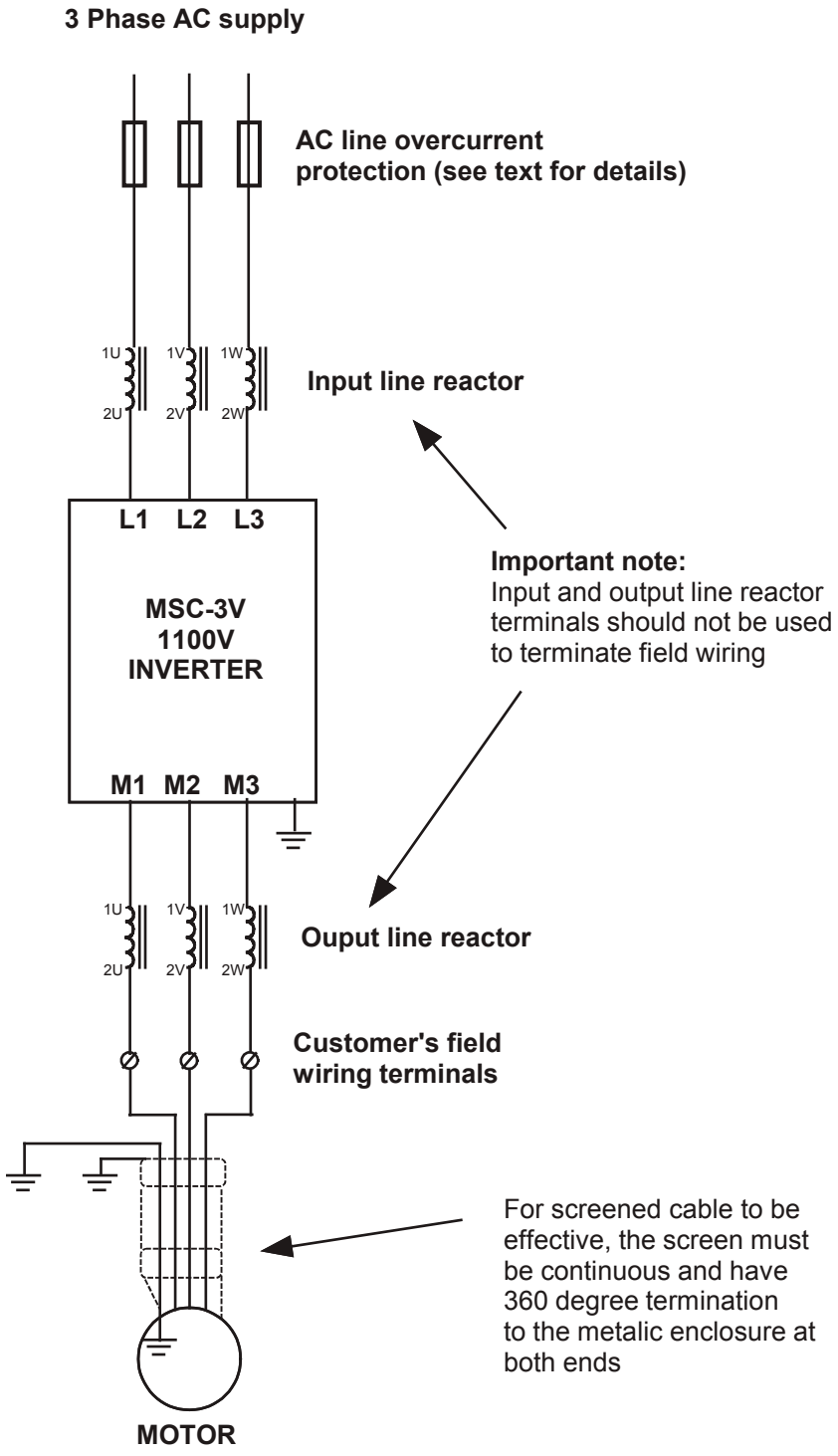
Motor thermal protection

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 complete motor thermal protection, microtherms or thermistors should be installed in the motor winding and wired to the appropriate trip relay. MSC 3 Extended Features Option provides a thermistor relay function and other features.

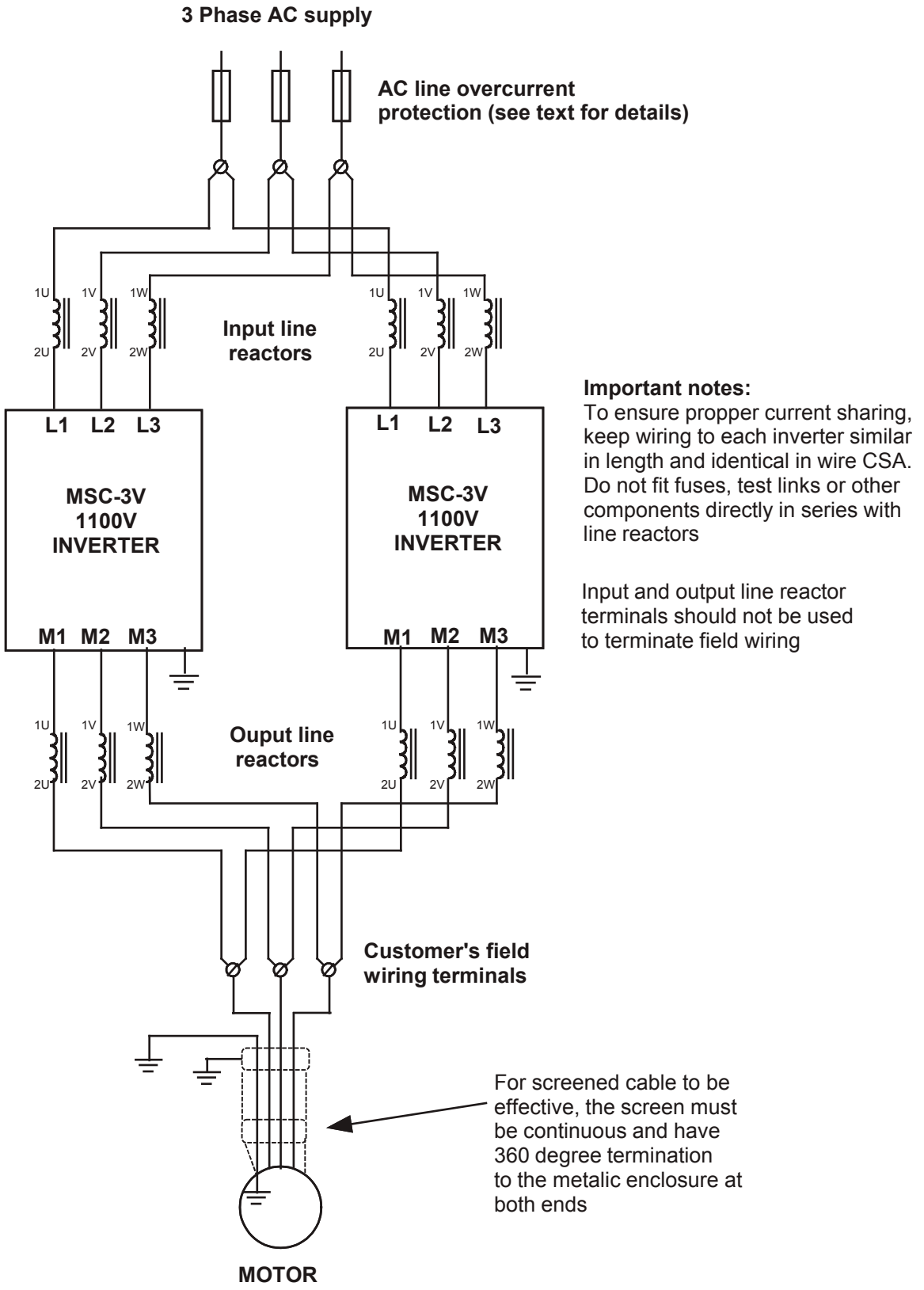


Line reactor terminal identification

Power Wiring for Single Units



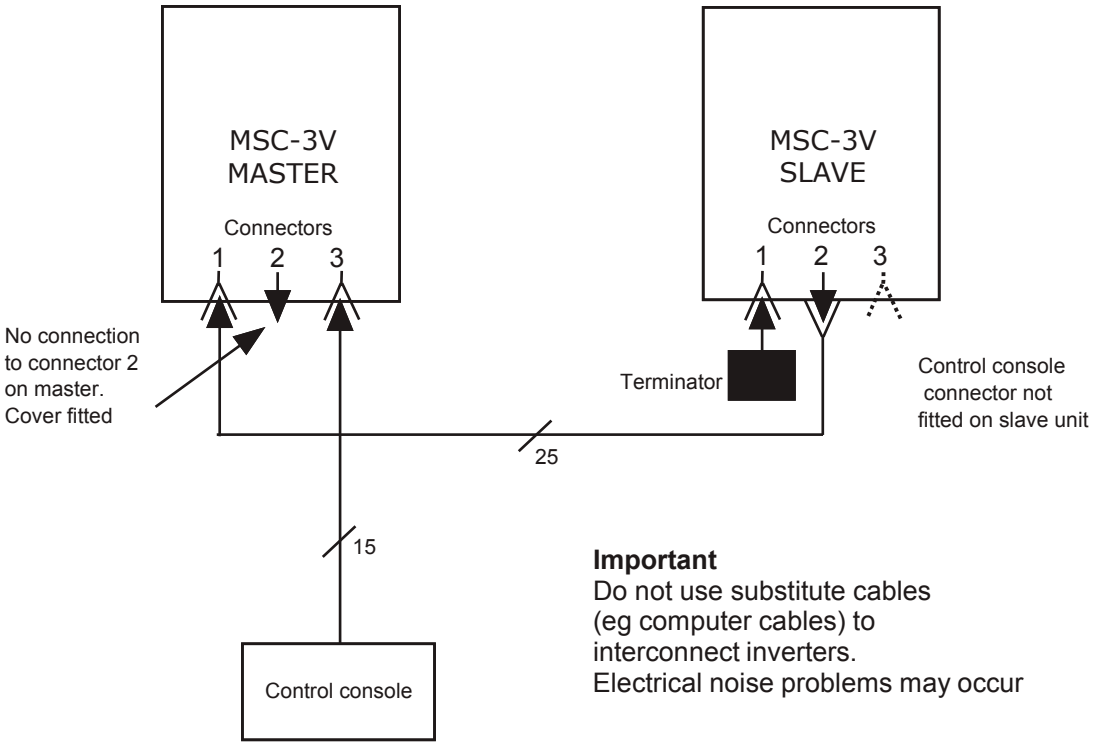
Power Wiring for Parallel Units



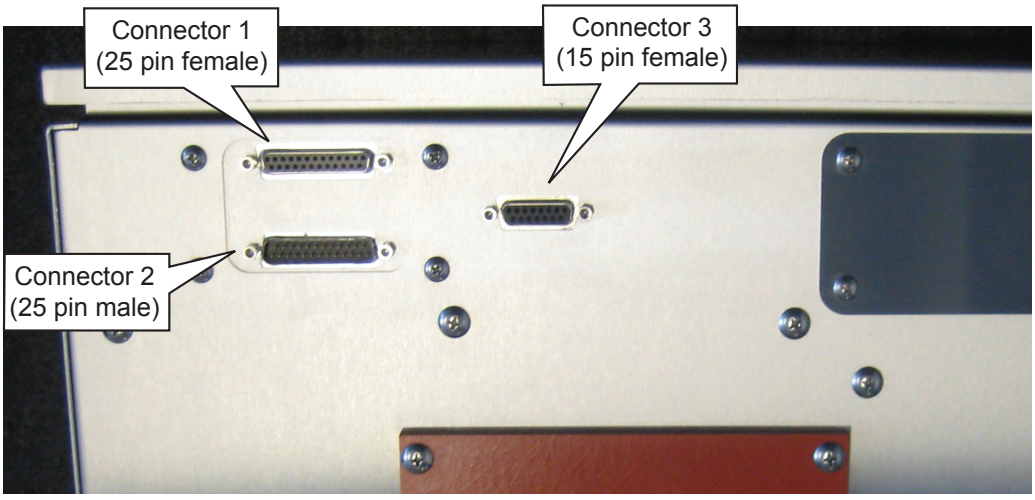
Important notes:
To ensure propper current sharing, keep wiring to each inverter similar in length and identical in wire CSA. Do not fit fuses, test links or other components directly in series with line reactors

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

Control Interconnection for Parallel Units



Important
Do not use substitute cables
(eg computer cables) to
interconnect inverters.
Electrical noise problems may occur



Control connector identification

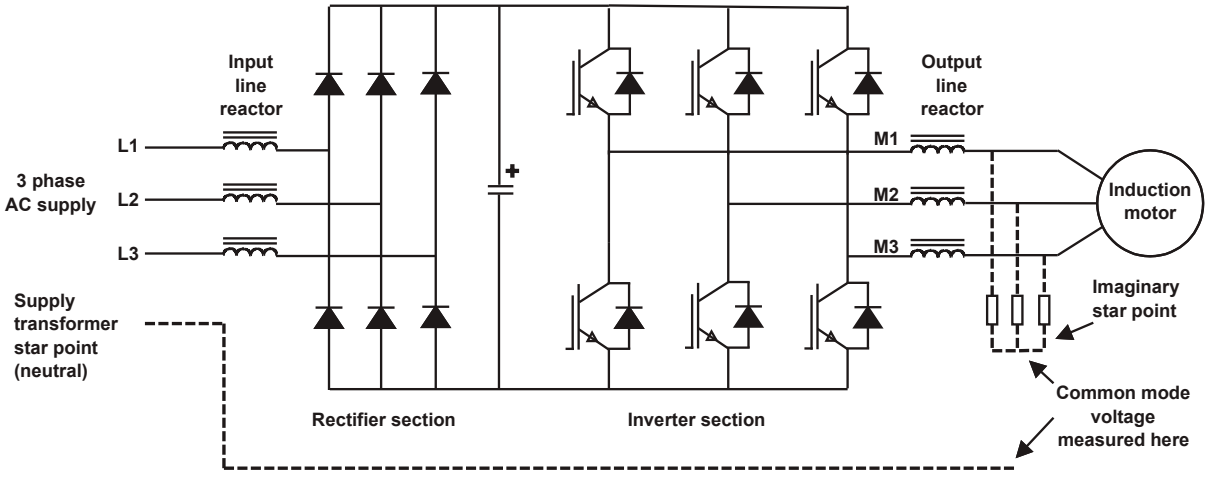
(MSC-3V module viewed from below)

Compatability Issues

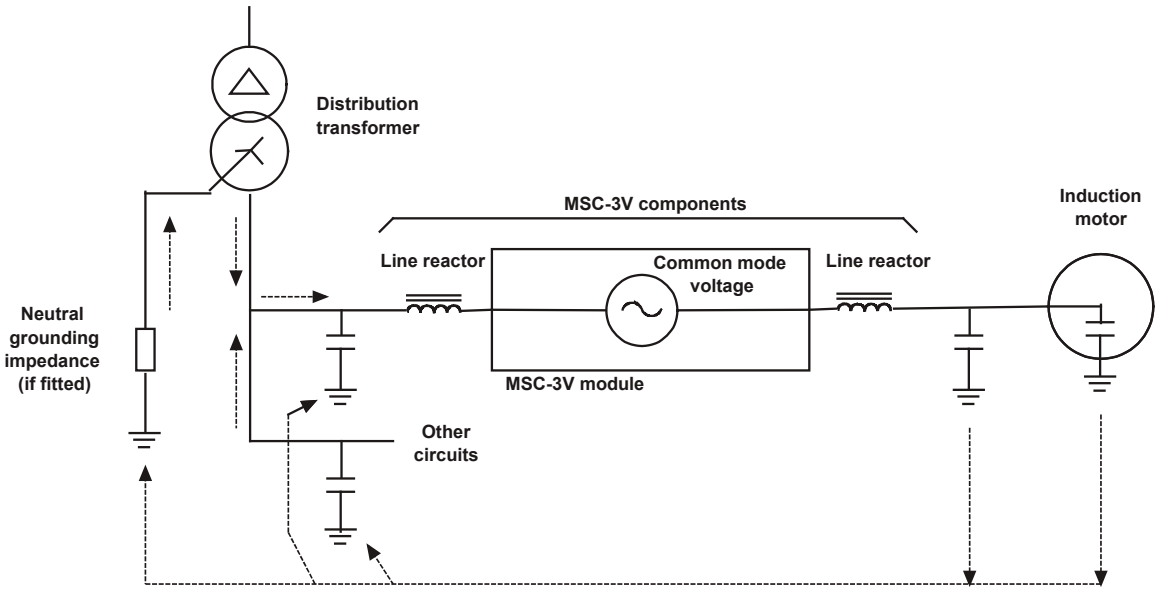
Earth leakage monitoring

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.

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.



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, however it may be an issue in systems with earth leakage monitoring, depending on the characteristics of the particular earth leakage monitoring device used. The particular characteristic of concern is the frequency response of the earth leakage monitoring device. The common mode voltage mentioned above is a pulse waveform predominantly containing frequencies at or above the switching frequency of the inverter (500Hz, 1kHz for MSC-3V). The impedance of the capacitive current path decreases with increasing frequencies, so the higher frequency components will predominate.



Single line diagram showing potental paths for capicitive leakage currents

The particular issue with earth leakage monitoring devices is that their behaviour is closely specified in the various standards, but only at 50/60Hz and the behaviour at higher frequencies such as a few kHz not specified at all. A number, but not all, earth leakage monitoring device manufacturers recognise the possibilities for nuisance tripping and tailor the frequency response of their equipment to eliminate sensitivity to frequencies higher than 200…300Hz. We have tested several popular earth leakage monitoring devices in the Mining and Industrial 500mA category and found them not to exhibit this problem. Additional devices will be tested as they become available to us. Please contact the factory for details or if you have a device that you would like tested.

Electromagnetic Compatibility (EMC)

Installation practices for EMC compliance

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 order to achieve the required electrical performance at high frequencies, it is essential that the screen of the cable have a 360º 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.

Wiring 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. Armored 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.	✗

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, I^2t (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 or from one of 8 preset configurations.

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

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 “Config 1”, starting on page 22.

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 A05 SET CTL DEFS on page 54.

Settings for your application

The functionality of each control terminal (D1…. D4) is individually configurable. Full details begin on page 71 - G00 INPUT/OUTPUT.

Quick Setup

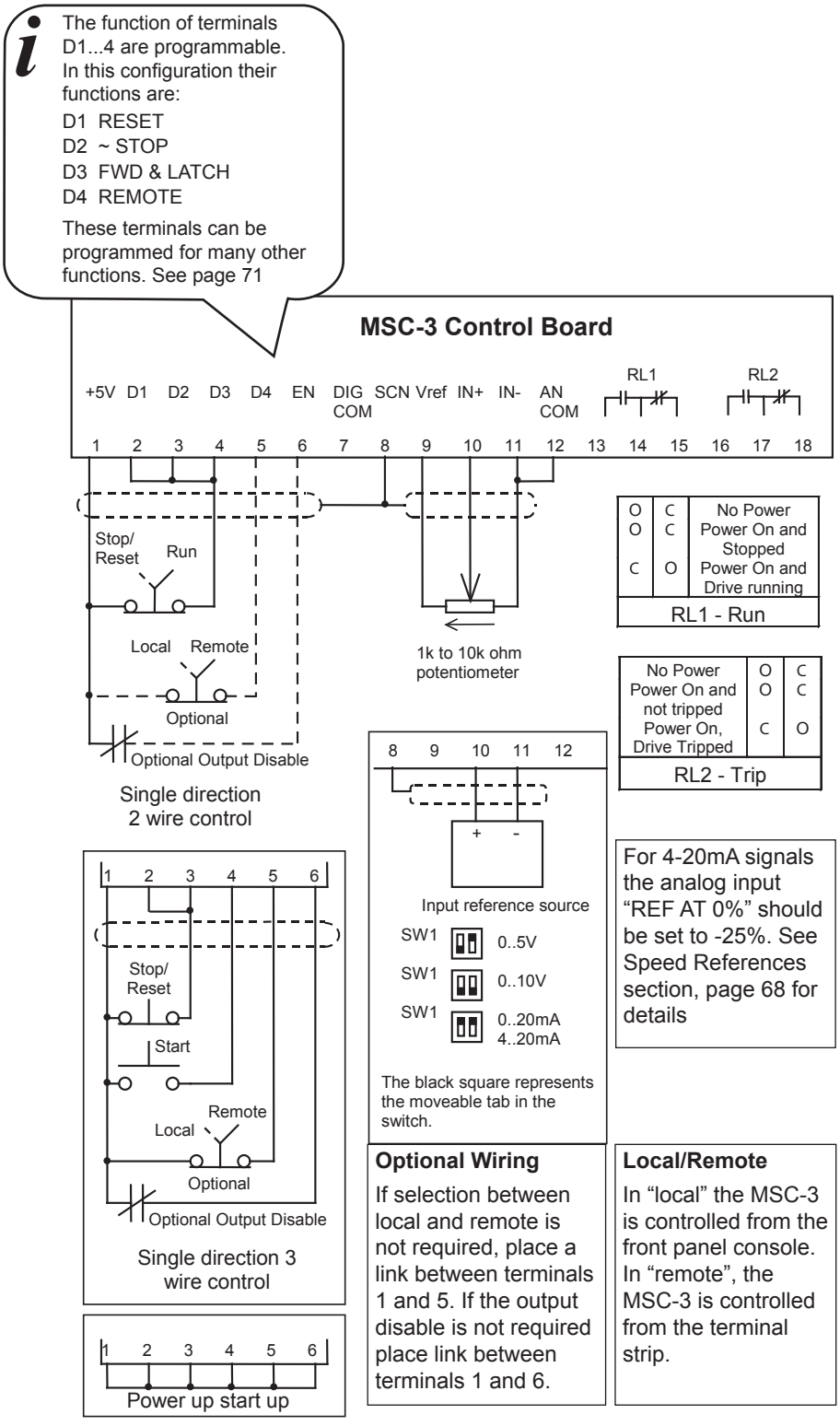
To assist with quick configuration of the most frequently encountered applications, there are a number of application specific setup guide pages in this manual. Terminal strip configuration and associated setup notes are provided on the pages listed below.

Industrial Terminals Typical Connection Diagram – Terminal Config 1

General

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-3V 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.



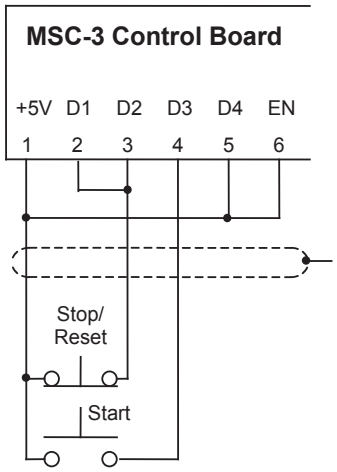
Quick Setup for Terminal Config 1.

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

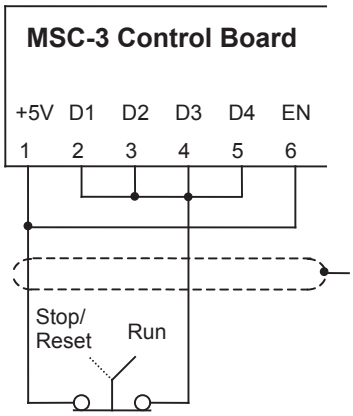
Procedure

STEP 1. Complete the power wiring according to the instructions on page 7

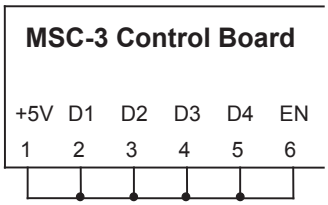
STEP 2. Choose your control method from one of the following. Connect your control wiring as shown.



Pushbutton control
(3 - wire control)



Switch or contact control
(2 - wire control)

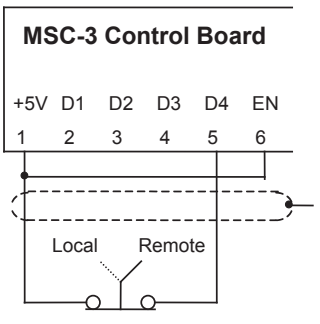


Power up start
MSC-3 will start as soon as power is applied

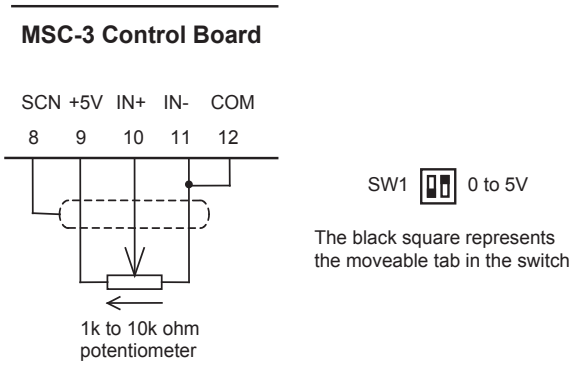
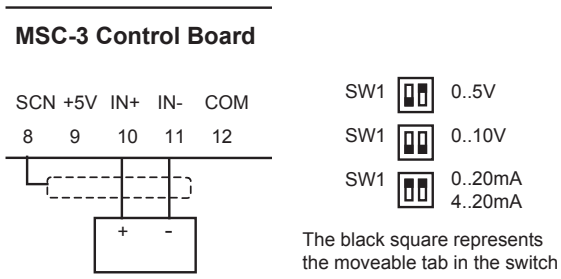
Local / Remote Selection

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 77.

In “local” the MSC-3V 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 Set SW1 as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to –25%. Press Enter.	
Preset speed This provides a single fixed speed.	Select REMOTE from the REFERENCES menu. Use the arrows to display the options. Press Enter when PRESET is displayed. Now set your desired preset speed. No speed reference wiring is necessary
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Select REMOTE from the REFERENCES menu. 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-3V startup, setting the parameters according to the table below. Alternative values may be used to suit the application.

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H00 DISABLE	71
		G11 DIG IN1 = I07 RESET	
		G12 DIG IN2 = I02 ~STOP	
		G13 DIG IN3 = I00 FWD & LATCH	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN (Default setting)	74
	Relay 2	G16 RELAY 2 = O01 TRIP (Default setting)	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	References Remote	F01 REMOTE = AN1 or PRESET or CONSOLE as selected in Step 3.	66
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	

End of procedure

Application: Water pumping with automatic pressure control

This setup is for a typical centrifical pump application that requires water pressure control using a water pressure transducer and PID controller function provided by the MSC-3V extended features option board. Prior to commissioning, you will need to know the type of water pressure transducer signal that is to be used (0-10V,4-20mA etc).

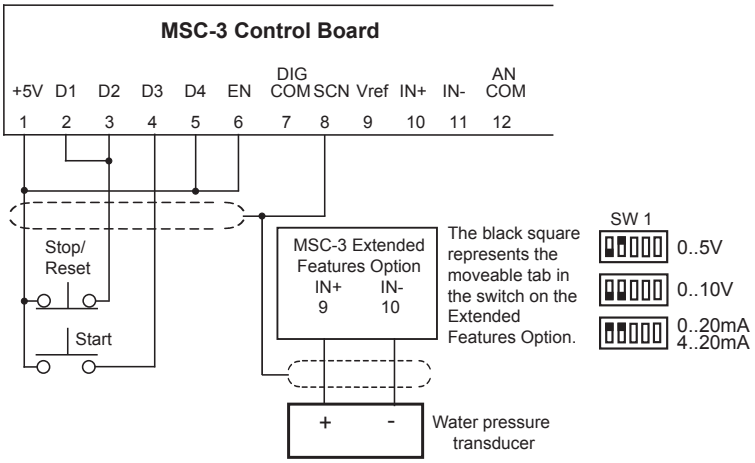
Procedure

STEP 1 Complete the power wiring according to the instructions on page 7

STEP 2 Connect the control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3 is enabled.



STEP 3 Connect the signal wiring from the water pressure transducer as shown. Consult the pressure transducer manufacturer's literature for power supply requirements of the transducer. Set the switches on the extended features option board to suit the type of signal.

Set SW1 on the Extended Features Option as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Press ▲ until you see P22 ANALOG INPT. Press Enter. Set the REF AT 0% to –25%. Press Enter.

STEP 4 Follow the instructions on page 47 for MSC-3V startup, setting the parameters according to the table below. Alternate values may be used to suit the application. See the Extended Features Option manual for information on tuning the PID performance.

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H00 DISABLE	71
		G11 DIG IN1 = I07 RESET	
		G12 DIG IN2 = I02 ~STOP	
		G13 DIG IN3 = I00 FWD & LATCH	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN (Default setting)	74
	Relay 2	G16 RELAY 2 = O01 TRIP (Default setting)	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	Remote	F01 REMOTE = P38.. PID OUTPUT	66
PID Control	PID set point value	P33 SV CHOICE = PRESET 1 Set to % of transducer full scale equivalent to required pressure.	Extended Features Option Manual
Performance	Acceleration Time	C04 ACCEL TIME = 1 sec	59
	Deceleration Time	C05 DECEL TIME = 1 sec	

STEP 5 Now connect the wire to terminal 6

End of Procedure

Quick Setup for Terminal Config 4.

Features	Forward and reverse operation controlled from pushbuttons. Selection between Local and Remote modes by a switch or contact closure.

Procedure

STEP 1. Complete the power wiring according to the instructions on page 7

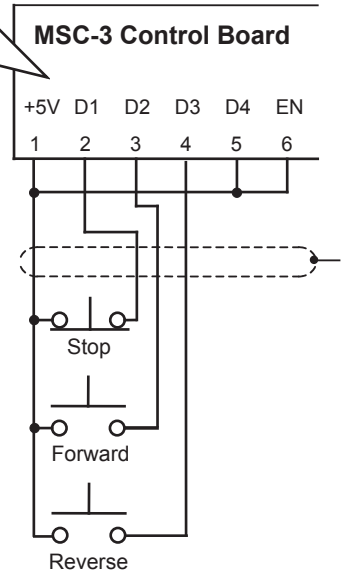
STEP 2. Connect your control wiring as shown

.

CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3 is enabled.

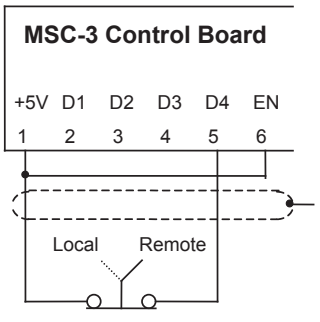
The function of terminals D1...4 are programmable. In this configuration their functions are:
D1 ~STOP
D2 FWD & LATCH
D3 REV & LATCH
D4 REMOTE
These terminals can be programmed for many other functions. See page 71



Local / Remote Selection

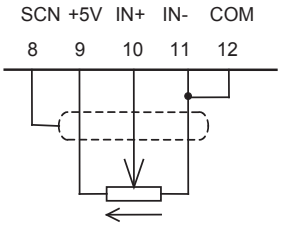
The Local/Remote Selection can be used in conjunction with any of the above circuits. Wire terminals 5 and 6 as shown.

In “local” the MSC-3 is stopped and started from the front panel console. In “remote”, the MSC-3V 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

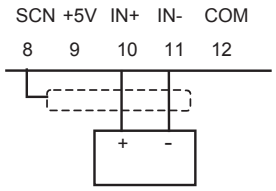
<table>
<tr>
<td>Speed control from an external potentiometer

This is typically used for simple manual speed control. See also Console Reference below.</td>
<td>MSC-3 Control Board
 

1k to 10k ohm potentiometer

SW1 0 to 5V
The black square represents the moveable tab in the switch</td>
</tr>
<tr>
<td>Speed control from an external signal

Set SW1 as shown

i If a 4 to 20 mA reference is to be used select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to -25%. Press Enter</td>
<td>MSC-3 Control Board
 

SW1 0..5V
SW1 0..10V
SW1 0..20mA
4..20mA
The black square represents the moveable tab in the switch</td>
</tr>
<tr>
<td>Preset speed
This provides a single fixed speed.</td>
<td>Select REMOTE from the REFERENCES menu. Use the arrows to display the options. Press Enter when PRESET is displayed. Now set your desired preset speed. No speed reference wiring is necessary</td>
</tr>
<tr>
<td>Console reference
This uses the Up and Down arrows on the front panel to control the speed.</td>
<td>Select REMOTE from the REFERENCES menu. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.</td>
</tr>
</table>

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 DISABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN3 = I01 FWD & LATCH	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN (Default setting)	74
	Relay 2	G16 RELAY 2 = O01 TRIP (Default setting)	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
	Reverse	D05 Reverse = ENABLE	
Stop/Start	Reset by PF	E10 RESET BY PF = H00 ENABLE	65
References	Remote	F01 REMOTE = AN1	66
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	

STEP 5 Now connect the wire to terminal 6.

End of Procedure

Application: Machine drive with forward and reverse jog

This setting is for a typical industrial process that requires stop/start with the ability to jog the machine in both directions. A roll forming machine may be controlled this way. The speed signal could be from the ▲and ▼ buttons on the console or a remote potentiometer.

Procedure

STEP 1. Complete the power wiring according to the instructions on page 7

STEP 2. Connect your control wiring as shown

.

CAUTION

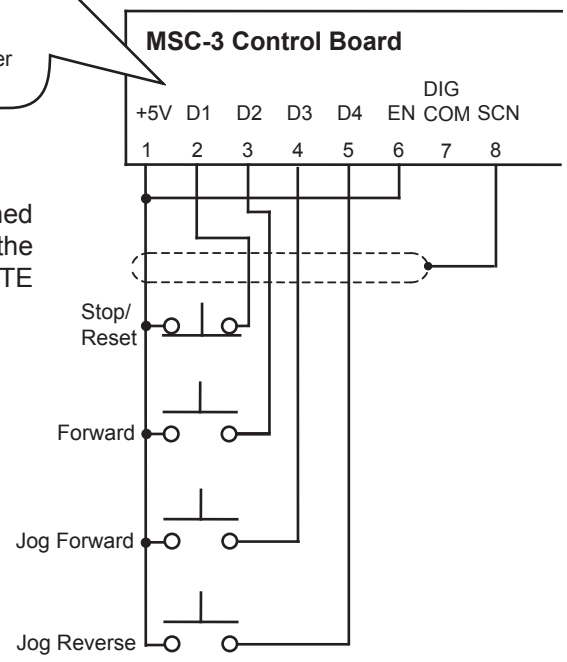
Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3 is enabled.

The function of terminals D1...4 are programmable. In this application their functions are:

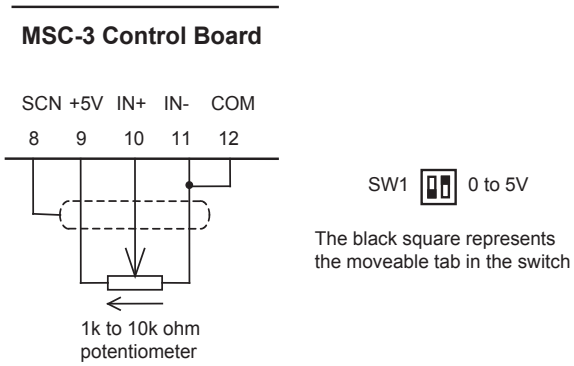
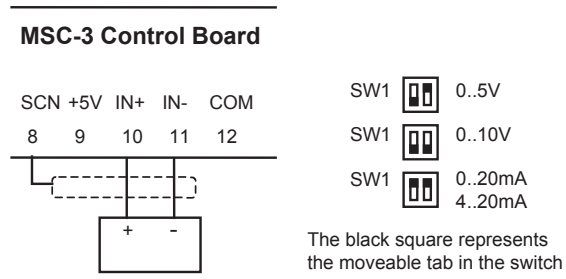
D1 ~STOP
D2 FWD & LATCH
D3 JOG FWD
D4 JOG REV

These terminals can be programmed for many other functions. See page 71

Note: Since no terminal is assigned to the REMOTE function, the MSC-3 will operate in the REMOTE mode by default. See page 66.



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 Set SW1 as shown *i* If a **4 to 20 mA** reference is to be used select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to -25%. Press Enter	
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Select REMOTE from the REFERENCES menu. 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 47for MSC-3V startup, setting the parameters according to the table below. Alternative values may be used to suit the application.

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN3 = I09 JOG FWD	
		G14 DIG IN4 = I10 JOG REV	
	Relay 1	G15 RELAY 1 = O00 RUN (Default setting)	74
	Relay 2	G16 RELAY 2 = O01 TRIP (Default setting)	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
	Reverse	D05 Reverse = ENABLE	
Stop/Start	Reset by PF	E10 RESET BY PF = H00 ENABLE	65
References	Remote	F01 REMOTE = Set to the source chosen in step 3	66
	Jog forward speed	F04 JOG FWD = PRESET	67
	Jog reverse speed	F05 JOG REV = PRESET	
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	

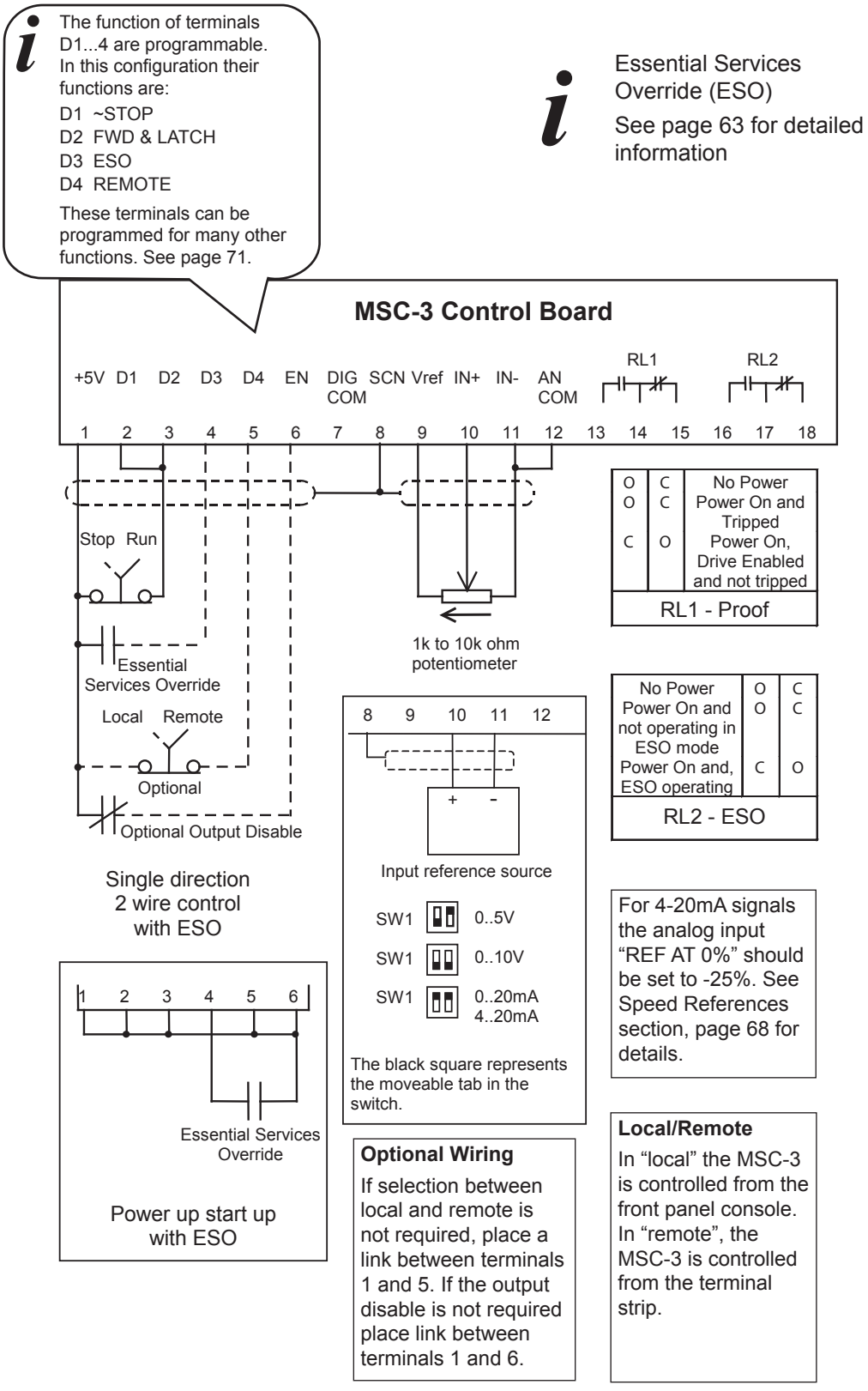
STEP 5 Now connect the wire to terminal 6.

End of Procedure

HVAC Terminals Typical Connection Diagram – Terminal Config 3

General

This section shows the typical configuration applicable to pump and fan drives in the HVAC industry. Typically these will be controlled from an external speed signal, frequently supplied from the output of a building management system. Terminal Config 3 is selected by choosing the terminal strip and relay functions according to the input/output section of the table on page 37. See also page 71. Note that specific setup instructions are provided for the more common HVAC applications in the sections that follow this.



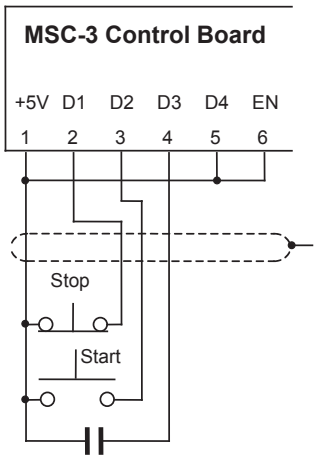
Quick Setup for Config 3.

Features	Forward Operation Local / Remote selection from a contact closure or from the console. See page 77 for details of remote override operation. Local operation is from the console and Remote is from the terminal strip. The Essential Services Override feature can be enabled.

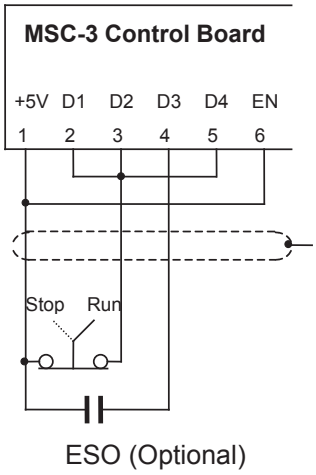
Procedure

STEP 1. Complete the power wiring according to the instructions on page 7

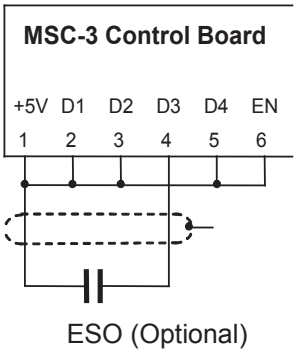
STEP 2. Choose your control method from one of the following. Connect your control wiring as shown



Pushbutton control
(3 - wire control)



Switch or contact control
(2 - wire control)



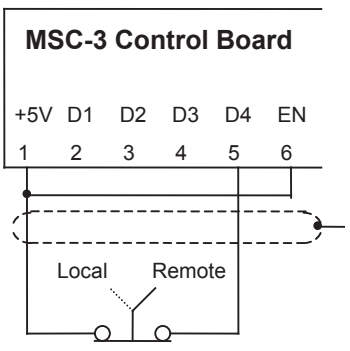
Power up start
MSC-3 will start as soon as power is applied

CAUTION
Do not connect the wire into terminal 6 yet. The terminal configuration cannot be changed while the MSC-3 is enabled.

Essential Services Override (ESO)
See page 63 for detailed information

Local / Remote Selection

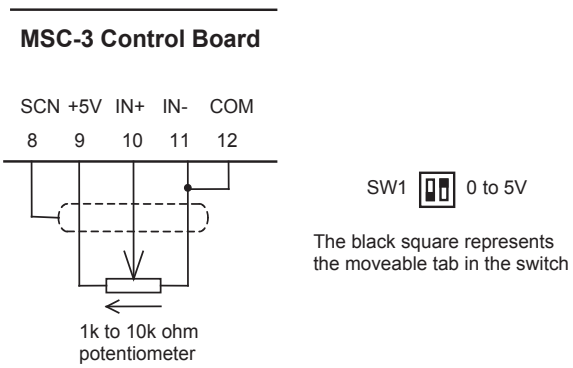
The Local/Remote Selection can be used in conjunction with any of the above circuits. Wire terminals 5 and 6 as shown. The Local/Remote selection can be overridden from the control console. See Remote Override Operation on page 77.

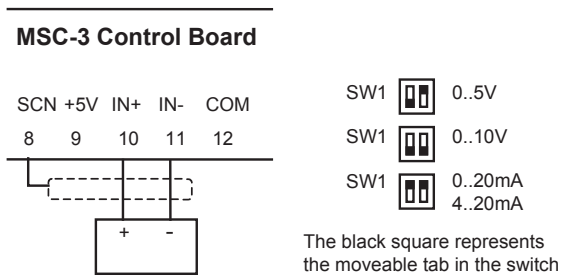


In “local” the MSC-3 is stopped and started from the front panel console. In “remote”, the MSC-3 stop / start is controlled from the terminal strip. The source of the speed reference in both modes may be independently configured to come from a wide variety of sources including the terminal strip, console 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.

<table>
<tr>
<td>Speed control from an external potentiometer

This is typically used for simple manual speed control. See also Console Reference below.</td>
<td> 
</td>
</tr>
<tr>
<td>Speed control from an external signal

Set SW1 as shown. If a 4 to 20mA reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to –25%. Press Enter.</td>
<td> 
</td>
</tr>
<tr>
<td>Preset speed
This provides a single fixed speed.</td>
<td>Select REMOTE from the REFERENCES menu. Use the arrows to display the options. Press Enter when PRESET is displayed. Now set your desired preset speed. No speed reference wiring is necessary</td>
</tr>
<tr>
<td>Console reference
This uses the Up and Down arrows on the front panel to control the speed.</td>
<td>Select REMOTE from the REFERENCES menu. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.</td>
</tr>
</table>

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	Remote	F01 REMOTE = AN1	66
	ESO	F03 ESO=PRESET (100%)	
	Ramp time in ESO	F06 ESO RAMP TIME = 10 sec	
Performance	Acceleration Time	C04 ACCEL TIME = 60 sec	59
	Deceleration Time	C05 DECEL TIME = 60 sec	

STEP 5. Now connect the wire to terminal 6.

End of procedure

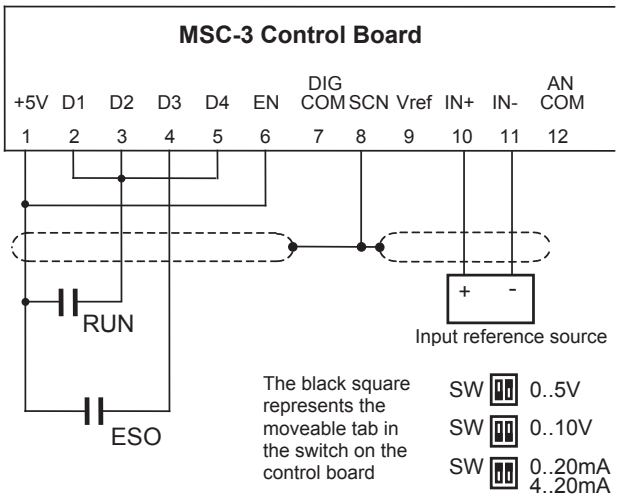
Application: Supply air or smoke spill fan

This setup is for a typical HVAC supply air or smoke spill fan application that requires speed control from a remote signal source for normal operation, a preset speed during essential services operation and local control from the front panel console. Prior to commissioning, you will need to know the type of speed signal is to be used (0-10V, 4-20mA etc)

Procedure

STEP 1. Complete the power wiring according to the instructions on page 7

STEP 2. Connect the control and signal wiring as shown. Set the switches on the control board to suit the type of signal[2].



CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3V is enabled.

Essential Services Override (ESO)

See page 63 for detailed information

Set SW1 as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to –25%. Press Enter.

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	Remote	F01 REMOTE = AN1	66
	ESO	F03 ESO=PRESET (100%)	
	Ramp time in ESO	F06 ESO RAMP TIME = 10 sec	
Performance	Acceleration Time	C04 ACCEL TIME = 60 sec	59
	Deceleration Time	C05 DECEL TIME = 60 sec	

STEP 4. Now connect the wire to terminal 6.

End of procedure

Application: Return air fan

This setup is for a typical HVAC return air fan application that requires speed control from a remote signal source for normal operation, and local control from the front panel console. Prior to commissioning, you will need to know the type of speed signal is to be used (0-10V, 4-20mA etc).

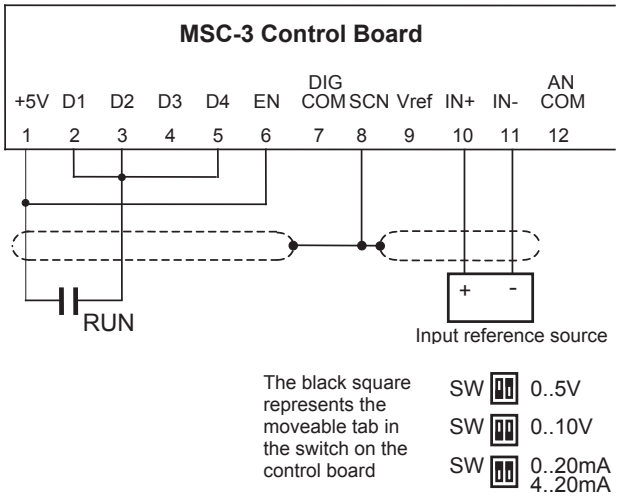
Procedure

STEP 1 Complete the power wiring according to the instructions on page 7

STEP 2 Connect the control and signal wiring as shown. Set the switches on the control board to suit the signal type[3].

CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3V is enabled.



STEP 3 Follow the instructions on page 47 for MSC-3V startup, setting the parameters according to the table below. Alternate values may be used to suit the application.

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	Remote	F01 REMOTE = AN1	66
Performance	Acceleration Time	C04 ACCEL TIME = 60 sec	59
	Deceleration Time	C05 DECEL TIME = 60 sec	

STEP 4 Now connect the wire to terminal 6

End of Procedure

[3] Set SW1 as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to –25%. Press Enter.

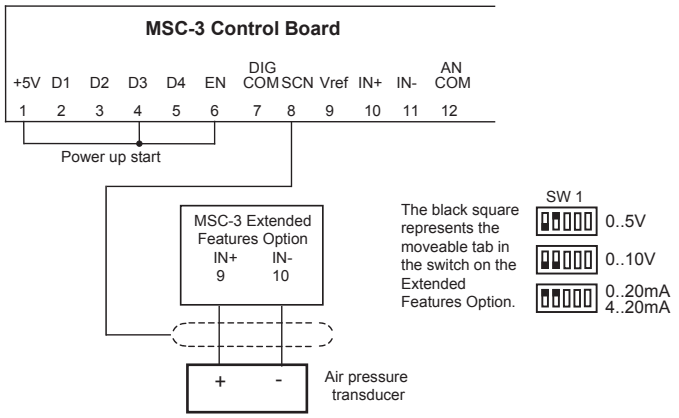
Application: Stair pressurisation fan with internal PID

This setup is for a typical HVAC stair pressurisation fan application that requires air pressure control using an air pressure transducer and PID controller function provided by the MSC-3V extended features option. The MSC-3 is configured to run in essential services override (ESO) mode. Prior to commissioning, you will need to know the type of air pressure transducer signal that is to be used (0-10V,4-20mA etc).

Procedure

STEP 1 Complete the power wiring according to the instructions on page 7

STEP 2 Connect the control wiring as shown.



CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3V is enabled.

Essential Services Override (ESO)

See page 63 for detailed information

STEP 3 Connect the signal wiring from the air pressure transducer as shown. Consult the pressure transducer manufacturer's literature for power supply requirements of the transducer. Set the switches on the extended features option board to suit the type of signal.

Set SW1 on the Extended Features Option as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Press ▲ until you see P22 ANALOG INPT. Press Enter. Set the REF AT 0% to –25%. Press Enter.

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	ESO	F03 ESO =P38.. PID OUTPUT	66
	Ramp Time in ESO	F06 ESO RAMP TIME = 10 sec	
PID Control	PID set point value	P33 SV CHOICE = PRESET 1 Set to % of transducer full scale equivalent to required pressure.	Extended Features Option Manual
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	

STEP 5 Now connect the wire to terminal 6

End of Procedure

Application: Stair pressurisation fan with external PID

This setup is for a typical HVAC stair pressurisation fan application that requires air pressure control using an air pressure transducer and a PID controller external to the MSC-3. The MSC-3V is configured to run in essential services override (ESO) mode. Prior to commissioning, you will need to know the type of speed signal that is to be used (0-10V, 4-20mA etc) between the output of the external PID controller and the MSC-3.

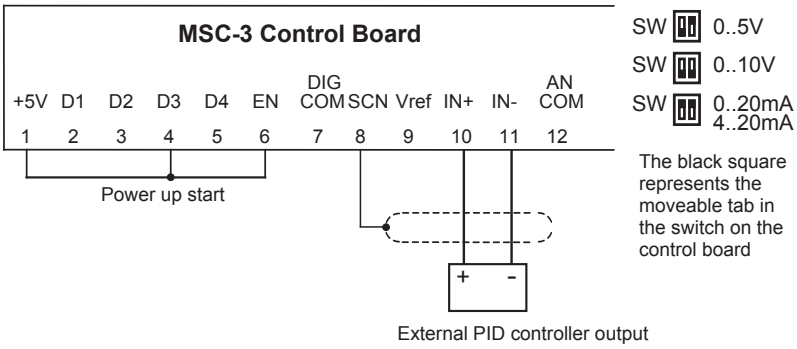
Procedure

STEP 1 Complete the power wiring according to the instructions on page 7

STEP 2 Connect the control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3 is enabled.



Essential Services Override (ESO)

See page 63 for detailed information

STEP 3 Connect the signal wiring from the external PID controller as shown. Consult the PID controller manufacturer's literature for other connections and power supples required by the PID controller. Set the switches on the control board to suit the type of signal[4].

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Reset by PF	E10 RESET BY PF = H00 ENABLE	65
References	ESO	F03 ESO = AN1	66
	Ramp time in ESO	F06 ESO RAMP TIME = 10 sec	
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	

STEP 5 Now connect the wire to terminal 6

End of procedure

[4] Set SW1 as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Set the REF AT 0% to –25%. Press Enter.

Application: Cooling tower fan with reverse acting internal PID

This setup is for a typical cooling tower fan application that requires water temperature control using a water temperature transducer and the PID controller function provided by the MSC-3V extended features option board. Prior to commissioning, you will need to know the type of temperature sensor signal that is to be used (0-10V, 4-20mA etc).

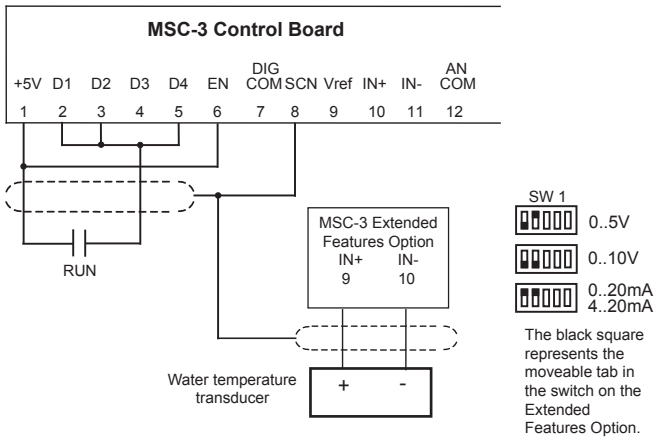
Procedure

STEP 1 Complete the power wiring according to the instructions on page 7

STEP 2 Connect the control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet. The terminal configuration cannot be changed while the MSC-3V is enabled.



STEP 3 Connect the signal wiring from the water temperature transducer as shown. Consult the transducer manufacturer's literature for power supply requirements of the transducer. Set the switches on the Extended Features Option to suit the type of signal.

Set SW1 on the Extended Features Option as shown. If a **4 to 20mA** reference is to be used, select REMOTE from the REFERENCES menu. AN1 should be displayed. Press Enter. Press ▲ until you see P22 ANALOG INPT. Press Enter. Set the REF AT 0% to –25%. Press Enter.

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

Menu	Item	Suggested Setting	Page for detailed information
Input/Output	Terminal strip configuration	G10 Enable/Reset = H01 ENABLE	71
		G11 DIG IN1 = I02 ~STOP	
		G12 DIG IN2 = I00 FWD & LATCH	
		G13 DIG IN = I08 ESO	
		G14 DIG IN4 = I11 REMOTE	
	Relay 1	G15 RELAY 1 = O00 RUN	74
	Relay 2	G16 RELAY 2 = O01 TRIP	
Motor	Motor Voltage	B01 MOTOR VOLTS = Motor nameplate voltage	55
	Motor Amps	B02 MOTOR AMPS = Motor nameplate amps	
	Motor Hz	B03 MOTOR Hz = Motor nameplate frequency	
	Motor RPM	B04 MOTOR RPM = Motor nameplate RPM	
Protection	Current Limit	D01 CURRENT LIMIT = Motor nameplate current +10%	61
	I^2t (thermal overload)	D02 I2t = Motor nameplate current	
Stop/Start	Auto Restart	E08 A/Rs ALLOWED = 5 starts	65
	Reset by PF	E10 RESET BY PF = H00 ENABLE	
References	Remote	F03 REMOTE = P38.. PID OUTPUT	66
Performance	Acceleration Time	C04 ACCEL TIME = 10 sec	59
	Deceleration Time	C05 DECEL TIME = 10 sec	
PID Control	PID Setpoint variable	P33 SV CHOICE = PRESET1 (set to % equal to the required temperature proportion of transducer full scale)	Extended Features Option Manual
	Proportional band control	P26 PB(%) = -300 Note: Negative value gives reverse acting PID	

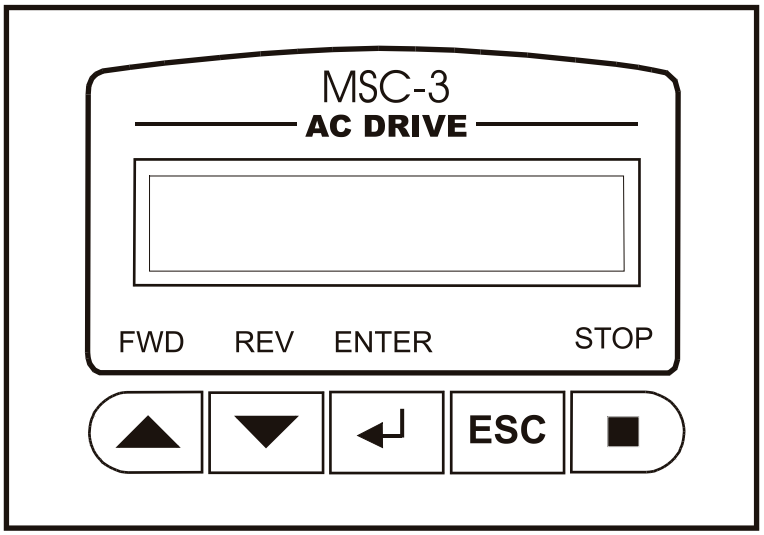
STEP 5 Now connect the wire to terminal 6

End of procedure

MSC-3V Start up

Connect the input and motor power wiring in accordance with the installation information on pages 8 - 18. Select the terminal configuration you require from the table on page 69. Connect the control wiring according to the appropriate Control Wiring Diagram or follow a quick setup. The MSC-3 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 MOTOR, PERFORMANCE and the INPUT/OUTPUT menus to set up the MSC-3 before running the motor to prevent any unexpected motor operation. The MSC-3 is supplied with a link between the En terminal and the +5V terminal which is all that is required to run the MSC-3 from the console. A connection between these two terminals must always be made for the motor to run.



The five pushbuttons and display form a console through which drive features and settings are altered to suit the application. When the MSC-3 is first powered up, the start banner is displayed for approximately 2 seconds. An example of the start banner is shown below. It displays the drive size, software version and the temperature of the MSC-3 hardware. While the banner is displayed the internal fan is switched on to verify it's operation. If the fan is not required it will then be turned off.

```
V44
V4.0.1.x        23C
```

MSC-3V Run mode

Once the start banner is removed the display is set in the Run Mode. The top line contains the run variable. The second line contains the speed reference and the drive status. An example of the Run Mode display is shown below:

```
25.0 Hz
50.0   FWD
```

The example shows that the desired output speed is 50 Hz and the motor is rotating at 25 Hz in the forward direction as indicated by the status.

In local mode, to start the drive, select a direction by pressing either of the run buttons: ▲FWD or ▼REV button. Use the ▲ FWD button to increase the speed reference and the ▼ REV button to decrease it. The motor should accelerate up to the desired speed. If it does not, refer to the Trouble Shooting Guide on page 81 of this manual.

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

Operation and access to the Run Mode and Menu Mode is done with the console push buttons. The action of each push button changes with the mode of operation and the state of the drive. The following table describes how the console push buttons affect the drive control.

Console Push Button operations

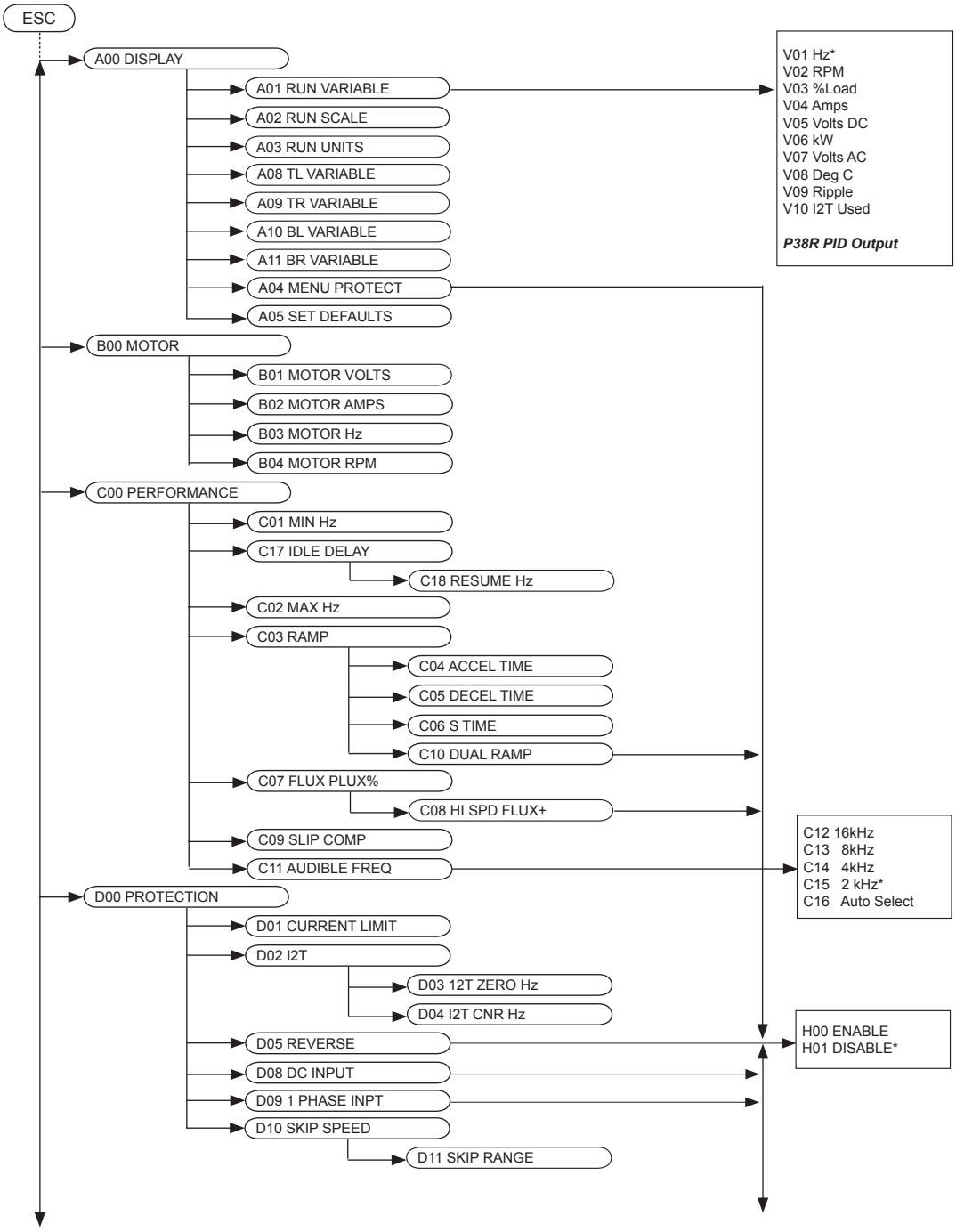
Console Mode	Motor Running	Motor Stopped
Menu mode used for entering setup information *i* Press ESC from the run display mode to enter menu mode.	• Pressing STOP will stop the motor • Pressing ▲ or ▼ will either select another menu item or adjust a setting • Pressing ↵ will select the displayed menu item or accept the value being adjusted. • Pressing ESC will abort value adjustment or the menu currently displayed. If the currently dispalyed menu is the top of the menu tree, the console changes mode to the Run Display mode	• Pressing STOP will not reset trip conditions to allow trip messages to be viewed after exiting menu mode • Pressing ▲ or ▼ will either select another menu item or adjust a setting • Pressing ↵ will select the displayed menu item or accept the value being adjusted. • Pressing ESC will abort value adjustment or the current menu. If the current menu is the top of the menu tree, the console changes mode to the Run Display mode
Run Display mode - when the CONSOLE REF **is** the active speed source	• Pressing STOP will stop the motor • Pressing ▲ or ▼ will either increase or decrease the motor speed • Pressing ↵ will have no effect • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode	• Pressing STOP will reset any trip condition • If no trip is present, pressing ▲ or ▼ will either start the motor running forward or reverse (internally latched). • If a trip is present, ▲ and ▼ adjust the speed reference without running the motor. • Pressing ↵ will toggle the drive operation between local and Remote if the Remote Override feature is enabled see page 40. If the Remote Override feature is not enabled pressing will have no effect. • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode
Run Display mode - when the CONSOLE REF **is not** the active speed source	• Pressing STOP will stop the motor • Pressing ▲,▼ or ↵ will have no effect • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode	• Pressing STOP will reset any trip condition. • Pressing ▲, ▼ will have no effect. • Pressing ↵ will toggle the drive operation between local and Remote if the Remote Override feature enabled. If the Remote Override feature is not enabled pressing will have no effect. • Pressing ESC will abort the Run Display mode and the console changes to the Menu mode.

MSC-3V Menu mode

The Menu mode is entered from the Run mode by pressing the ESC push button (pressing ESC again will return to Run mode). Use the ▲ and ▼ push buttons to display each menu item. To enter the menu press the ↵ push button. This action will either display another menu or display a setting ready for adjustment.

Control Console Menu

The following pages show the structure of the control console menu.



↵ Enter selects menu group (e.g. A00 DISPLAY) or parameter (e.g. V01 Hz)

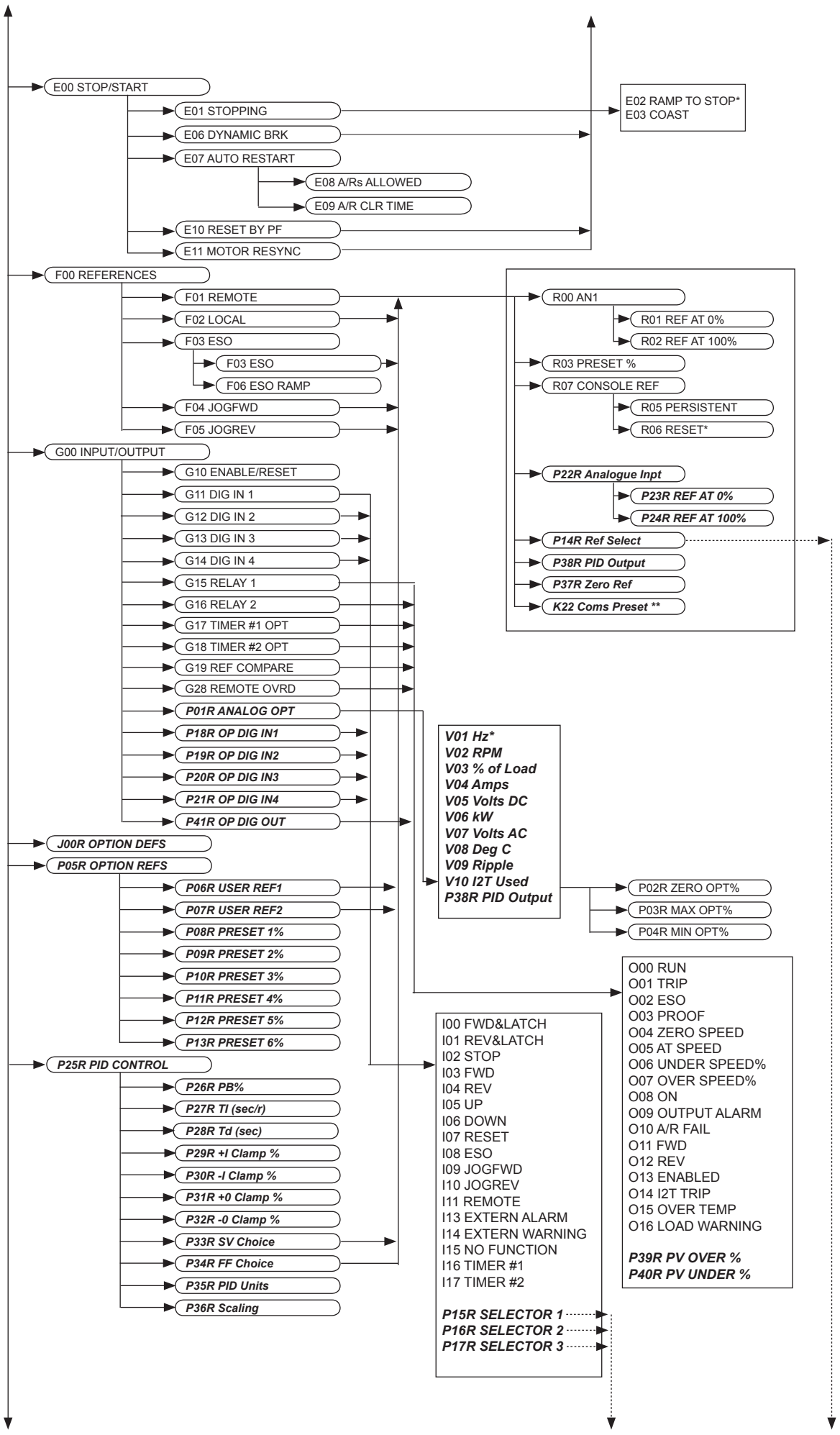
▲(Up) or ▼(Down) moves within menu group or for adjustable parameters changes the parameter value

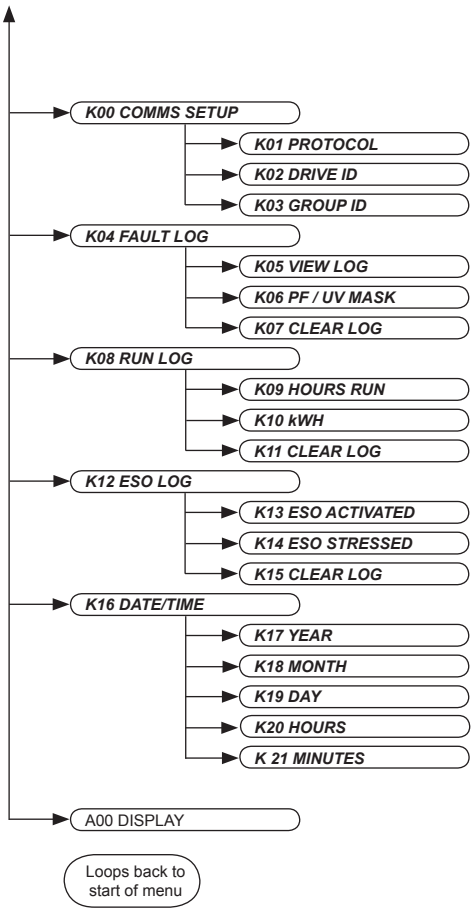
↵ Saves adjusted parameter value

ESC Ignores adjusted parameter value or retuns to previous menu level

Bold Italic Parameters on this page appear automatically on fitting the Extended Features Option card

* Indicates default setting e.g. default for A01 RUN VARIABLE is V01 Hz


E00 STOP/START
E01 STOPPING
E06 DYNAMIC BRK
E07 AUTO RESTART
E08 A/Rs ALLOWED
E09 A/R CLR TIME
E10 RESET BY PF
E11 MOTOR RESYNC
E02 RAMP TO STOP*
E03 COAST
F00 REFERENCES
F01 REMOTE
F02 LOCAL
F03 ESO
F03 ESO
F06 ESO RAMP
F04 JOGFWD
F05 JOGREV
R00 AN1
R01 REF AT 0%
R02 REF AT 100%
R03 PRESET %
R07 CONSOLE REF
R05 PERSISTENT
R06 RESET*
P22R Analogue Inpt
P23R REF AT 0%
P24R REF AT 100%
P14R Ref Select
P38R PID Output
P37R Zero Ref
K22 Coms Preset **
G00 INPUT/OUTPUT
G10 ENABLE/RESET
G11 DIG IN 1
G12 DIG IN 2
G13 DIG IN 3
G14 DIG IN 4
G15 RELAY 1
G16 RELAY 2
G17 TIMER #1 OPT
G18 TIMER #2 OPT
G19 REF COMPARE
G28 REMOTE OVRD
P01R ANALOG OPT
P18R OP DIG IN1
P19R OP DIG IN2
P20R OP DIG IN3
P21R OP DIG IN4
P41R OP DIG OUT
V01 Hz*
V02 RPM
V03 % of Load
V04 Amps
V05 Volts DC
V06 kW
V07 Volts AC
V08 Deg C
V09 Ripple
V10 I2T Used
P38R PID Output
P02R ZERO OPT%
P03R MAX OPT%
P04R MIN OPT%
J00R OPTION DEFS
P05R OPTION REFS
P06R USER REF1
P07R USER REF2
P08R PRESET 1%
P09R PRESET 2%
P10R PRESET 3%
P11R PRESET 4%
P12R PRESET 5%
P13R PRESET 6%
O00 RUN
O01 TRIP
O02 ESO
O03 PROOF
O04 ZERO SPEED
O05 AT SPEED
O06 UNDER SPEED%
O07 OVER SPEED%
O08 ON
O09 OUTPUT ALARM
O10 A/R FAIL
O11 FWD
O12 REV
O13 ENABLED
O14 I2T TRIP
O15 OVER TEMP
O16 LOAD WARNING
P39R PV OVER %
P40R PV UNDER %
P25R PID CONTROL
P26R PB%
P27R TI (sec/r)
P28R Td (sec)
P29R +I Clamp %
P30R -I Clamp %
P31R +0 Clamp %
P32R -0 Clamp %
P33R SV Choice
P34R FF Choice
P35R PID Units
P36R Scaling
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
I13 EXTERN ALARM
I14 EXTERN WARNING
I15 NO FUNCTION
I16 TIMER #1
I17 TIMER #2
P15R SELECTOR 1
P16R SELECTOR 2
P17R SELECTOR 3



Bold Italic Parameters on this page appear automatically on fitting the Extended Features Option e.g. ***P22R Analog Inpt*** is the analogue input of option card fitted in the right slot, left slot would be ***P22L Analog Inpt***.

* Indicates default setting

** Any communications option card fitted

P14R Ref Select	*P15R Selector 1*	*P16R Selector 2*	*P17R Selector 3*
P06R User Ref 1	Low	Low	Low
P07R User Ref 2	Low	Low	High
P08R Preset 1	Low	High	Low
P09R Preset 2	Low	High	High
P10R Preset 3	High	Low	Low
P11R Preset 4	High	Low	High
P12R Preset 5	High	High	Low
P13R Preset 6	High	High	High

i The parameters shown here are specifically for the Modbus protocol communication option. Communication options for other protocols will have parameters specific to that protocol as well as the more general parameters shown here. See individual communications option instruction manuals for further information.

Bold Italic Parameters on this page appear automatically on fitting the Modbus option card

A00 DISPLAY

This menu allows selection of run variables and, in the case of output frequency, adjustment of its display format and units. It also provides a restore factory defaults function.

A01 RUN VARIABLE

A single run variable is selected from this menu for display on the run screen.

V01 Hz	Output Frequency
V02 RPM	Motor Speed
V03 % Load	Relative Motor Load
V04 Amps	Drive ouput current
V05 Volts DC	DC link voltage
V06 kW	Drive output power
V07 Volts AC	Cycles drive output voltage/V_{uv}/V_{vw}
V08 C	Power circuit temperature (Celsius)
V09 Ripple	A number proportional to the RMS current in the DC bus capacitors, provided for factory diagnostic purposes
V10 I^2t used	Motor thermal overload level

A02 RUN SCALE

Default Value: 50.0

The default run variable is output frequency in Hz. This is the only run variable that may be re-scaled. It can be changed to any number from 1.0 to 9999 (or 999.9 with one decimal place). Set this to the value that you want to see when the MSC-3 is operating at maximum speed.

With ***A02 RUN SCALE*** displayed on the top line, press enter and the run scale value is displayed ready for edit. Use the up and down push buttons to adjust each individual digit. Press Enter to move to the next digit. To abandon the adjustment at any time, press the ESC push button.

Once the last digit has been adjusted, press Enter. The value remains on the display and is waiting for decimal point assignment. Use the up and down push buttons to shift the decimal point and Enter to accept the position.

Press ESC to return to ***A00 DISPLAY.***

A03 RUN UNITS

Default Value: Hz

The MSC-3 is able to display the output frequency in user defined units. The default setting is Hz, but it can be changed, so that the display will show user preferred units. For example, mtr/min, Cans/hr or anything else up to 8 characters. The output frequency is the only run variable whose units can be changed. The available characters are found in Appendix A

With ***A03 RUN UNITS*** displayed on the top line press Enter and the existing run units are displayed on the second line. Use the up and down push buttons to select a different character.

When the desired character is displayed, press Enter and the next character may now be adjusted. Repeat this seven more times. Changes to the run units can be abandoned at any point by pressing the ESC push button.

When the eighth character is selected, pressing Enter will accept the new units setting.

A07 Meter Disp.

This menu allows selection of the meter display where four run variables are displayed at once. For example:

50.0Hz	15.3A
90%L	11.2kW

Pressing Enter reveals the selection for each position of the meter display. The meter display is shown when escaping the menus.

A08 TL Variable

Default Value: **V01** Hz

Select the variable for the top left position

A09 TR Variable

Default Value: **V04** Amps

Select the variable for the top right position

A10 BL Variable

Default Value: **V03** %Load

Select the variable for the bottom left position

A11 BR Variable

Default Value: **V06** kW

Select the variable for the bottom right position

Each menu selects a single run variable. Pressing Enter accepts the current choice and reveals the next variable selection. Pressing Enter after ***A11 BR Variable*** menu returns to the ***A07 Meter Disp.*** menu.

Pressing ESC aborts the selection and returns to the A07 Meter Disp. menu.

Available choices for each menu above:

V01 Hz	Output Frequency
V02 RPM	Motor Speed
V03 % Load	Relative Motor Load
V04 Amps	Drive output current
V05 Vdc	DC link voltage
V06 kW	Drive output power
V07 Vac	Cycles drive output voltage/V_{uv}/V_{vw}
V08 C	Power circuit temperature (Celcius)
V09 Ripple	A number proportional to the RMS current in the DC bus capacitors, provided for factory diagnostic purposes
V10 I2t used	Motor thermal overload level
	Options

A04 Menu Protect

The feature protects the entire menu mode with a code so that settings and configurations are protected from unauthorized changes. After you enable this feature, return to the Run Screen. The next time anyone presses ESC to enter the Menu mode the following message will appear:

A07 Enter Code
0

Use the up and down buttons to adjust the code value to the number 1470. Press Enter to accept. If entered correctly, the familiar menu mode will be displayed. If the correct code is not entered you are returned back to the run screen.

A05 SET CTL DEFS

This menu allows the factory default parameters to be reinstalled. The MSC-3 must be disabled before you can restore the defaults. Pressing the Enter button will cause the message ***A06 CHECK WIRING*** to be displayed. This is intended as a warning and an opportunity to confirm that terminal wiring is suited to the default settings, otherwise unexpected drive operation may result.

Pressing the ENTER button again will cause the defaults to be loaded.

B00 MOTOR

This menu allows you to enter motor nameplate information. Press the Enter button to view and modify Motor Volts, Motor Amps, Motor Hz and Motor rpm.

B01 MOTOR VOLTS

Default value: 1000 V

Range: 900...1100 V

Use the up or down push buttons to adjust this setting to the motor nameplate voltage. Press Enter when finished and the motor nameplate current is displayed or ESC to abort the adjustment

B02 MOTOR AMPS

Default value: The current listed on page 79 under Continuous current for general purpose rating for the particular MSC-3V model.

Range: 18 to 137% of drive overload current listed in the MSC-3 Output Current Specifications table on page 81.

Use the up or down push buttons to adjust this setting to the motor nameplate current in amps. Press Enter when finished and the motor frequency is displayed or ESC to abort the adjustment.

Entering the Nameplate Current of your motor determines the operation points for the Flux Plus (page 60) and Slip Comp (page 60) features. This setting is not used to limit the output current of the MSC-3. Refer to ***D01 CURRENT LIMIT*** for that particular feature.

B03 MOTOR Hz

Default value: 50 or 60 Hz

Range: 30..200 Hz

Use the up or down push buttons to adjust this setting to the motor nameplate frequency (Hz). Press Enter when finished or ESC to abort the adjustment. This setting does not affect the minimum or the maximum frequency output of the MSC-3. Refer to ***C01 MIN Hz*** and ***C02 MAX Hz*** for those features.

B04 MOTOR RPM

Default value: 1465 or 1765 RPM

Range: 500 RPM...(60 times the ***B03 MOTOR Hz*** entered previously) RPM

Enter the motor nameplate RPM data. Use the ▲ or ▼ push buttons to adjust this setting to the motor nameplate speed (RPM). Press Enter when finished or ESC to abort the adjustment.

C00 PERFORMANCE

This section allows you to set the motor performance characteristics.

C01 MIN Hz

Default value: 0 Hz

Range: 0 to 195Hz

This sets the minimum frequency that the MSC-3 will run at when given a run signal. The value is entered in Hz. There must be a difference of at least 5Hz between the MIN Hz and the MAX Hz setting. For example, if MAX Hz is set to 45Hz, then the largest allowed value for MIN Hz is 40Hz. Use the up or down push buttons to adjust the MIN Hz value, press Enter to accept the value or press ESC to abort the adjustment. It is possible to use the full span of the analog input to adjust the speed reference through the remaining reduced speed range. For example: Max Hz = 50Hz and Min Hz = 20Hz, the analog input ***R01 Ref at 0%*** should be set to 40%. Zero at the analog input will produce a reference of 20Hz. Full span at the input will produce a reference of 50Hz.

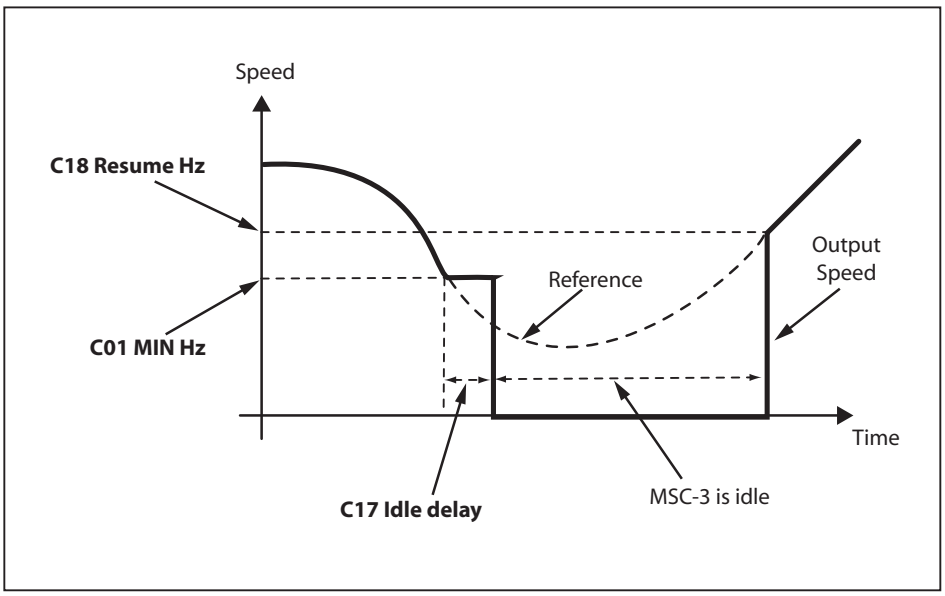
Minimum Speed Idle Function

The minimum speed idle function will stop MSC3 operation if the output frequency has been C01 MIN Hz for a time interval specified by C17 Idle delay. The MSC3 will restart operation when the reference exceeds the C18 Resume Hz value. This feature can function with references sourced from option boards as well (e.g. PID control reference from the extended features option)

Note the conditions for the MSC3 to enter the idle state are:

- MSC3 output enabled (the “EN” terminal connected to “+5V” terminal).
- MSC3 must not be tripped.
- Reverse is disabled (D05 Reverse).
- ESO is not active.
- The jog function is not active.
- No motor stop condition exists: ~STOP wiring in remote mode; STOP push button press in local mode.
- A run signal is given: FWD & LATCH wiring in remote mode; FWD push button press in local mode.
- The C18 Resume Hz value must be greater than the C01 MIN Hz value.
- The selected speed reference is lower than both C01 MIN Hz speed and the
- C18 Resume Hz value for the C17 Idle delay period.

The diagram below illustrates the function.



C17 Idle delay

Default value: 20 sec

Range: 0 to 600 sec

The ***C17 Idle delay*** sets the time interval of operation at minimum speed before the MSC-3V enters the idle state. Use the up or down buttons to adjust the idle delay time or press ESC to abort adjustment.

C18 Resume Hz

Default value: 0 Hz

Range: 0..200 Hz

The ***C18 Resume Hz*** is the speed reference threshold above which the MSC-3V resumes normal operation. If the value for ***C18 Resume Hz*** is less than the ***C01 MIN Hz*** value, the idle function is disabled and the MSC3 will operate at or above the ***C01 MIN Hz*** speed indefinitely Use the up or down buttons to adjust resume Hz value or press ESC to abort adjustment.

C02 MAX Hz

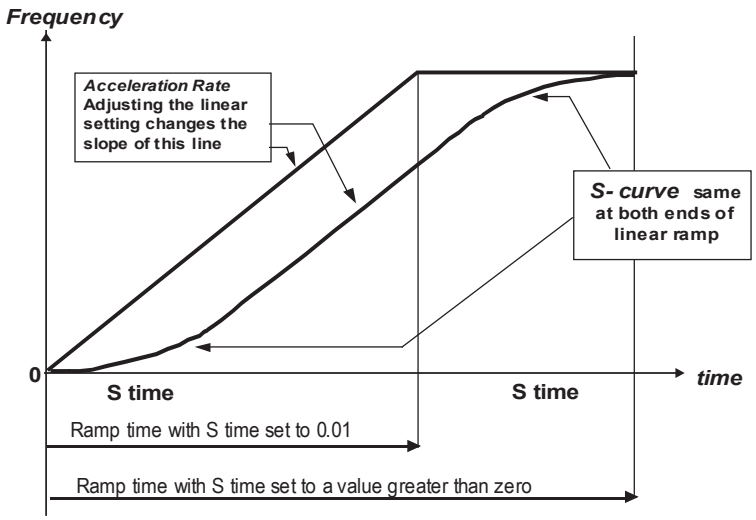
Default value: 50 or 60Hz (depends on model)

Range: 5Hz to 200Hz

This sets the frequency that the drive will run with the speed reference at maximum. There must be a difference of at least 5Hz between the MIN Hz and the MAX Hz setting. Changing this value scales the ***A02 RUN SCALE*** by the proportional amount. Use the up or down push buttons to adjust the MAX Hz value, press Enter to accept the value or press ESC to abort the adjustment.

C03 Ramp

The MSC-3 has a programmable Ramp with adjustable acceleration, deceleration and S-curve rates. Individual settings are provided for the linear and curved portions of the ramp



When the motor accelerates, the ACCEL TIME and S TIME settings are used. When the motor decelerates, the DECEL TIME and S TIME settings are used. Press Enter to adjust these parameters.

CAUTION

A separate ramp setting is used during Essential Services Override (ESO) operation. See ***F06 ESO Ramp*** on page 66 for details.

Alterations to any ramp parameter is not permitted while the drive is operating in ESO mode, (see page 63 for more information on ESO)

C04 ACCEL TIME

Default value: 10 sec

Range: 0.5 to 600 sec

The ACCEL TIME is the time taken for the motor to go from zero speed up to motor rated speed (assuming minimum S TIME). An MSC-3 with Motor Hz set to 50 Hz and an ACCEL TIME of 10 seconds will take 10 seconds to go from 0 Hz to 50 Hz. Use the up or down buttons to adjust the ACCEL TIME or press ESC to abort adjustment.

C05 DECEL TIME

Default value: 10 sec

Range: 0.5 to 600 sec

The DECEL TIME is the time taken for the motor to go from motor rated speed down zero speed (assuming minimum S TIME). An MSC-3 with Motor Hz set to 50 Hz and a DECEL TIME of 10 seconds will take 10 seconds to go from 50 Hz to 0 Hz. Use the up or down buttons to adjust the DECEL TIME or press ESC to abort adjustment.

C06 S TIME

Default value: 0.01 sec

Range: 0.01 to 40.00 sec

The S TIME is the time taken for the motor to reach the limit of acceleration (as set by the rated speed and the ACCEL TIME or DECEL TIME). Using the S TIME ensures smooth speed increases and decreases. The longer the S TIME, the smoother the speed transition.

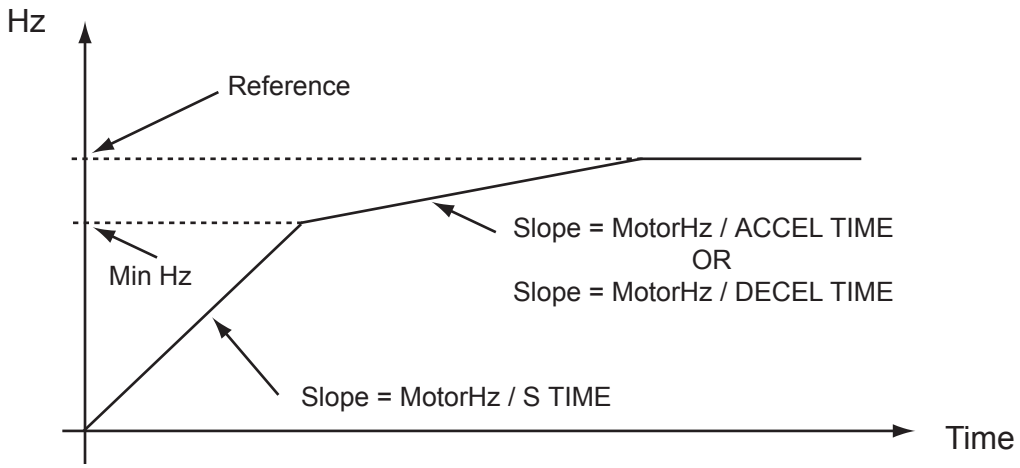
The S TIME will extend the ramp time as set by the ACCEL and DECEL TIME. The ramp time is now approximately equal to the S TIME plus ACCEL TIME or DECEL TIME.

C10 Dual Ramp

Available Choices: H00 ENABLE

H01 DISABLE (Default)

When this feature is enabled, the C06 S TIME parameter specifies the acceleration and deceleration below the C01 MIN Hz setting. Above the C01 MIN Hz setting, the acceleration and deceleration times are as per C04 ACCEL TIME and C05 DECEL TIME respectively. Note that there is no S time when this feature is enabled. The following graph demonstrates this feature.



C07 Flux plus %

Default value: 25%

Range: 0 to 200% of adjustment range

The MSC-3 uses a sensorless flux vector control algorithm to control the motor operation. This control algorithm provides independent control of motor flux throughout the speed range and is highly robust against motor parameter changes. It uses the motor nameplate parameters entered in the B00 MOTOR menu as the basis for its calculations to produce the correct flux in the motor. For a motor to produce full torque it must have the correct flux applied to it. This is particularly critical at low speed. Flux Plus adjusts the motor flux estimate to provide additional control where specific adjustments to the motor torque response are required.

This feature enables an adjustment in the flux vector algorithm that can increase motor flux to produce more torque for the same motor current. The amount of extra torque produced will vary from motor to motor depending on motor size, efficiency and the operating speed.

Increase the value to produce more torque. This should be done in small steps to ensure the drive does not go into Current Limit. If the drive does go into current limit decrease the Flux Plus value slightly. This is the maximum torque that the motor can produce.

Use the up or down buttons for the adjustment. Press Enter when adjusted or ESC to abort adjustment.

C08 Hi Spd Flux+

Available Choices: H00 ENABLE

H01 DISABLE (default)

When this is disabled the flux plus decreases with increasing speed. This allows more efficient operation of the MSC-3 on loads that have a high starting torque but do not require any extra torque during normal operation. If your load requires high torque throughout the entire speed range Enable Hi Spd Flux+. Press Enter to view the setting. Use the up or down push button to enable or disable Hi Spd Flux+. Press Enter to accept the new setting or ESC to abandon.

C09 SLIP COMP

Default value: 0%

Range: 0 to 150% of slip speed

Motor slip is the difference between the shaft speed and the frequency applied to the motor (synchronous speed) and is dependent on load. Slip Comp can provide compensation for this varying slip to produce near constant shaft speed under varying loads. The MSC-3 estimates the slip of the motor using the parameters entered in the MOTOR parameters menu and the motor load. A value of 100% nominally correct for the slip speed implied by the ***B04 MOTOR RPM*** setting. Flux Plus may be used in conjunction with Slip Comp to provide increased output torque at low speeds. Press Enter then use the up and down buttons to adjust the amount of SLIP COMP. When adjusted, press Enter to accept the new setting or ESC to abort the adjustment.

C11 AUDIBLE FREQ

Available Choices:

C12 16kHz

C13 8kHz

C14 4kHz

C15 2kHz (default)

C16 Auto select

This value sets the maximum frequency that the drive uses in the creation of its PWM output voltage. This frequency is noticeable as an audible sound that the motor makes. Usually higher settings produce less audible noise but increase the switching losses, which produces more heat in the drive. For most efficient operation select 2 kHz. Press Enter then use the up or down buttons to choose the AUDIBLE FREQ. Press Enter when finished to accept the choice or ESC to abort. The ***C16 AUTO SELECT*** automatically chooses the highest audible frequencies that is consistent with the measured heat sink temperature and other operating conditions of the MSC-3.

D00 PROTECTION

This section lets you set the motor protection features.

D01 CURRENT LIM

Default value: 110% of the current listed on page 81 under Continuous current for general purpose rating for the particular MSC-3V model.

Range: 18 to 100% of drive overload current listed in the MSC-3 Output Current Specifications table on page 81.

This sets the maximum output current of the MSC-3. If excessive load is applied to the motor, the drive will only apply this amount of current to the motor until the overload condition is removed. Current limiting is achieved by reducing the speed of the motor. The Current Limit value cannot be set higher than the maximum overload current for the drive.

Press Enter then use the up or down buttons to adjust the CURRENT LIM. Press Enter when finished to accept the adjustment or ESC to abort.

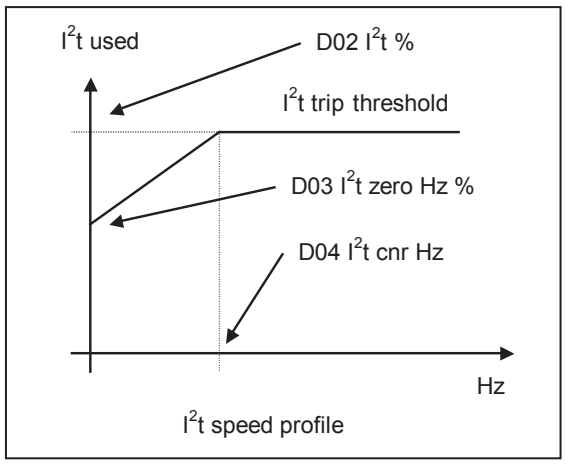
D02 I2t

The I^2t feature estimates the heating of the motor according to the motor load. When the estimated heating exceeds I^2t setting, the drive will trip on I^2t. For a motor running at 110% of its I^2t current this will take approximately two minutes. The time to trip will shorten with higher motor currents.

I^2t motor heating estimate data is maintained while ever power is applied to the MSC-3 regardless of stopping or starting the motor.

If power is removed from the drive after an I^2t trip, the motor should be allowed to cool down before the inverter is restarted. Motors running highly loaded at low speeds should have external cooling and an external motor thermal sensing device such as microtherms or thermistors for protection.

The I^2t feature has the ability to set the trip threshold as a function of output frequency. This allows the I^2t to protect motors that have reduced cooling at low speeds because they are not externally cooled. The diagram below is an example of the I^2t trip threshold profile.



CAUTION

The I^2t function is disabled during Essential Services Override (ESO) operation. See page 63 for more information.

D02 I2t

Default value: The current listed on page 81 under Continuous current for general purpose rating for the particular MSC-3V model.

Range: 18 to 100% of the current listed on page 65 under Continuous current for general purpose rating for the particular MSC-3V model.

This sets the upper limit of I^2t and is entered in amps. This is equivalent to the usual I^2t setting. Use the up and down push buttons to adjust the D02 I2t value and press Enter to accept the value or ESC to abandon changes.

D03 I2t zero Hz

Default value: The current listed on page 81under Continuous current for general purpose rating for the particular MSC-3V model.

Range: 18 to 100% of the current listed on page 81 under Continuous current for general purpose rating for the particular MSC-3V model.

This sets the trip threshold when the speed is zero. This value cannot be set higher than the ***D02 I2t*** value set above. Use the up and down push buttons to adjust the ***D03 I2t zero Hz*** value and press Enter to accept the value or ESC to abandon changes.

D04 I2t cnr Hz

Default value: 10Hz

Range: 2 to 200Hz

The D04 I2t cnr Hz value sets the frequency above which the profile uses the trip threshold as set by ***D02 I2t***. Below this frequency the I^2t value is set by the slope on the I^2t profile. Use the up and down push buttons to adjust the D04 I2t value and press Enter to accept the value or ESC to abandon changes.

D05 Reverse

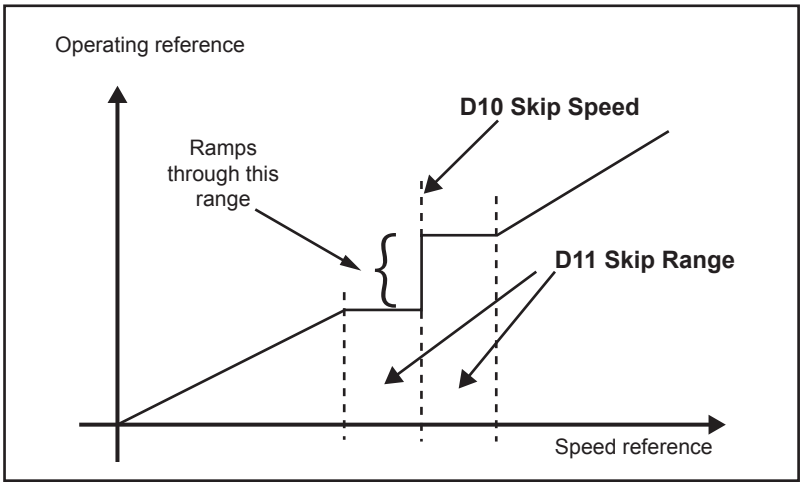
Available Choices: H00 ENABLE

H01 DISABLE (default)

The MSC-3 is shipped with its reverse direction disabled to prevent damage to mechanical devices or hazardous equipment operation caused by the motor running backwards. Press Enter to view the setting. Use the up or down push button to enable or disable Reverse. Press Enter to accept the new setting or ESC to abandon.

D10 Skip Speed

In some systems, operating a motor within a certain range of speeds can cause system instability, which may lead to hazardous or damaging conditions. The skip speed feature provides the MSC3 a means to avoid operation at these speeds. The MSC3 allows the motor to accelerate or decelerate through the speed range as normal, but will not permit the motor to settle in the troublesome speed range. The diagram below shows how the speed profile is affected by a skip speed.



D10 Skip Speed

Default value: 30 Hz

Range: 0..200Hz

This sets the centre or main frequency to skip. Use the up and down push buttons to adjust the D10 Skip Speed value and press Enter to accept the value or ESC to abort the adjustment.

D11 Skip Range

Default value: 0 Hz

Range: 0..200Hz

This sets the frequency range either side of the D10 Skip Speed. Use the up and down push buttons to adjust the D11 Skip Range value and press Enter to accept the value or ESC to abort the adjustment.

Essential Services Override

There are circumstances in some applications for which it is desirable to disable certain of the protective features of the MSC-3. These are situations where continued operation has a higher priority than preventing damage to the MSC-3 or associated motor. A typical example is a building air conditioning application in which a fan is required to operate as part of a smoke clearance system. Various standards, for example, AS/NZS 1668.1:1998: *The use of ventilation and air conditioning in buildings - Fire and smoke control in multi-compartment buildings* require that all thermal protection be disabled during operation in a smoke clearance mode and equipment allowed, if necessary, to run to destruction.

The MSC-3 provides a special mode, Essential Services Override (ESO), to give effect to these requirements. Operation in ESO requires a control terminal to be configured for the ESO function and that this terminal to be connected to +5V (terminal 1) whenever ESO operation is required.

During ESO operation the MSC-3 is forced to run and the following protective functions are disabled:

- Heatsink over temperature protection
- I^2t protection
- Motor thermistor protection (if fitted)
- Supply Fail

In addition, the Auto Restart function is automatically enabled with unlimited auto restarts permitted.

In order to allow the MSC-3 to be independently optimised for both the usual operating condition and

operation in ESO mode, separate parameters are provided for ESO and non ESO operating modes.

Function	Parameter for normal (non - ESO) operation	Parameter for ESO operation
Acceleration time	C04 ACCEL TIME	F06 ESO RAMP
Deceleration time	C05 DECEL TIME	
Source of speed reference	F01 REMOTE F02 LOCAL F04 JOGFWD F05 JOGREV	F03 ESO

In addition, Relay Output Function O02 (see page 74 under ***G15 RELAY 1***) may be used to indicate that the MSC-3 is in ESO mode.

WARNING regarding Essential Services Override

The Essential Services Override (ESO) feature provides a “run to destruction” mode of operation for applications that justify this approach. For applications in which this approach is not mandatory, the safety and other implications of the ESO operating mode should be carefully considered in the light of alternative approaches before choosing to use the ESO functionality of the MSC-3. It is fundamental to the ESO mode of operation that all protection against overheating of the MSC-3 and the associated motor is disabled. This may represent a fire or other hazard. Damage to the MSC-3 due to overheating during ESO operation is not covered by warranty.

Equipment that has been exposed to ESO operation under conditions that may have been outside the normal boundaries of rated operation should be inspected for damage and internal component degradation prior to being returned to service in a critical application. This inspection and any necessary repairs should be conducted irrespective of whether the MSC-3 appears to be working normally or not. Only competent personnel should undertake this work.

CAUTION

Any use of the Essential Services Override feature should be arranged to comply with all local rules and regulations concerning the particular application.

E00 STOP/START

This section sets the motor stopping and starting modes.

E03 Coast stop

Choices: H00 Enabled
H01 Disabled (default)

Enabling ***E03 Coast stop*** instantly removes voltage applied to the motor permitting the motor shaft to coast to zero speed in a time governed by the mechanical load coupled to the shaft. By disabling ***E03 Coast stop***, the motor shaft is stopped in a controlled manner in a time governed by ***C03 Ramp*** settings. Press up or down push buttons to enable or disable coast stop mode. Press Enter to select the new setting or ESC to abort.

E06 DYNAMIC BRK

Available Choices: H00 ENABLE
H01 DISABLE (default)

Dynamic Braking provides the means for dissipating the motor regenerative energy into an external resistor.

This may be required when the MSC-3 experiences regenerative currents from an overhauling load or a high inertia load that is required to decelerate rapidly. Dynamic Braking requires the dynamic braking option to be connected to the MSC-3. Please see the dynamic braking instruction manual for resistor sizing and dynamic braking application information.

Use the up or down buttons to select either Enable or Disable. Press Enter to accept the selection or ESC to abort.

E07 AUTO RESTART

Auto Restart allows the MSC-3 to automatically attempt to restart after a trip occurs. If the MSC-3 trips, it will wait 10 seconds then attempt to clear the fault. If it is unsuccessful it will keep trying every ten seconds. It will do this the number of times specified in A/Rs ALLOWED. If the fault is cleared and the drive runs without tripping for the ***E09 A/R CLR TIME*** the number of auto restarts attempted will start counting from one again. If the trip is cleared by any other means the fault count will start from one again.

Note: Alteration to any of the Auto Restart parameters is not permitted while the MSC-3 is operating in ESO mode.

E08 A/Rs ALLOWED

Default value: 0

Range: 0 to 15 restarts

This number indicates how many times the MSC-3V will attempt to restart after a trip. For the motor to run after the trip is cleared, the drive must be given a valid run command. Select 0 restarts in order to de-activate Auto Restart.

Use the up or down buttons to adjust A/Rs ALLOWED. Press Enter to accept the adjustment or ESC to abandon.

E09 A/R CLR TIME

Default value: 20 min

Range: 0.1 to 20 min

If the MSC-3 operates for the ***E09 A/R CLR TIME*** without any trips occurring the number of restarts is reset to the value of ***E08 A/Rs ALLOWED***. Set the ***E09 A/R CLR TIME*** to 0.1min for infinite auto restarts.

Use the up or down buttons to adjust ***E09 A/R CLR TIME***. Press Enter to accept the adjustment or ESC to abort.

E10 Reset by PF

Available Choices: H00 ENABLE

H01 DISABLE (default)

Enabling this facility allows the MSC-3V to reset all trips when a momentary power failure occurs. This feature is useful in power-up start applications because trips may be cleared without any extra switch logic by turning the power off and straight back on again without waiting for the drive to completely power down.

Use the up or down buttons to select either Enable or Disable. Press Enter to accept the selection or ESC to abort.

E11 Motor Resync

Available choices: H00 ENABLED

H01 DISABLED (default)

This menu enables (or disables) the motor resynchronisation function. When enabled the MSC-3V assumes the motor shaft is spinning at an unknown speed prior to commencement of operation. When- operation begins the MSC-3V scans for the shaft speed. When the shaft speed is detected, a smooth transition into operation begins. The motor resynchronisation function avoids slowing the motor shaft through current limit braking.

Use the up or down push buttons to enable or disable motor resynchronisation. Press Enter to accept the new setting or ESC to abandon.

F00 REFERENCES

This lets you set the speed references for all the MSC-3 operating modes. When options e.g. Extended Features Option are fitted the extra input options will appear where the word “Options” appears in the lists below. More preset speeds or a second analog input are examples of this.

For more information on the different drive operating modes see the Control Connections and Configurations on page 21

F01 REMOTE

Choices: R00 AN1 (default)
R03 PRESET %
R07 CONSOLE REF
Options‡

When the drive is operating in remote mode it will take its speed reference from this source. Use the up and down push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

F02 LOCAL

Choices: R00 AN1
R03 PRESET
R07 CONSOLE REF (default)
Options‡

When the drive is operating in local mode it will take its speed reference from this source. Use the up and down push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

F03 ESO

Choices: R00 AN1
R03 PRESET (default)
R07 CONSOLE REF
Options‡

When the drive is operating in ESO mode it will take its speed reference from this source. Use the up and down push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

If Reverse operation is required in ESO enter the desired speed as a negative value.

F06 ESO Ramp

Default value: 10.0 sec
Range: 0.5 to 600 sec

When the drive is operating in ESO mode it will use this ramp setting for acceleration and deceleration instead of the ***C04 ACCEL TIME*** and ***C05 DECEL TIME*** settings.

The ESO Ramp time is the time taken for the motor to go from zero speed up to motor rated speed (assuming minimum S TIME). A MSC-3 with the Motor Hz set to 50 Hz and an ESO Ramp of 10 seconds will take 10 seconds to go from 0Hz to 50Hz. Use the up or down buttons to adjust the ESO Ramp or press ESC to abort adjustment.

‡ Various additional speed reference options will appear in the list when an option e.g. Extended Features Option, is fitted.

F04 JOGFWD

Choices: R00 AN1
R03 PRESET (default)
R07 CONSOLE REF
Options‡

When the drive is running in JOGFWD it will take its speed reference from this source. Use the up and down push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

F05 JOGREV

Choices: R00 AN1
R03 PRESET (default)
R07 CONSOLE REF
Options‡

When the drive is running in JOGREV it will take its speed reference from this source. Use the up and down push buttons to select a reference and press Enter to accept the selection or ESC to abandon.

‡ Various additional speed reference options will appear in the list when an option e.g. Extended Features Option, is fitted.

Speed References

R00 AN1

When the Analog Input is selected as a speed reference for any of the different operating modes, two parameters need to be checked. The MSC-3 will let you do this every time the analog input is selected as a reference. They are ***R01 REF AT 0%*** and ***R02 REF AT 100%***. Use the up or down buttons to change the values (if required). Press enter to accept the value or ESC to abort.

MSC3 Analog Input Scaling

To calculate the values for REF AT 0% and REF AT 100% you need to know the following:

- Two analog input values and the speed required at each value
- The maximum speed.
- The input range, 5V, 10V or 20mA

Now use the following formulae to calculate the values for REF AT 0% and REF AT 100%

$$m = \frac{\frac{highspeed - lowspeed}{max\ speed}}{highinput - lowinput}$$

$$REFAT0\% = (\frac{highspeed}{max\ speed} - m * highinput) * 100$$

$$REFAT100\% = 100 * m * inputrange + REFAT0\%$$

Examples:

Standard 4-20mA At 4mA input we want 0Hz and at 20mA input we want 50Hz, maximum speed 50Hz using the 0-20mA input range.	**Bipolar Input** At 1V input we want 40Hz in reverse and at 4V input we want 30Hz in forward, maximum speed 40Hz using the 0-5V input range.
$m = \frac{\frac{50-0}{50}}{20-4} = 0.0625$ $REFAT0\% = (\frac{50}{50} - 0.0625 * 20) * 100 = -25$ $REFAT100\% = 100 * 0.0625 * 20 - 25 = 100$	$m = \frac{\frac{30+40}{40}}{4-1} = 0.583$ $REFAT0\% = (\frac{30}{40} - 0.583 * 4) * 100 = -158$ $REFAT100\% = 100 * 0.583 * 5 - 158 = 133$
Reduced Input Range At 2V input we want 30Hz and at 4V input we want 40Hz, maximum speed 60Hz using the 0-10V input range.	**Inverse Acting Bipolar Input** At 10V input we want 60Hz in reverse and at 0V input we want 60Hz, maximum speed 60Hz using the 0-10V input range.
$m = \frac{\frac{40-30}{60}}{4-2} = 0.083$ $REFAT0\% = (\frac{40}{60} - 0.083 * 4) * 100 = 33$ $REFAT100\% = 100 * 0.083 * 10 + 33 = 117$	$m = \frac{\frac{60+60}{60}}{0-10} = -0.2$ $REFAT0\% = (\frac{60}{60} + 0.2 * 0) * 100 = 100$ $REFAT100\% = 100 * -0.2 * 10 + 100 = -100$

R01 REF AT 0%

Default value: 0%

Range: -1000% to 1000%

This value specifies what the reference will be when 0% of the input signal is present at the analog input terminals. For a 4 to 20mA input signal, ***R01 REF AT 0%*** must be set to –25%.

R02 REF AT 100%

Default value: 100%

Range: -1000% to 1000% of input span

This value specifies what the reference will be when 100% of the input signal present at the analog input terminals.

R03 PRESET

Default value: 60%

Range: -100% to 100% of ***CO2 MAX Hz***

If PRESET is chosen as the speed source you must enter the preset speed value. Use the up or down buttons to adjust the preset speed. The preset speed is entered in % of ***CO2 MAX Hz.*** Press Enter to accept the speed value or press ESC to abort.

R07 CONSOLE REF / MOTORIZED POT FUNCTION

When this is selected, the reference is set from the console using the up and down buttons as well as the UP and DOWN input terminals. The console reference has three exclusive modes of operation: power on reset mode, stop reset mode and persistent mode.

Power on reset mode sets the console reference to zero when the MSC-3V is powered on. This mode is active if neither stop reset nor persistent mode is active.

Stop reset mode sets the console reference to zero whenever the MSC-3V is powered on or when commanded to stop running the motor.

Persistent mode ensures the console reference (prior to loss of power supply) is restored when the MSC-3V is re-powered.

Upon selection of the ***R07 CONSOLE REF***, sequential menus choices set up the console reference operational mode. these menus are ***R05 PERSISTENT*** and ***R06 STOP RESET***.

R05 PERSISTENT

Choices: H00 Enabled

H01 Disabled (default)

Enabling ***R05 PERSISTENT*** configures the console reference for **persistent mode** operation. The console reference prior to removal of power supply is restored the next time the MSC-3V is powered on. Persistent mode overrides both power on reset mode and stop reset mode. Press up or down push buttons to enable or disable persistent mode. Press Enter to select the new setting or ESC to abort.

R06 STOP RESET

Choices: H00 Enabled

H01 Disabled (default)

Enabling ***R06 STOP RESET*** configures the console reference for **stop reset mode** operation. Each time the MSC-3V is powered on or commanded to stop the motor, the console reference will be set to zero. Stop reset mode is overridden by persistent mode. Stop reset mode overrides power on reset mode. Press up or down push buttons to enable or disable stop reset mode. Press Enter to select the new setting or ESC to abort.

G00 INPUT/OUTPUT

Use these functions to create a custom terminal configuration.

G10 Enable/Reset

Available Choices: H00 ENABLE
H01 DISABLE (Default)

This sets the operation of the Enable terminal between being purely an enable terminal and also being able to reset a trip condition. When set to ENABLED, applying a positive edge to the ENABLE input will attempt to reset a trip condition. When this feature is set to DISABLED the ENABLE input cannot reset the MSC-3 after a trip.

Use the up and down push buttons to select ENABLED or DISABLED. Press Enter to accept the setting or Esc to abort.

Custom Terminal Configuration

G11 DIG IN1

G12 DIG IN2

G13 DIG IN3

G14 DIG IN4

These four menu items permit an individual function assignment to each input terminal. Pressing enter on these menu items presents a list of input functions with the currently assigned function being presented first. These terminals are all active high.

Some input functions require the selection of one or more speed references. When these functions are selected the choice of speed reference will follow with the currently assigned reference displayed first. The list of speed references is as per the ***F00 REFERENCES*** menu item.

Use the up and down push buttons to move through the list, press Enter to select the new function or ESC to abort.

[5] MSC-3 is disabled by disconnecting terminal 6. This is equivalent to applying zero volts to terminal 6.

Control Terminal Functions

Function	Description	Parameters
I00 FWD & LATCH	A momentary contact closure on this input will start the motor in the forward direction. When the input is removed the motor continues to run in the forward direction (latching). It requires an I02 ~STOP function to be assigned in order to break the latch and stop the motor.	None
I01 REV & LATCH	A momentary contact closure on this input will start the motor in the reverse direction. When the input is removed the motor continues to run in the reverse direction (latching). It requires I02 ~STOP function to be assigned in order to break the latch and stop the motor. The reverse direction must be enabled for the motor to run backwards.	None
I02 ~STOP	This input is required to be held for the motor to run. If it is opened any latched input is cleared and the motor will stop running. This is used with FWD & LATCH and REV & LATCH to stop the motor. This function is ignored in LOCAL mode.	None
I03 FWD	While this input is held the motor will run in the forward direction. When the input is removed the motor will stop running (non latching). The I03 FWD function disregards the state of the I02 ~STOP input and the drive will not stop while I03 FWD input is present and the Enable input is wired to +5V. Both I03 FWD & I04 REV inputs must be wired to +5 to activate bipolar operation.	None
I04 REV	While this input is held the motor will run in the reverse direction. When the input is removed the motor will stop running (non latching). The I04 REV function disregards the state of the I02 ~STOP input and the drive will not stop while I04 REV input is present and the Enable input is wired to +5V. Both I03 FWD & I04 REV inputs must be wired to +5 to activate bipolar operation.	None
I05 UP	Increases the motorised pot reference.	None
I06 DOWN	Decreases the motorised pot reference. For the UP and Down terminals to have an effect the motorised pot must be selected as a speed source. They also require other terminals to stop and start the motor.	None
I07 RESET	Will attempt to reset a trip condition.	None

Function	Description	Parameters

I08
ESO
	While this input is held the MSC-3 will operate in essential services override (ESO). After selecting this function you will be asked for a speed source to be selected.
	When this input is activated:
	• The motor runs at the selected ESO speed,
	• The following trips are ignored:
	  • Supply Fail
	  • Over Temp
	  • I^2t Trip
	  • Thermistor
	• Infinite auto restart of all other trips is enabled
	• The ramp acceleration and deceleration times are set by ***F06 ESO RAMP***. See page 66.
	• Auto Restart and Ramp parameters cannot be changed whilst ESO is in operation
	• Bipolar reference mode is activated
	• Reverse operation may occur and is dependent on speed source. Refer to ***F03 ESO*** of the ***F00 REFERENCES*** menu for ESO speed source selection.
		ESO
		speed reference

I09 JOGFWD	Contact closure on this input will run the motor forward at the JOGFWD speed. It will also clear any latched inputs. When the contact is opened the motor will stop. After selecting this function you will be asked for a speed reference to be selected.	JOGFWD speed reference
I10 JOGREV	Contact closure on this input will run the motor reverse at the JOGREV speed. It will also clear any latched inputs. When the contact is opened the motor will stop. After selecting this function you will be asked for a speed reference to be selected.	JOGREV speed reference
I11 REMOTE	Contact closure on this input means that the MSC-3 will follow the control inputs on the terminal strip and the motor will run at the speed set by the Remote speed reference. When the contact is opened the MSC-3 will be controlled from the console and will run at the speed set by the Local speed reference. This input requires other terminals to stop and start the motor. After selecting this function you will be asked for a Remote speed reference and a Local speed reference to be selected. **If the I11 REMOTE function is not assigned to an input terminal, remote mode operation is assumed.**	2 speed references
I13 EXTERN ALARM	Contact closure on this input registers a trip and the status message “EX ALARM” is displayed.	None
I14 EXTERN WARN	Contact closure on this input displays the status message “EX WARN”.	None
I15 NO FUNCTION	Contact closure activates no function at all. The signal is not used.	None

I16 TIMER #1	Making or braking contact closure on this input activates (or deactivates) timer #1. See ***G17 Timer #1*** opt for timer behaviour.	None
I17 TIMER #2	Making or braking contact closure on this input activates (or deactivates) timer #2. See ***G18 Timer #2 opt*** for timer behaviour.	None

G15 RELAY1

G16 RELAY2

These two menu items permit an individual function assignment to each relay output. Pressing enter on these menu items presents a list of output functions with the currently assigned function being presented first.

Some relay functions require a value to be set. When these functions are selected the chance to set the value will follow with the current value displayed first.

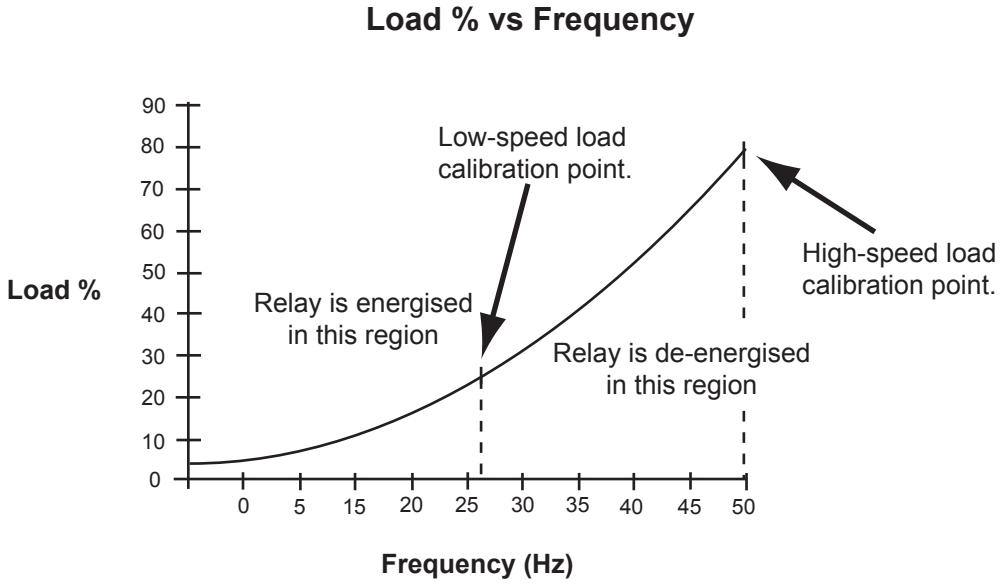
Use the up and down push buttons to move through the list, press Enter to select the new function or ESC to abort.

Relay Output Functions

Function	Indication when energised	Parameters
O00 RUN	Indicates that the drive is running in either forward or reverse.	None
O01 TRIP	Indicates the presence of a trip that has stopped the output of the drive	None
O02 ESO	Indicates that the MSC-3 is in the essential services mode.	None
O03 PROOF	Indicates that the MSC-3 is enabled and not tripped.	None
O04 ZERO SPEED	Indicates that the MSC-3 is at zero speed.	None
O05 AT SPEED	Indicates that the motor speed is equal to the reference speed.	None
O06 UNDER SPEED %	Indicates that the motor speed is below the entered value	% of CO2 MAX Hz
O07 OVER SPEED %	Indicates that the motor speed is above the entered value	% of CO2 MAX Hz
O08 ON	The relay is energized.	None
O09 OUTPUT ALARM	Indicates that the drive output current is more than 12.5% of motor rated current. See page 76.	None
O10 A/R FAIL	Indicates that the drive could not auto restart as all restarts have been exhausted.	None
O11 FWD	Indicates that the motor is running in the forward direction.	None
O12 REV	Indicates that the motor is running in the reverse direction.	None
O13 ENABLED	Indicates that the MSC-3 is enabled.	None
O14 I2t TRIP	Indicates that the I^2t motor overload feature has activated.	None
O15 OVER TEMP	Indicates that the MSC-3 is too hot for safe operation.	None
O16 LOAD WARNING	Indicates that the motor load is above the preset characteristic line. See detail description following.	2 Calibration points

O16 LOAD WARNING

The Load Warning feature of the MSC3 functions as a warning indication of abnormalities in the operating load characteristics of the motor and load. The indication of an abnormality is resolved by comparing the immediate load signal value to an idealised quadratic load characteristic. If the immediate load is less than the idealised load for the operating speed, the abnormality is detected. The graph below illustrates a load characteristic.



The function is set up for failsafe operation. When the load is in the region above the characteristic line, or the MSC-3 is stopped, the relay is energised. If the detected load is in the region below this line, the relay is de-energised.

Setup

Load ratings of an application are not required for the calibration of the feature. Instead two calibration points are used to set up the idealised load characteristic. Setup for the load warning feature is done after other custom settings have been made (eg Auto restart, I^2t, current limit, etc). The procedure is as follows:

1. Check the motor settings (voltage, current, frequency and speed) are correct.
2. Check the maximum frequency is correct.
3. Run the motor and load towards the low speed end of the speed range.
4. Determine which output relay to use (RELAY1, RELAY2, etc) and go to the function selection for this output.

For example RELAY1.

* From the run display press ESC to display the ***A00 DISPLAY*** menu.
* Use the ‘Up’ or ‘Down’ push buttons to find ***G00 INPUT/OUTPUT*** and press ‘Enter’.
* Use the ‘Up’ or ‘Down’ push buttons to find ***G15 RELAY1*** and press ‘Enter’.
* Use the ‘Up’ or ‘Down’ push buttons to find ***O16 LOAD WARNING*** and press ‘Enter’.

The display shows ***O16 LOAD WARNING*** on the top line and the bottom line is blank.

5. Press the ‘Down’ push button. This will record the present speed and load. Press ‘ESC’ several times to return to the run display.
6. Run the motor and load towards the high speed end of the speed range.
7. Return to the chosen relay output function selection

Continuing the above example.

* From the run display press ESC to display the ***A00 DISPLAY*** menu.
* Use the ‘Up’ or ‘Down’ push buttons to find ***G00 INPUT/OUTPUT*** and press ‘Enter’.
* Use the ‘Up’ or ‘Down’ push buttons to find ***G15 RELAY1*** and press ‘Enter’.
* Use the ‘Up’ or ‘Down’ push buttons to find ***O16 LOAD WARNING*** and press ‘Enter’.

The display shows ***O16 LOAD WARNING*** on the top line and the bottom line is blank.

8. Press the ‘Up’ push button. This will record the present speed and load. Press ‘ESC’ several times to

return to the run display.

9. This checklist sets up the Load Warning feature and assigns the indications to one of the digital outputs.

O09 OUTPUT ALARM

This relay function is designed as a status indication. It indicates the presence of a load abnormality by comparing the motor current to a fixed threshold of 12.5% of the motor rated name-plate current when the MSC-3 is running. The usual application of this function is to sense the disconnection of the motor. ***O16 LOAD WARNING*** should be used for sensing the motor load torque. The table below lists the states of the relay and the corresponding conditions.

Let: $I_{Threshold}$ = 12.5% of the ***B02 MOTOR AMPS*** value

mag(Is) < $I_{Threshold}$	Relay NO	Relay NC	Comment
False	Closed	Open	Correct operation
True	Open	Closed	The drive cannot sense sufficient motor current

This function is assigned to a relay by selecting ***O09 OUTPUT ALARM*** as that relay's logic function.

G17 Timer #1 opt

G18 Timer #2 opt

Choices: All available control terminal functions fro I00 to I16 and option inputs

Default: I15 No function

The output of each timer can activate other terminal strip functions. For example the timer output can be directed to the ***I00 FWD&LATCH*** input. Pressing Enter displays the function activated by the to the timer output. Use the up or down push buttons to view other function choices. Press Enter to select the new function or ESC to abort.

G22 T1 delay off

G25 T2 delay off

Choices: H00 Enabled

H01 Disabled (default)

These menus permit each timer to be configured for delay off timing. By default timers are configured for **delay on** timing where the leading edge of the input signal is delayed. If delay off enabled, the trailing edge of the input signal is delayed. Press up or down push buttons to enable or disable delay off timing. Press Enter to select the new setting or ESC to abort.

G23 T1 inv input

G26 T2 inv input

Choices: H00 Enabled

H01 Disabled (default)

These menus offer the option of inverting the input to each timer. By default the input to each timer is NOT inverted. Press up or down push buttons to enable or disable input inversion. Press Enter to select the new setting or ESC to abort.

G24 T1 delay sec

G27 T2 delay sec

Default value: 10 sec

Range: 0.5 to 600.0 sec

This menu specifies the delay time in seconds. Press up or down push buttons to adjust the delay time. Press Enter to set the new delay time or ESC to abort.

G19 Ref Compare

Allows a specified reference to be compared to a specified value. If the specified reference is greater than the ***"G20 Comp. Value"***, the compare output is true and is directed to the selected input function.

G19 Ref Compare

Choices: R00 AN1 (default)
R03 PRESET %
R07 CONSOLE REF
Options

Specifies the reference to compare. Use the up and down buttons to select a reference. Press Enter to make the selection or ESC to abort.

G20 Comp. Value

Default Value: 0 %

Range: 0 to 100 %

This is the value the selected reference is compared to. Use the up and down buttons to adjust the value. Press Enter to accept the value or ESC to abort.

G21 Comp. Output

Choices: All available control terminal functions fro I00 to I16 and option inputs

Default: I15 No function

Connects the output of the compare function to a control terminal function. Use the up and down buttons to select a function. Press Enter to make the selection or ESC to abort.

G28 Remote Ovrd.

Choices: H00 Enabled (default)
H01 Disabled

This menu enables or disables the remote override feature. The remote override feature permits the "ENTER" push button to override wiring to the remote terminal of the MSC-3V. Press up or down push buttons to enable or disable the remote override feature. Press Enter to select the new setting or ESC to abort.

Display Messages

The MSC-3 displays a variety of messages on the second line of its display to indicate the drive status. These messages may be divided into two types, trip messages and run messages.

The MSC-3 will protect itself under a variety of fault conditions. When one of these conditions is experienced the MSC-3 will trip, shut down the motor output and display one of the following messages. The message will be displayed until the fault is cleared and a reset signal is applied.

Trip Message	Meaning
OPT SC n	An output short circuit has been detected. This is caused by either an Over Current or a Ground Fault on the motor terminals.
OV n	The DC Bus voltage has exceeded its maximum value.
OC	The output current has exceeded the MSC-3's intermittent output current rating (derived from total output current of all modules).
H/WOC n	The output current has exceeded the MSC-3's intermittent output current rating (derived from total output current of individual modules).
DC LOW	The DC Bus voltage has fallen below its minimum threshold.
PWR FAIL	All input phases on the input power supply are either low or missing.
SUPPLY F	There is a problem with the input power supply. One phase is either partially or totally missing and motor operation will be impaired.
OT n	The MSC-3 is too hot.
I2T TRIP	An I^2t trip has occurred.
EX ALARM	User defined trip input activated. (See I13 page 73)
CHARGING n	There has been a fault whilst charging the DC Bus capacitors.
OPTION TRIP e.g. OT THERM	Option Trip Messages Thermistor trip on Extended Features Option

"n" specifies the inverter module that instigated the trip condition. If there was more than one reason to trip or more than one module tripped, the number of the first module to register any trip will be shown. "0" is the master module and"1", "2", '3" etc remresents slave modules. Tripped messages without a trailing numeral are only instigated by the master module.

The following messages indicate the current operating condition of the MSC-3.

Run Message	Meaning
CHARGING	The MSC-3 is waiting for the DC Bus capacitors to be fully charged before running the motor.
C LIMIT	The motor is drawing its maximum overload current.
V LIMIT	The motor is regenerating or the input voltage is too high.
ESO	The MSC-3 is operating in Essential Services Override mode
OPTION STATUS	Option Status Messages
OVR PWR	The motor's absorbed power exceeds the MSC-3 rating when operating from a single phase supply.
EX WARN	User defined warning input activated (See I14 page 73)
IDLE REM	The MSC-3V is idle in remote mode
IDLE LOC	The MSC-3V is idle in local mode
FWD REM	The MSC-3 is running in the FWD direction in remote mode.
FWD LOC	The MSC-3 is running in the FWD direction in local mode.
REV REM	The MSC-3 is running in the REV direction in remote mode.
REV LOC	The MSC-3 is running in the REV direction in local mode.
EN REM	The MSC-3 has an enable signal in remote mode.
EN LOC	The MSC-3 has an enable signal in local mode.
NOT EN	The MSC-3 is ON but has no enable signal so it is not able to turn a motor.

MSC-3V Specifications

Input Supply Voltage
MSC-3V 950 to 1100Vac, 3Ø Input voltages have a tolerance of -15% to +10%
Input Frequency
48 to 62 Hz
Output Voltage
MSC-3V 0 to 1100Vac, 3Ø The output voltage can not be higher than the input voltage
Output Frequency
Range: 0 to 200Hz Resolution: 0.1% Linearity: 0.2% of maximum frequency
Enclosure Rating
IP66 Heat sink area IP20 Front section inside users cabinet
Environmental Rating
Storage Temperature: -20 to +70ºC -4 to 158ºF Operating Temperature: 0 to 40ºC 32 to 104ºF 0 to 50ºC† 32 to 122ºF† †Dependent on load current Relative Humidity: 5 to 95% Non Condensing Altitude: 0 to 1000m 0 to 3281 feet
Standards Compliance
Models marked with this symbol comply with the Australian EMC Framework requirements
Models marked with this symbol are listed by Underwriters Laboratories Inc and comply with UL 508C
The I^2t 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
Up, Down, Enter, Escape, Stop/Reset
Terminal Strip
Digital Inputs +5V and DIG 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 AN 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 AN COM Relay Outputs 2 Form C Outputs (single pole change over 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**[6] 2 to 16kHz **Current Limit** 18 to 100% of overload current rating **I^2t** 18 to 100% of max cont current **I^2t Zero Hz** 18 to 100% of max cont current **I^2t cnr Hz** 2 to 200Hz **Drive Stopping** Ramp to stop Coast to stop Dynamic braking **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 DC Input Dynamic Braking Reset by Power Failure Remote override 1 Phase Input

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

MSC-3V Input and Output Current Specifications

Model	Continuous output current (A RMS)	Overload output current (A RMS)[1]	Continuous AC line current (A RMS)[2]	Overload AC line current (A RMS)[3]
MSC-3V 30	30	45	38	56
MSC-3V 44	44	66	55	83
MSC-3V 58	58	87	73	109
MSC-3V 66	66	99	83	124
MSC-3V 84	84	126	105	158
MSC-3V 100	100	150	125	188
MSC-3V 132	132	198	165	248
MSC-3V 168	168	252	210	315
MSC-3V 200	200	300	250	375
MSC-3V 300	300	450	375	563

[1] 60 second rating.

[2] Includes effect of 3% phase voltage imbalance. Use this value for cable and fuse/ circuit breaker selection.

[3] Includes effect of 3% phase voltage imbalance and overload at full speed (i.e. maximum motor shaft power condition). 60 seconds maximum.

MSC-3V Trouble Shooting Guide

Symptom	Cause	Remedy
Front Display does not illuminate.	Input power wiring not connected properly.	Check input power wiring, refer to the MSC-3 Electrical Installation Diagram.
	Input voltage not within specification.	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 DIG 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 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.

Symptom	Cause	Remedy
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. If faster or controlled deceleration is required fit a dynamic braking module.
V LIMIT message appears continuously.	Input voltage has exceeded maximum rating.	See MSC-3Vv General Specifications for input voltage ratings.
OPT SC message appears	Short circuit on motor terminals. Earth Fault on motor terminals	Check wiring to motor terminals. Check wiring to motor terminals.
OC	Motor current was greater than the MSC-3's maximum current.	Check drive and motor current ratings.
OV message appears.	Input voltage has exceeded maximum ratings. Motor is overhauling.	See general specification and check the input is within ratings. Check input supply for voltage transients. Fix the external source. Ensure load cannot overdrive the motor. If necessary fit dynamic braking.
OT message	Ventilation problem. Drive is constantly overloaded.	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. Check the MSC-3 continuous current and ambient temperature rating.
Motor is unstable.	*SLIP COMP* is set too high. *FLUX PLUS* set too high. Incorrect motor voltage selected. Incorrect motor frequency selected. *CURRENT LIMIT* is set too low.	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. Reduce FLUX PLUS setting. Enter correct MOTOR VOLTAGE from the MOTOR menu. Enter correct *MOTOR FREQUENCY* from the *MOTOR* menu. Increase *CURRENT LIMIT* setting.
Excessive Motor Heating.	Motor is running at low speeds for long times. Motor damaged or incorrectly wired. Incorrect motor voltage selected. Incorrect motor frequency selected.	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. Check the motor and motor wiring for faults. Enter correct *MOTOR VOLTAGE* from the *MOTOR* menu. Enter correct *MOTOR FREQUENCY* from the *MOTOR* menu.

To Display the Input (AC Line) and Output (Motor) Voltages

This assumes that the drive has just had power applied and no control buttons have been pressed.

1. Press ESC once or twice[1] to enter the menu mode. the display will show A000 DISPLAY.
2. Press ENTER

   The drive will show A01 RUN VARIABLE.
3. Press ENTER

   The drive will show the current selection for the run variable (the particular variable that is shown when the drive is running - the default is Hz)
4. Press the up or down buttons until V07 VOLTS AC is shown.

   Press enter to select this as the run variable.
5. Press ESC twice to exit the menu mode and return to the run mode (where we started).

The top line of the display will slowly and contiuosly cycle through 3 different AC voltage readings, these are:

Output voltage

Vuv

Vvw

The first one is the inverter output (motor) voltage. If the drive is not running, this will be zero. The second two are the Ac line input voltages.

More detailed information on display operation is on page 52.

[1] This depends on whether the meter display (four variables at once) or the standard run variable display (one variable and reference) was selected last time the drive was powered.

Your MSC-3V Setup Notes

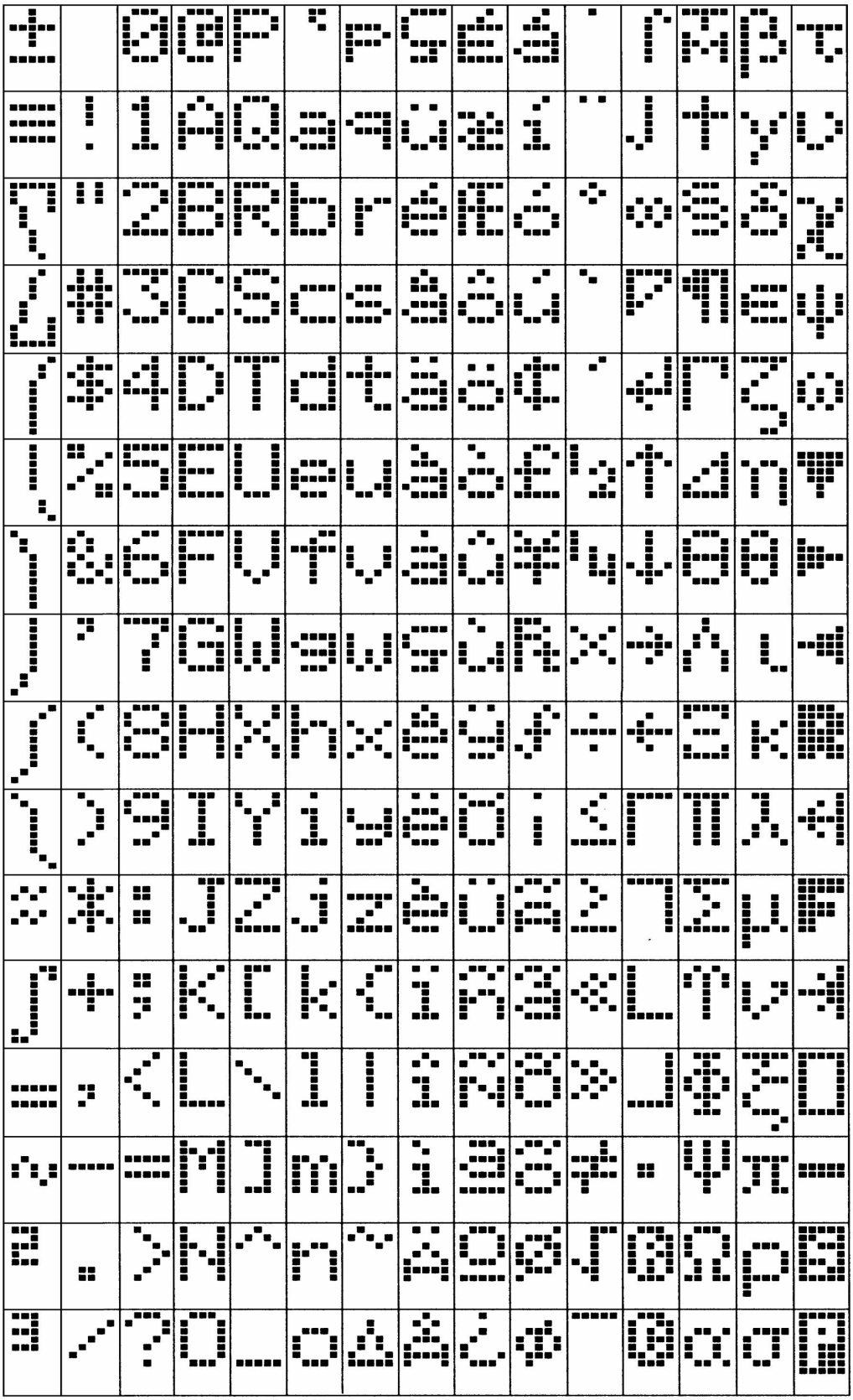
Photocopy this page or complete in pencil **Date .....**

Site Designator ..... **MSC-3V Serial No. .....**

	User	Default		User	Default
A00 DISPLAY			E09 A/R CLR TIME		20
A01 RUN VARIABLE		Hz	E10 Reset by PF		Disabled
A02 RUN SCALE		50.0	E11 Motor Resync		Disabled
A03 RUN UNITS		Hz	**F00 REFERENCES**		
A04 Menu Protect		Disabled	F01 REMOTE		AN1
A08 TL Variable		Hz	F02 LOCAL		CONSOLE
A09 TR Variable		Amps	F03 ESO		PRESET %
A10 BL Variable		% Load	F06 ESO Ramp		10.0
A11 BR Variable		kW	F04 JOGFWD		PRESET %
B00 MOTOR			F05 JOGREV		PRESET %
B01 MOTOR VOLTS		1000	**G00 INPUT/OUTPUT**		
B02 MOTOR AMPS		*	G10 Enable/Reset		Disabled
B03 MOTOR Hz		*	G11 DIG IN1		RESET
B04 MOTOR RPM		*	G12 DIG IN2		STOP
C00 PERFORMANCE			G13 DIG IN3		FWD + L
C01 MIN Hz		0	G14 DIG IN4		REMOTE
C02 MAX Hz		*	G15 RELAY 1		RUN
C04 ACCEL TIME		10.0	G16 RELAY 2		TRIP
C05 DECEL TIME		10.0	G17 Timer #1 opt		No function
C06 S Time		0.01	G18 Timer #2 opt		No function
C07 Flux plus %		25	G19 Ref Compare		AN1
C08 Hi Spd Flux +		Disabled	G20 Comp. Value		0
C09 SLIP COMP		0	G21 Comp. Output		No function
			G22 T1 Delay off		Disabled
C17 Idle Delay		20	G23 T1 inv input		Disabled
C18 Resume Hz		0	G24 T1 delay sec		10
D00 PROTECTION			G25 T2 delay off		Disabled
D01 CURRENT LIM		*	G26 T2 invinput		Disabled
D02 I2t		*	G27 T2 delay sec		10
D03 I2t zero Hz		*	G28 Remote Ovrd.		Enabled
D04 I2t cnr Hz		10			
D05 Reverse		Disabled			
D08 DC INPUT		Disabled	O06 UNDER SPEED		20%
D09 1 phase Inpt		Disabled	O07 OVER SPEED		80%
D10 Skip Speed		30	R01 REF AT 0%		0
D11 Skip Range		0	R02 REF AT 100%		100
E00 STOP/START			R03 PRESET %		60%
E03 Coast Stop		Disabled	R05 PERSISTENT		Disabled
E06 DYNAMIC BRK		Disabled	R06 STOP RESET		Disabled
E08 A/Rs ALLOWED		0			

* Drive Specific

Appendix A - MSC-3V Character Set



Appendix B - MSC-3V Transportation sizes and weights

The table below lists the approximate dimensions and weights for MSC-3V models in the standard packing material.

Model	Enclosure Type	Shipping Dimensions	Weight without Choke	Weight with Choke	Packaging
MSC-3V 44					

Appendix C - Glossary

~STOP	The logical inverse of STOP. This circuit must be closed for the MSC-3 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.
AN COM	The common terminal to which all analog inputs on the MSC-3 are referenced. This is separate to the DIG COM to reduce the possibility of interference between analog and digital functions.
AWG	American Wire Gauge
Console	The pushbuttons and LCD display on the front of the MSC-3
Constant Torque	A load characteristic in which the driving torque requirement is largely independent of speed. e.g. a horizontal conveyer
DC Bus Choke	An inductor connected in series with the DC bus inside the MSC-3. This provides several benefits including reducing the harmonic content of the AC line current.
DIG COM	The common terminal to which all digital inputs on the MSC-3 are referenced.
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 MSC-3.
ESO	Essential Services Override. A mode of operation that disables certain protection features in order to allow the MSC-3 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 analog inputs on the MSC-3. The MSC-3 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 MSC-3 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 MSC-3 that controls the rate at which the motor speed can increase or decrease.
Remote	Operation of the MSC-3 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 MSC-3 for the connection of the screen of all cabled associated with analog 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 MSC-3 control terminal strip to assist in generating a speed reference voltage etc.

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