DSP-II
INVENTIVE TECHNOLOGY

MSC-3
Instruction Manual

ZENER
VARIDRIVE SOLUTIONS

ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1976 Zener Electric has supplied many thousands of drives to industry. These drives have been installed into numerous applications resulting in a wealth of in house experience. The Zener MSC-3 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-3 manufactured has proven to operate correctly in the production test bay before dispatch.

SAFETY

Your MSC-3 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-3. The instruction manual should be completely read and understood before attempting to connect or operate the MSC-3. 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.

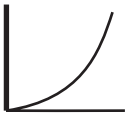
THE CONTENTS OF THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE

A Zener Drive for Every Application

The ZENER MSC-3 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

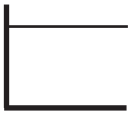


- Quiet Motor Operation (Audible frequency adjustable from 2 to 16kHz)
- 110% full overload capacity from 0-200Hz
- Controlled ramp from 0.1 sec to 1min
- Able to start into a high inertia load rotating at full speed without damage
- PID control for automatic process control
- Energy savings with speed 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 40ºC, 45ºC and a 50ºC rating are available.

IP30 ENCLOSED

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

Up to 170Amps

IP 54 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.

220-490Amp

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 170Amps

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 140Amps

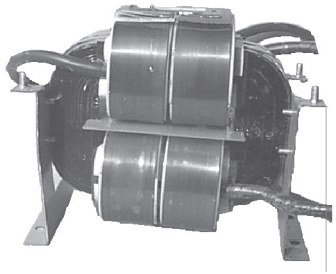
Zener MSC–3 Options

SUPPLY VOLTAGE

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

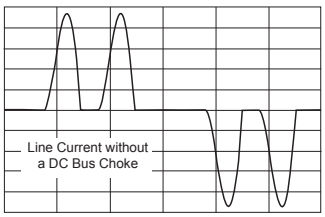
Supply Voltage	Supply Phase	Tolerance	Model
380 to 480Vac	3 Phase	-15, , +10%	MSC–3R
208 to 240Vac	3 Phase	-15, , +10%	MSC–3L
440 to 600Vac	3 Phase	-15, , +10%	MSC–3J
380 to 480Vac	1 Phase*	-15, , +10%	MSC–3R
208 to 240Vac	1 Phase*	-15, , +10%	MSC–3L

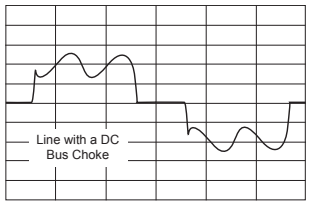
* Derating required for single phase operation. (See page 11)



DC BUS CHOKE

Provides a reduction of power line harmonics with the added benefit of reducing peak inrush currents, improved power factor and enhanced protection against AC line transients.

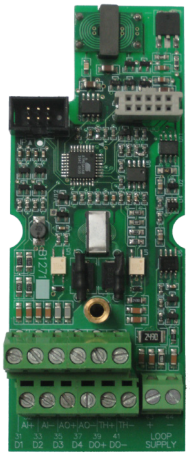




REMOTE DISPLAY PANEL

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.



OPTION BOARDS

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

AQ08000 24vdc 20mA Power Supply Card

AQ08001 Extended Features; provides additional analogue output, analogue input, thermistor input, 24VDC 20mA transducer loop power supply, 4 digital inputs and a low voltage digital output.

Check with your authorised Zener Distributor for other options and communications protocols.

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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.

Read all operating instructions before installing, wiring, operating, servicing or inspecting the MSC-3.
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-3 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-3 whenever it is connected to an electrical supply and for some time afterwards.
Before touching anything inside the MSC-3 enclosure or other equipment connected to the MSC-3 terminals, disconnect all sources of electrical power, wait at least 11 minutes for capacitors within the MSC-3 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-3 contains high energy circuits that may be hazardous. Do not operate the MSC-3 with the door open or any part of the enclosure removed.

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

Do not modify this equipment electrically, mechanically or otherwise. Modification may create safety hazards as well as voiding the UL listing of models so listed.

The MSC-3 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-3 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-3 is intended for use only in fixed wiring applications. It is not intended for use on a flexible supply cable.

The MSC-3 contains a substantial EMC line filter and as a result it is unsuitable for use on earth leakage protected circuits.

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

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

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

Receiving

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

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

After the initial inspection, the MSC-3 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.

Software

This manual applies to MSC-3 software revision 5.0.1. The software revision is displayed briefly at power up and may also be viewed in the service menu.

Installation

MSC-3 mounting location

In general, the MSC-3 should be mounted as close to the motor as practical, consistent with other requirements. This is not an absolute requirement, but the following advantages may support such a choice:

- Generally, electrical cabling costs per metre are lower for the unscreened power cable used on the AC supply side than for the screened output cable required between the MSC-3 and the motor. Cabling costs can therefore be expected to be lower when less screened cable is needed.
- EMC performance can be expected to be mildly enhanced with a shorter motor cable because of reduced leakage from the cable
- In circumstances where an isolator switch is required near the motor, it may be possible to connect this in the AC supply to the MSC-3. This has the advantages of saving two screened cable terminations and allowing the use of a non-metallic isolator switch enclosure where allowed by local electrical codes. There are also safety advantages for service personnel in that the local isolator switch also isolates the MSC-3 from the electrical supply.

The choice is predominantly an economic one. There are many perfectly satisfactory installations where, for a variety of specific site reasons, the most effective solution results in the MSC-3 and the motor being a long distance apart.

CAUTION Installation Information

- The MSC-3 must be mounted on a vibration free vertical surface, away from heat radiating sources. Do not mount the MSC-3 in direct sunlight or on a hot surface.
- The MSC-3 must be mounted vertically. No other mounting orientation is acceptable.
- If the MSC-3 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-3 in “confined spaces”[1]
- 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.
- DC Bus choke is mandatory with MSC-3Jxx (600VAC) and some other models.
- The optional DC Bus choke is fitted inside the MSC-3 in all models except Chassis A, IP30. For these models, the DC Bus choke is located in an additional enclosure fitted to the rear face of the MSC-3. The wiring between the MSC-3 and the choke is internal.

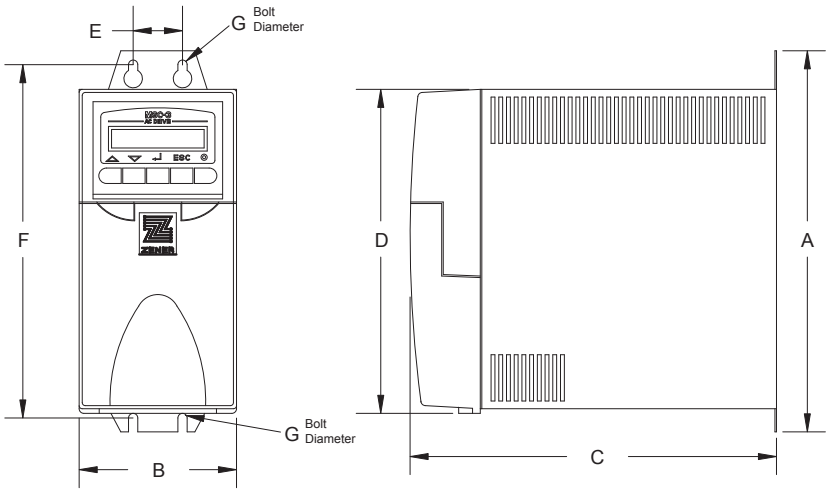
DC bus chokes

MSC-3 may be fitted with an optional DC bus choke. Fitting this option offers several benefits:

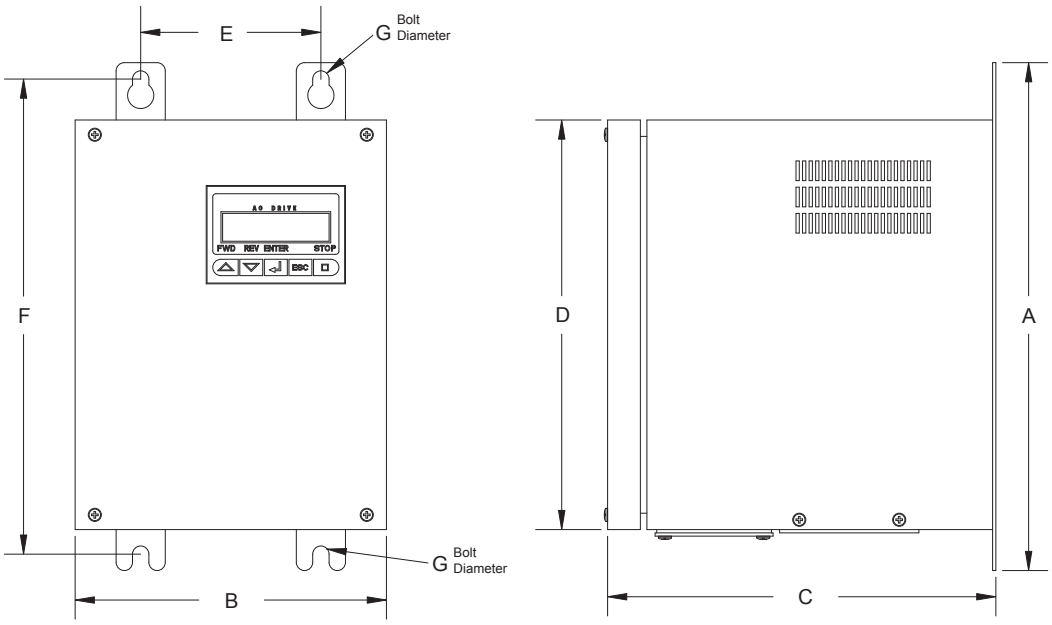
- Considerable reduction in harmonic and RMS currents in the AC line, particularly on low impedance (high fault level) electrical supplies. Values become relatively independent of AC line parameters, simplifying application design.
- Increased tolerance to phase imbalance in the 3 phase AC supply.
- Increased immunity to AC line transients.

1. 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-3 Mechanical Installation Information

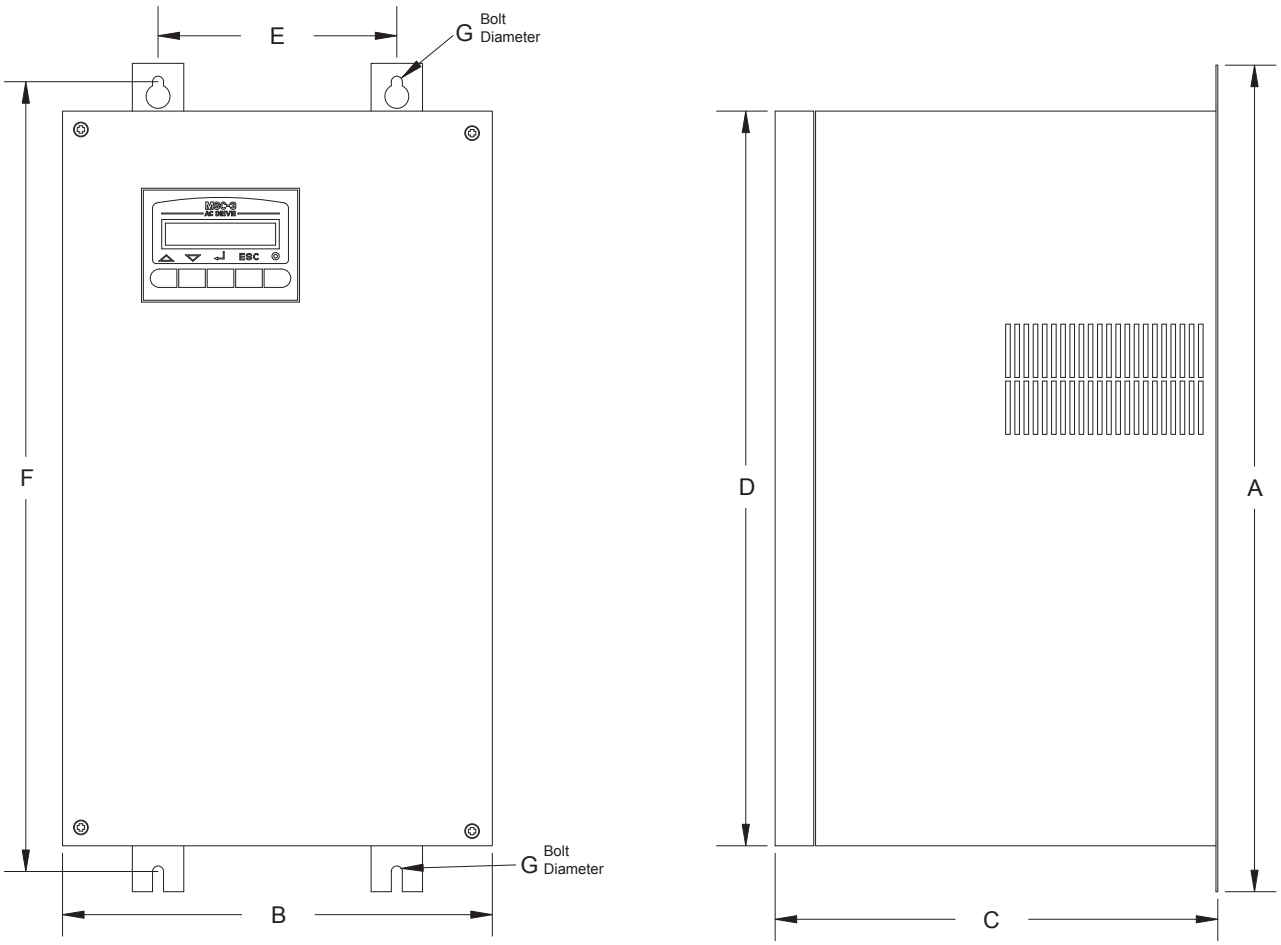


Chassis A IP30 / NEMA 1 (3 - 11 Amps)



Chassis A IP66 / NEMA 4 (3-11Amps)

CAUTION
Allow 50mm above, below and either side of the enclosure for ventilation



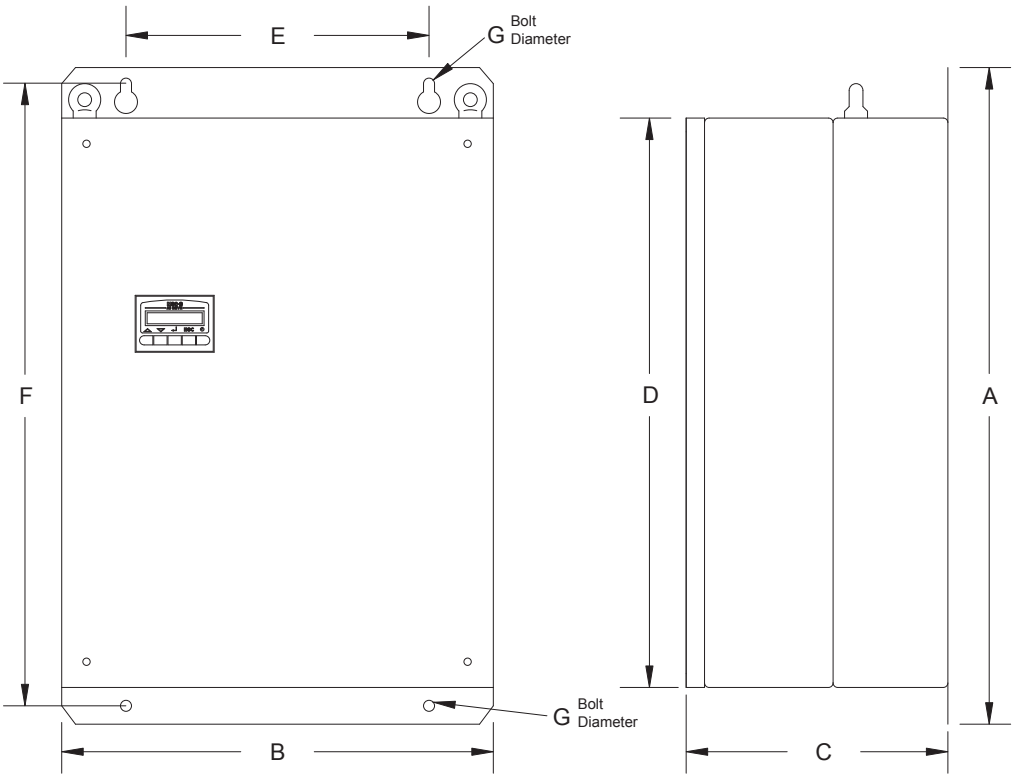
Chassis B (15 - 40 Amps)

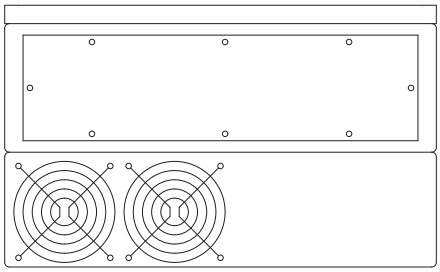
CAUTION
Allow 75mm above, below and either side of the enclosure for ventilation

Model	Enclosure type	Dimensions - tolerance +/- 1.0mm							Weight without choke	Weight with choke
		A	B	C	D	E	F	G		
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Chassis A IP30 / NEMA 1 (No DC Choke)	248mm 9.8”	102mm 4”	237mm 9.3”	208mm 8.2”	32mm 1.3”	230mm 9.1”	6mm 0.25”	3.5Kg 8lbs	
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Chassis A IP30 / NEMA 1 (With DC Choke)	248mm 9.8”	102mm 4”	309mm 12.2”	208mm 8.2”	32mm 1.3”	230mm 9.1”	6mm 0.25”		7.2Kg 16lbs
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Chassis A IP66 / NEMA 4	310mm 12.2”	190mm 7.5”	236mm 9.3”	250mm 9.8”	108mm 4.3”	287mm 11.3”	6mm 0.25”	5.7Kg 13lbs	8.6Kg 19lbs
MSC-3*15 MSC-3*23 MSC-3*30	Chassis B All types	459mm 18.1”	234mm 9.2”	243mm 9.6”	400mm 15.8”	130mm 5.1”	436mm 17.1”	6mm 0.25”	17.7Kg 38lbs	22.9Kg 51lbs
MSC-3*40	Chassis B All types	459mm 18.1”	234mm 9.2”	243mm 9.6”	400mm 15.8”	130mm 5.1”	436mm 17.1”	6mm 0.25”		24.8Kg 55lbs

* L, R or J to specify supply voltage - see page 60 for details

CAUTION
All MSC-3Jxx (600VAC) models must be used with DC bus choke.



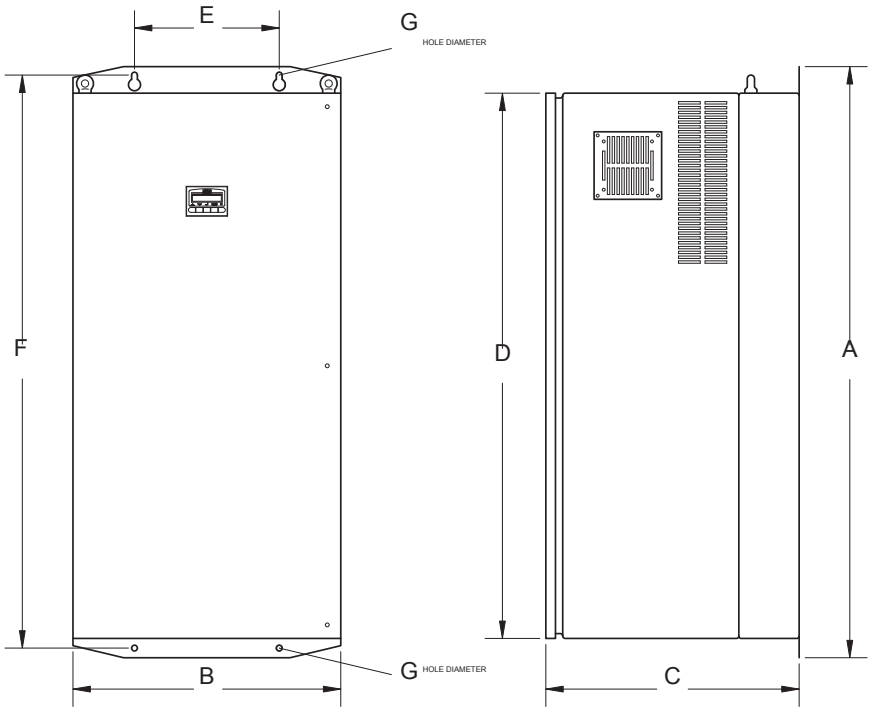


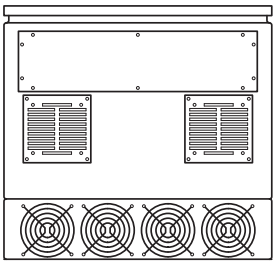
Chassis C (55 - 170Amps)

CAUTION
Allow 100mm above, below and either side of the enclosure for ventilation

Model	Enclosure type	Dimensions - tolerance +/- 1.0mm							Weight without choke	Weight with choke
		A	B	C	D	E	F	G		
MSC-3*55	Chassis C All types	715mm 28.1”	470mm 18.5”	290mm 11.4”	625mm 24.6”	330mm 13”	677mm 26.7”	12mm 0.47”	42Kg 92lbs	62Kg 136lbs
MSC-3*82	Chassis C All types	715mm 28.1”	470mm 18.5”	290mm 11.4”	625mm 24.6”	330mm 13”	677mm 26.7”	12mm 0.47”	44Kg 97lbs	64Kg 141lbs
MSC-3*109	Chassis C All types	715mm 28.1”	470mm 18.5”	290mm 11.4”	625mm 24.6”	330mm 13”	677mm 26.7”	12mm 0.47”	46Kg 101lbs	66Kg 145lbs
MSC-3*140	Chassis C All types	715mm 28.1”	470mm 18.5”	290mm 11.4”	625mm 24.6”	330mm 13”	677mm 26.7”	12mm 0.47”	50Kg 110lbs	70Kg 154lbs
MSC-3*170	Chassis C All types	715mm 28.1”	470mm 18.5”	290mm 11.4”	625mm 24.6”	330mm 13”	677mm 26.7”	12mm 0.47”		72Kg 158lbs

* L or R to specify voltage - see page 60 for details

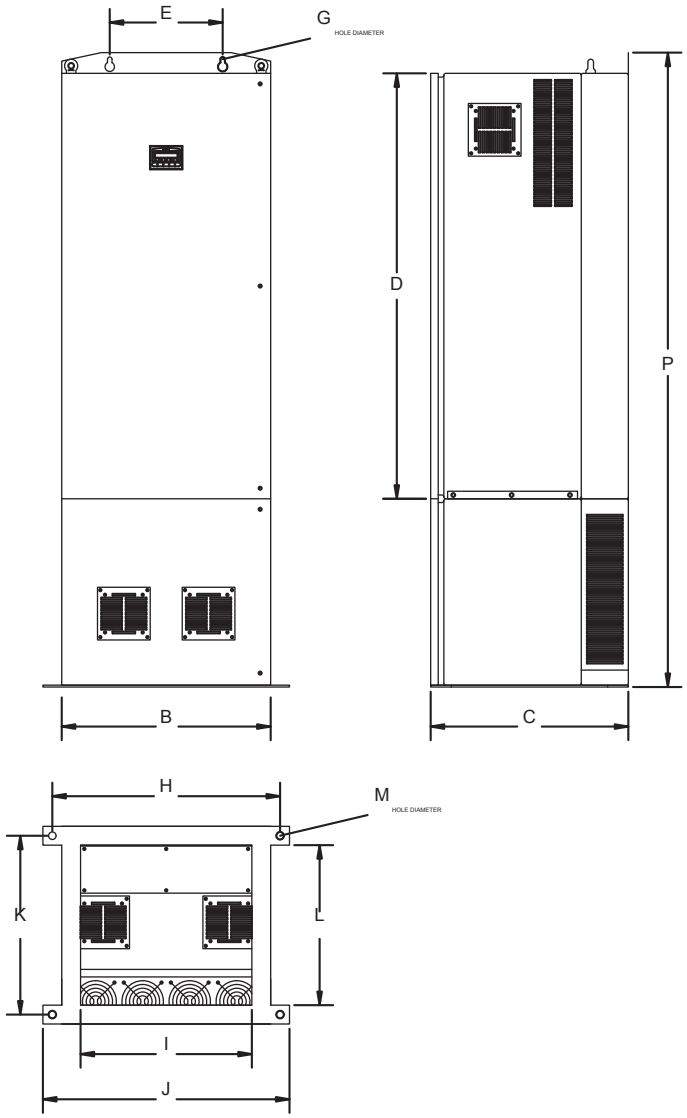




CAUTION

Allow 150mm above, below and either side of the enclosure for ventilation

Model	Enclosure type	Dimensions - tolerance +/- 1.0mm							Weight with choke
		A	B	C	D	E	F	G	
MSC-3R220	Chassis D All types	1225mm 48.2”	555mm 21.9”	525mm 20.7”	1132mm 44.6”	300mm 11.8”	1185mm 46.7”	12mm 0.47”	220Kg 484lbs
MSC-3R260									230Kg 506lb
MSC-3R315									240Kg 528lbs
MSC-3R360									270Kg 594lbs
MSC-3R390									280Kg 616lbs
MSC-3R430									290Kg 638lbs
MSC-3R490									300Kg 660lbs



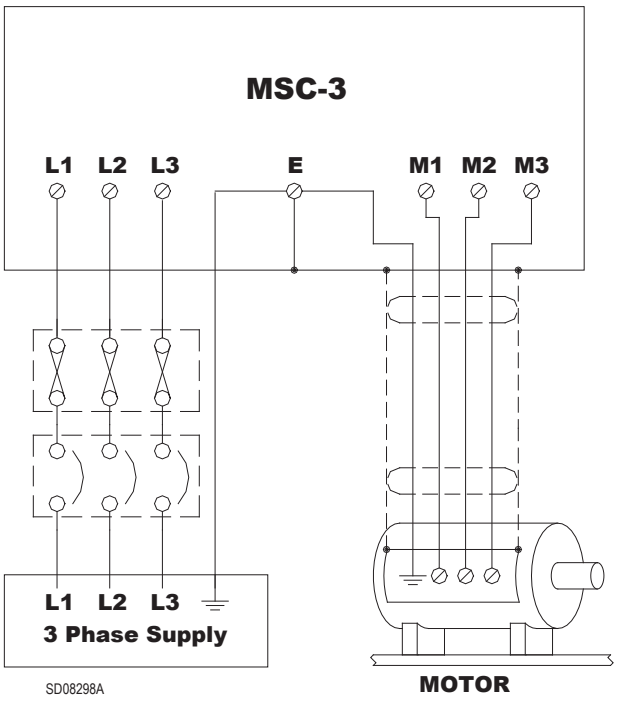
CAUTION

Allow 150mm above, below and either side of the enclosure for ventilation

Model	Enclosure type	Dimensions - tolerance +/- 1.0mm								Weight with choke and stand
		E,G	H	I	J	K	L	M	P	
MSC-3R220	Chassis D All types	as per previous page	618mm 4.3”	459mm 18.1”	659mm 25.9”	475mm 18.7”	425mm 16.7”	13mm 0.451	1684mm 69”	255Kg 561lbs
MSC-3R260										265Kg 583lbs
MSC-3R315										275Kg 605lbs
MSC-3R360										305Kg 671lbs
MSC-3R390										315Kg 693lbs
MSC-3R430										325Kg 715lbs
MSC-3R490										335Kg 737lbs

MSC-3 Power wiring for 3 Phase supply

Basic power wiring diagram



CAUTION

Be sure to review the information on the following pages concerning electrical installation issues.

See installation practices for Electromagnetic compatibility (EMC) compliance on page 13 and specific information for the EMC compliant installation of each chassis size on pages 14 - 18 BEFORE selecting or installing motor cables and glands.

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.

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.

Fuses or circuit breakers of the current limiting type are preferred in order to minimise the total energy let through in the unlikely, but possible, event of a major arcing fault in wiring or within MSC-3 enclosure.

Installations that are required to be UL compliant must use UL listed fuses of the amp rating and class detailed on page 10 of this manual.

Cable sizes

Cable sizes should be selected according to local wiring rules using the currents given in the table on page 10. Note that the power terminals of the MSC-3 are designed to accept normally stranded power cables with temperature rating of 70ºC or more. In the event that other cable types are to be used (particularly flexible cables with very fine stranding), the overall size of the conductor should be checked prior to final cable selection for proper fit in the power terminals. The combination of the cable and the supply circuit protection selected must be such that the supply cable is properly protected under all circumstances.

Electrical Isolation

A suitable means of isolating the MSC-3 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-3 enclosure), suitable marking must be applied to the outside of the MSC-3 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.

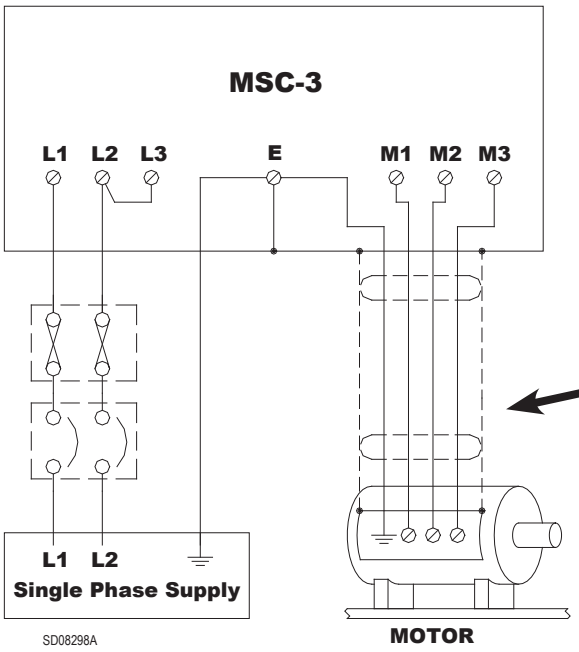
Fuse Circuit Breaker Ratings for All MSC-3 Models

Model Numbers	Chassis Size	Maximum RMS Input Current	Recommended Fuse or C/B Rating (A)	UL Class Fuse for UL compliant installation (A)†
MSC-3*3	A	4.1	10	10A, Class J
MSC-3*5	A	6.9	10	10A, Class J
MSC-3*7	A	9.6	16	15A, Class J
MSC-3*11	A	15.1	20	120A, Class J
MSC-3*15	B	22.5	32	30A, Class T
MSC-3*23	B	33.0	40	40A, Class T
MSC-3*30	B	43.1	63	60A, Class T
MSC-3*40	B	55.0	63	60A, Class T
MSC-3*55	C	78.0	100	100A, Class T
MSC-3*82	C	108.0	125	125A, Class T
MSC-3*109	C	148.0	160	175A, Class T
MSC-3*140	C	179.0	200	200A, Class T
MSC-3*170	C	187.0	200	200A, Class T
MSC-3R220	D	231.0	259	250A, Class T
MSC-3R260	D	270.0	320	320A, Class T
MSC-3R315	D	336.0	400	400A, Class T
MSC-3R360	D	370.0	400	400A, Class T
MSC-3R390	D	397.0	630	630A, Class T
MSC-3R430	D	434.0	630	630A, Class T
MSC-3R490	D	516.0	630	630A, Class T
* L, R or J for Chassis A and B, L or R for Chassis C to specify supply voltage - see page 133 for details.				
† The fuse **class** referred to here is the American designation fuse required for a UL compliant installation. this should not be confused with the British **Type** T etc designation, which refers to an entirely different kind of fuse.				

Motor thermal protection

The MSC-3 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.

MSC-3 Power wiring for Single Phase Supply



The D09 1 Phase Input Supply feature on page 80 must be enabled for single phase supply operation

CAUTION

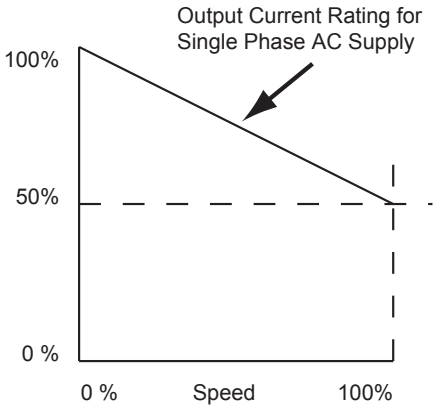
Be sure to review the information on the following pages concerning electrical installation issues.

See Installation practices for Electromagnetic compatibility (EMC) compliance on page 13 and specific information for the EMC compliant installation of each chassis size on pages 14 - 18 BEFORE selecting or installing motor cables and glands.

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.

Any model MSC-3 can be operated from a single phase AC supply. In addition to the electrical installation information on pages 9 and 10, the following additional constraints apply to operation on a single phase power supply:

- The single-phase supply voltage must be within the 3 phase supply voltage limits for the MSC-3 model to be used. For example, use an MSC-3Lxx model for a 240VAC single-phase supply or a MSC-3Rxx model for a 480VAC single phase supply.
- A standard 3-phase motor of a voltage rating appropriate to the MSC-3 model should be used. See the specifications section of this manual for output voltages.
- Fuses or circuit breakers for the AC supply should be according to the table on page 10.
- The MSC-3 is unsuitable for use with single-phase motors.
- The DC Bus Choke option is mandatory for operation from a single-phase supply.
- The continuous output current rating is reduced from the values stated for 3-phase supply operation according to the graph on the right.



- The maximum available output voltage will decrease to 95% of the RMS input voltage. This is a consequence operating from a single phase supply and means that the available motor torque at full speed will be reduced to approximately 90% of the motor rated torque. De-rating can be avoided if the single phase input voltage is at least 1.05 times the rated motor voltage.

MSC-3 with a DC Supply

Some models of MSC-3 may be used with a DC supply. There are a number of issues to be considered in properly applying MSC-3 in this situation, some of which involve the characteristics of the particular DC supply to be used.

Please consult the factory for proper application of MSC-3 on DC supply systems.

Installation practices for Electromagnetic Compatibility (EMC) compliance

Installation practices for EMC compliance

The EMC performance of the MSC-3 is installation dependent. For compliance with EMC standards, the use of a screened power cable between the MSC-3 and the motor is required. Other arrangements that provide a continuous metallic sheath enclosing only the motor phase conductors and the associated protective earth (PE) conductor may also be used.

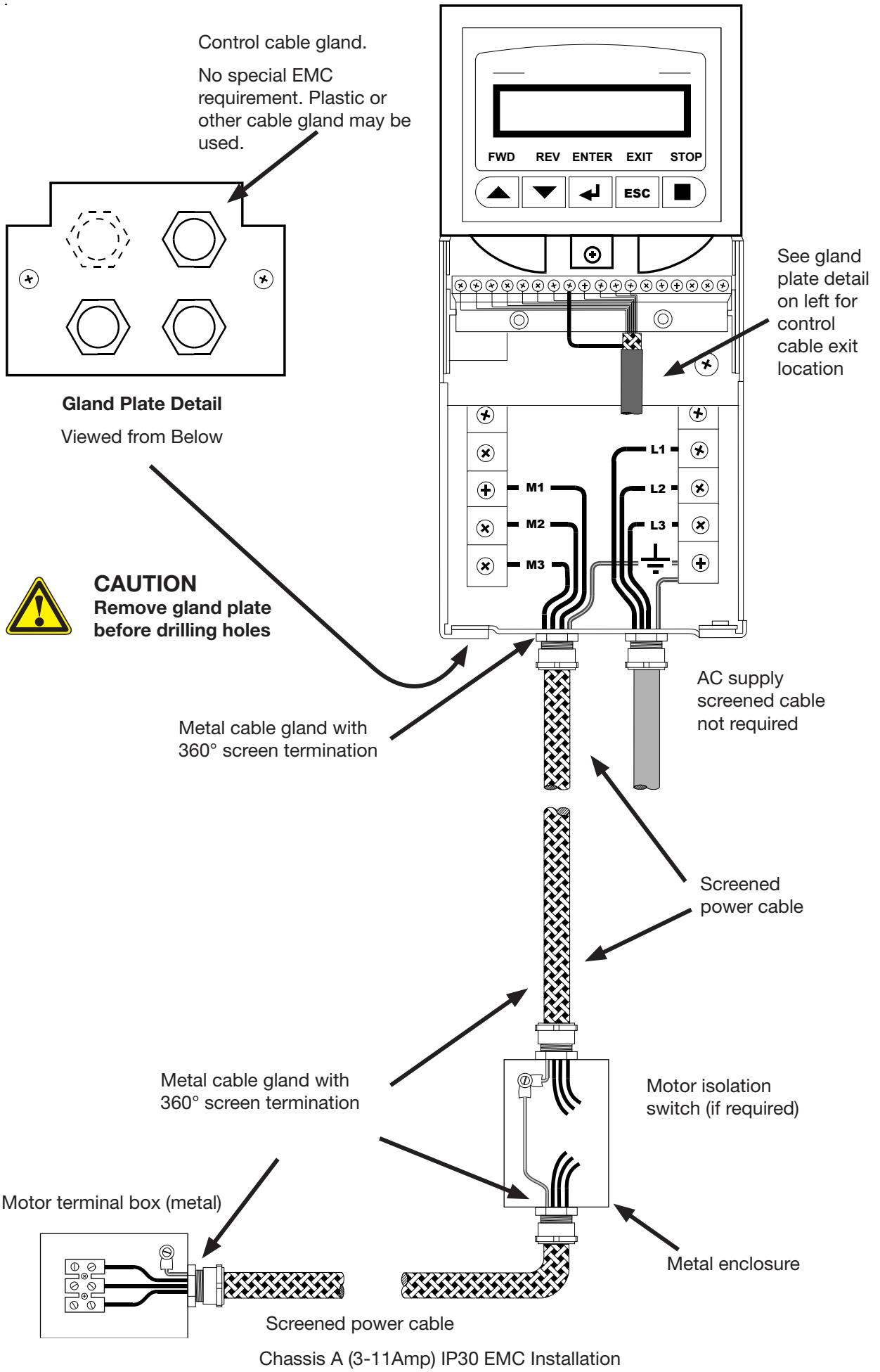
In order to achieve the required electrical performance at high frequencies, it is essential that the screen of the cable have a 360º connection to both the MSC-3 gland plate and the motor terminal box. The correct type of metal cable gland to suit the screened cable should be used. The protective earth (PE) conductor should be terminated in the usual way to meet the local wiring codes at the ground terminals provided in the MSC-3 and the motor. Isolation switches wired between the MSC-3 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.

Specific information for the EMC compliant installation of each chassis size is provided on pages 14 - 18.

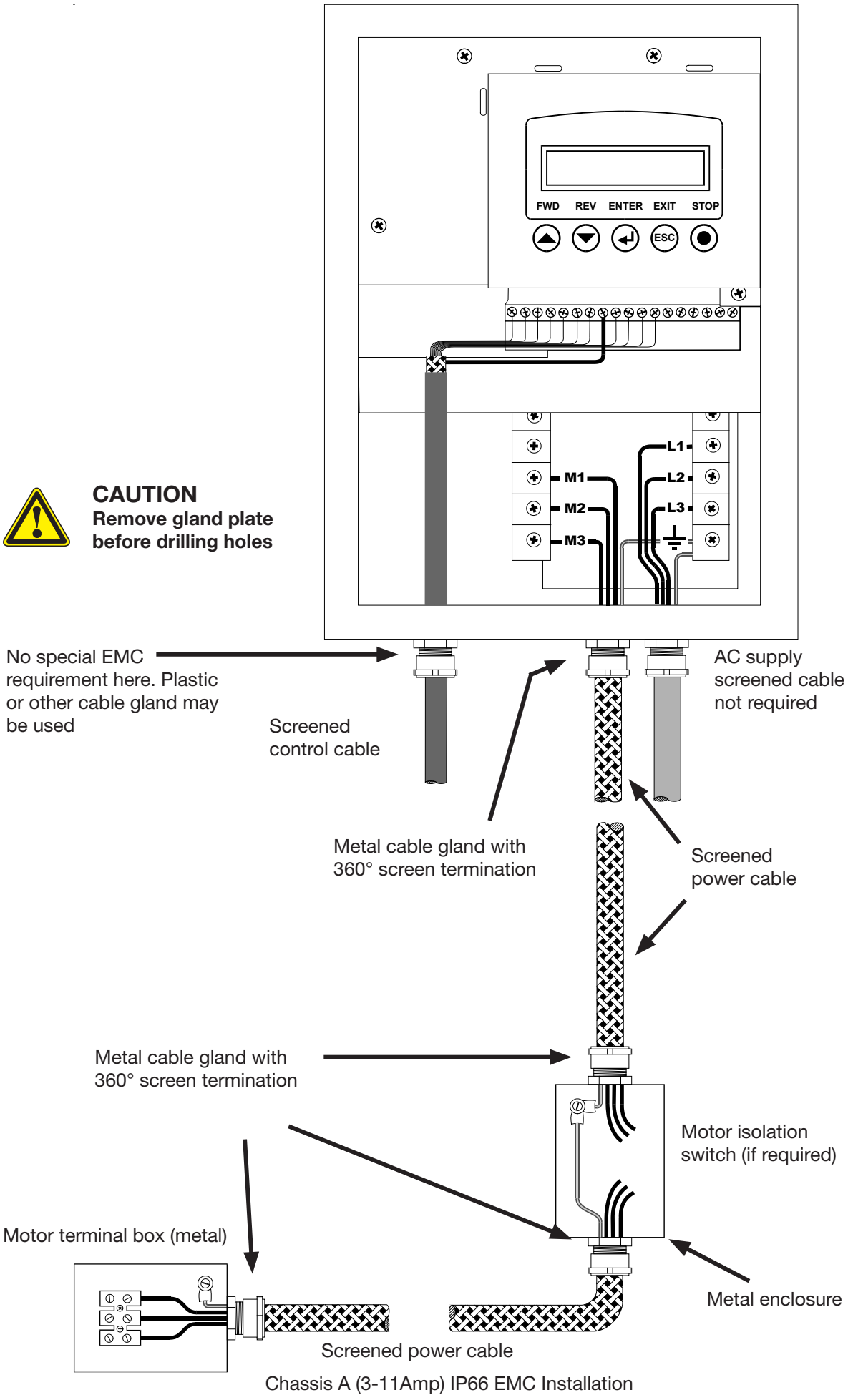
Wiring materials for EMC compliance

The EMC related properties of the shielded power cable used between the inverter and motor will have a significant impact on the overall EMC result achieved in any given installation. The EMC performance of an installation will usually be dominated by the lowest performance section of the inverter to motor cabling. For this reason it is imperative that appropriate material (including cable glands/terminators) is used in every part of this cabling. There is a wide range of materials available, and these may be generally categorised as follows:

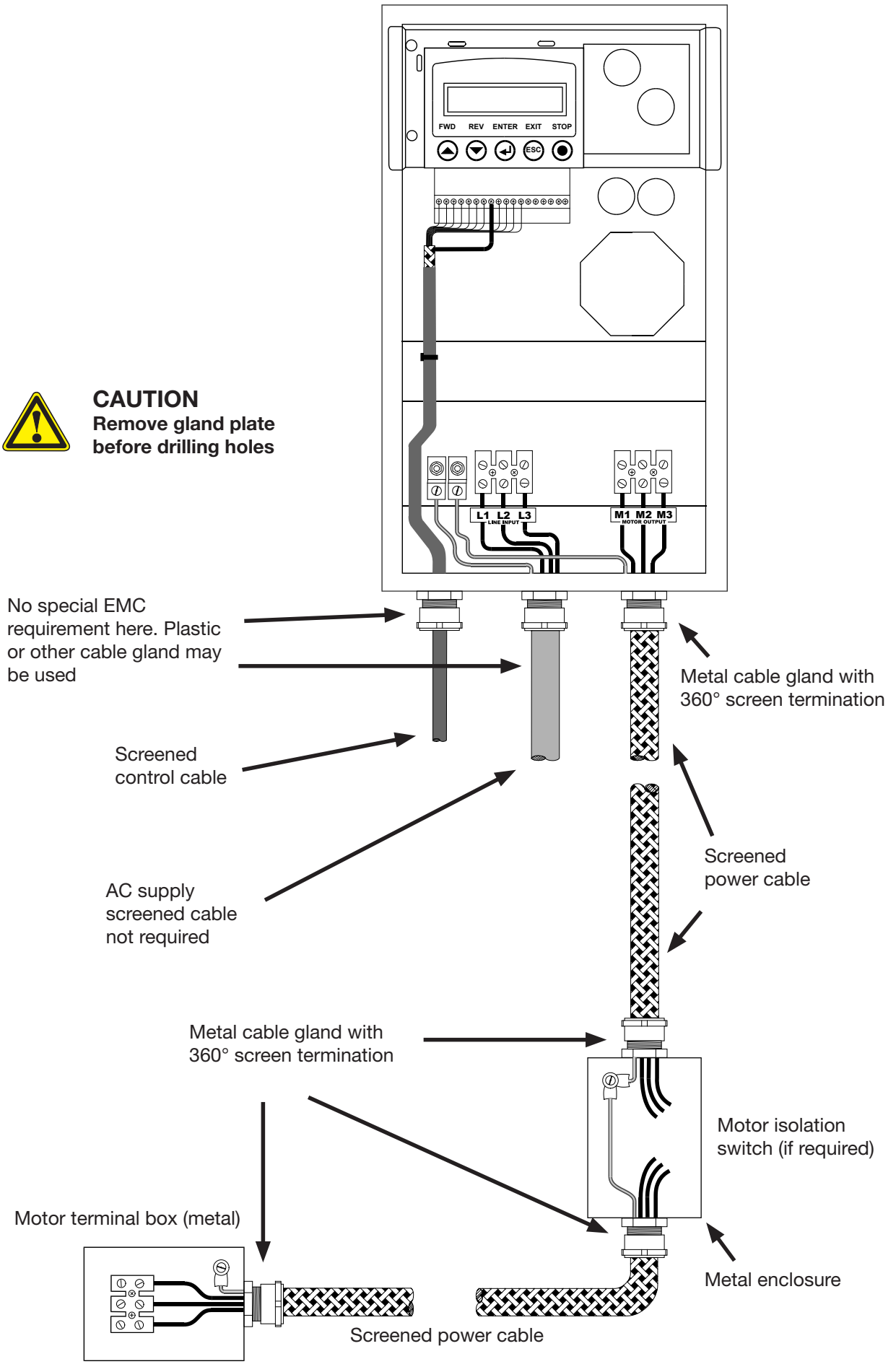
	Category	Technical Data	Comment	
1	Screened cable material from reputable manufacturers	Technical data will be available to allow assessment of the performance of the material against specific criteria	The manufacturer's claimed data can generally be relied on, provided that the proper installation and 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.	✗



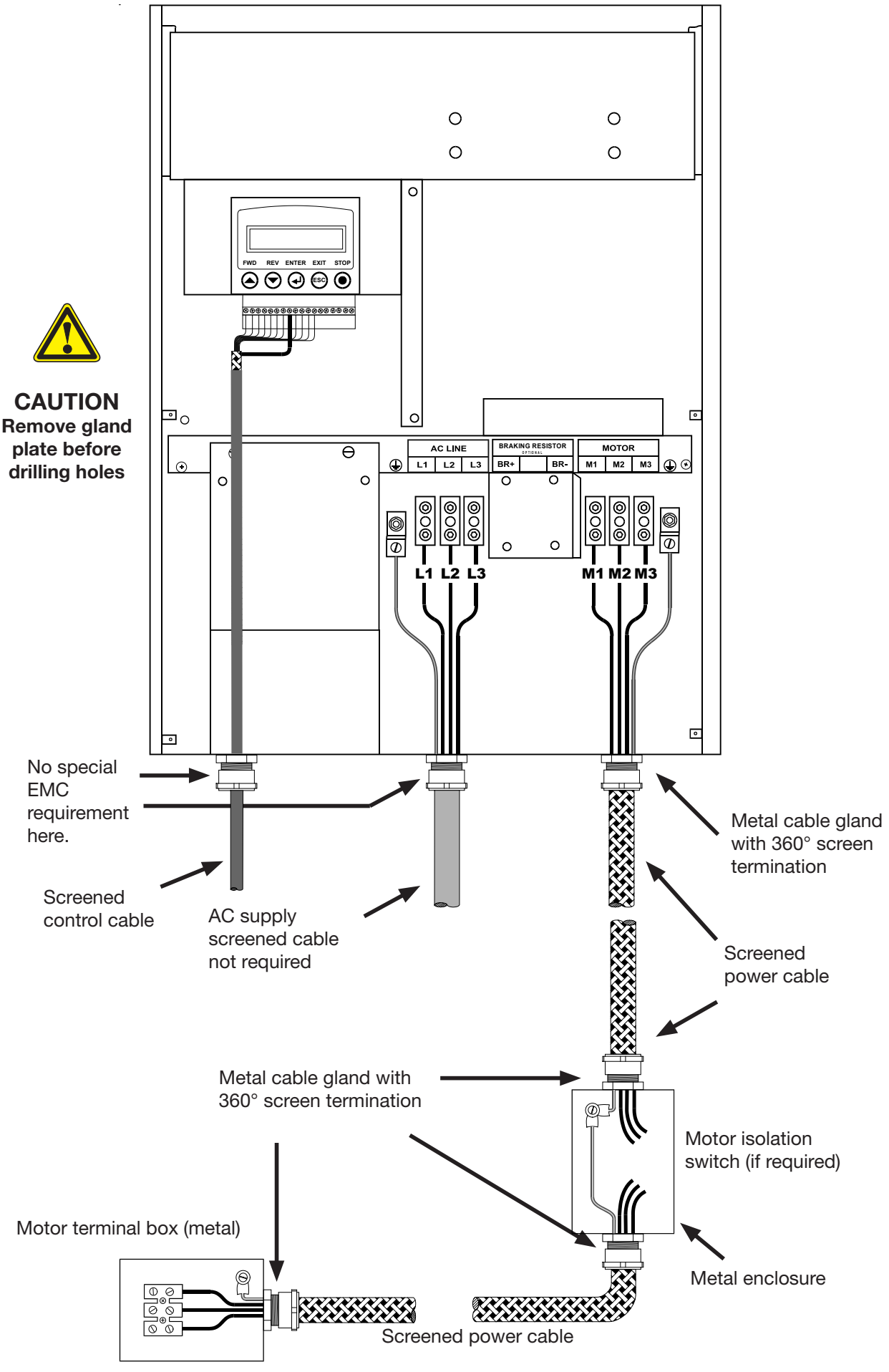
Chassis A (3-11Amp) IP30 EMC Installation



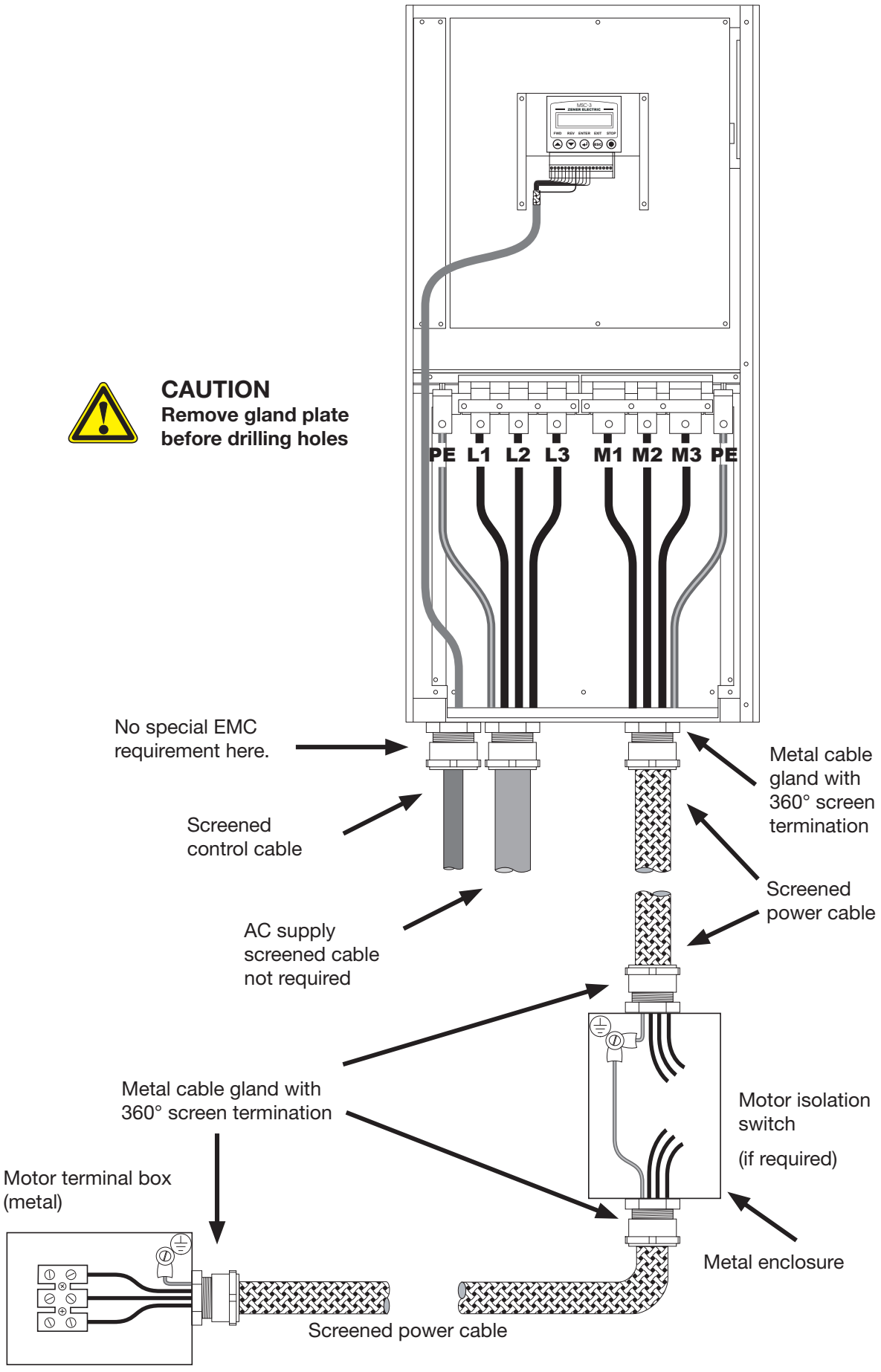
Chassis A (3-11Amp) IP66 EMC Installation



Chassis B (15-14Amp) EMC Installation



Chassis C (55 - 170Amp) EMC Installation



Chassis D (175 - 490Amps) EMC Installation

Control connections and configuration

General

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

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

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

Factory default settings

The factory default terminal configuration provides for single direction control from either the terminal strip or the front panel console, as selected by a local / remote input on the terminal strip. This is detailed as “Config 1”, starting on page 20.

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

Settings for your application

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

Quick Setup

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

	Page
Typical industrial application	20
Typical industrial applications	
Water pumping with automatic pressure control	24
Machine drive with stop/start, jog forward/reverse	29
Typical HVAC application	32
Typical HVAC applications	
Supply air or smoke spill fan	36
Return air fan	37
Stair pressurisation fan with internal PID	38
Stair pressurisation fan with external PID	40
Cooling tower fan with reverse acting internal PID	41
Full details on customising terminal functions	89

Industrial Terminals Typical Connection Diagram – Terminal Config 1

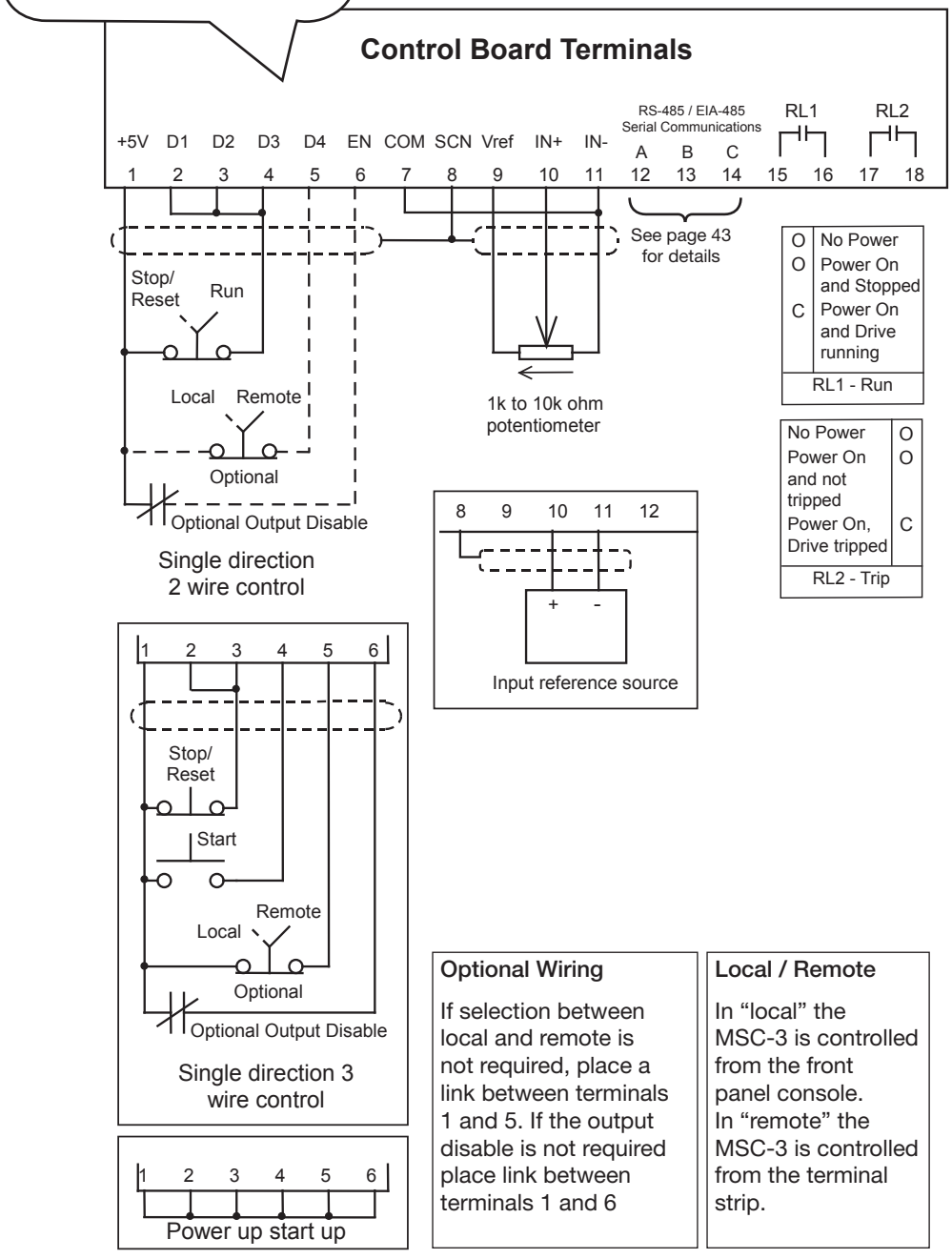
General

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-3 or a remote signal source. Switching between local and remote operation is controlled by a contact closure. This terminal configuration is the factory default. Several alternative arrangements for starting and stopping are shown.

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

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



Optional Wiring

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

Local / Remote

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

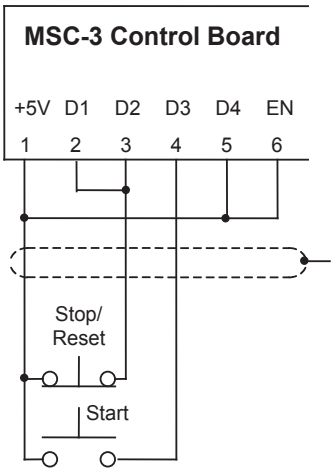
Quick Setup for Terminal Config 1.

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

Procedure

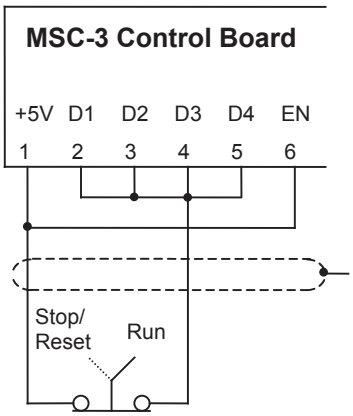
STEP 1. Complete the power wiring according to the instructions on pages 9 to 18

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



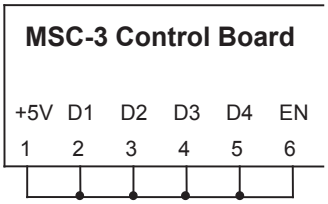
Push button control

(3 - wire control)



Switch or contact control

(2 - wire control)



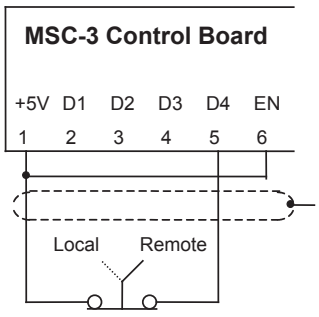
Power up start

MSC-3 will start as soon as power is applied

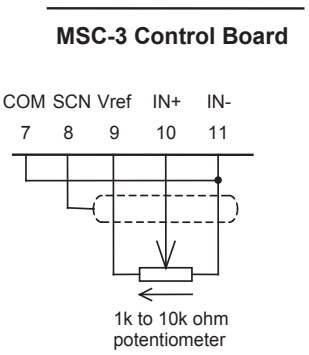
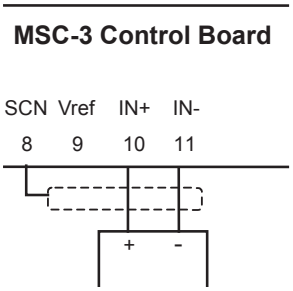
Local / Remote Selection

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 102.

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



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

Speed control from an external potentiometer This is typically used for simple manual speed control. See also Console Reference below.	
Speed control from an external signal Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when AI(10,11) is displayed. Press ESC Go to the G00 INPUT/OUTPUT menu and select G02 AI(10,11). Set G020 for the type of input signal (mA or voltage). Set G021 Min Input and G022 MAX Input to reflect the range of the signal, typically 4-20mA or 0-10V. For more information, see page 89.	
Preset speed This provides a single fixed speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when F100 PRESET 1 is displayed. Press Enter again. Now set your desired preset speed. Press Enter. No speed reference wiring is necessary.
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.

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

Menu	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I00 FWD & LATCH = D3(4) (default)	90
		I02 ~STOP = D2(3) (default)	91
		I07 RESET = D1(2) (default	92
		I11 REMOTE = D4(5) (default)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11) or PRESET or CONSOLE as selected in Step 3.	85
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74

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-3. 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

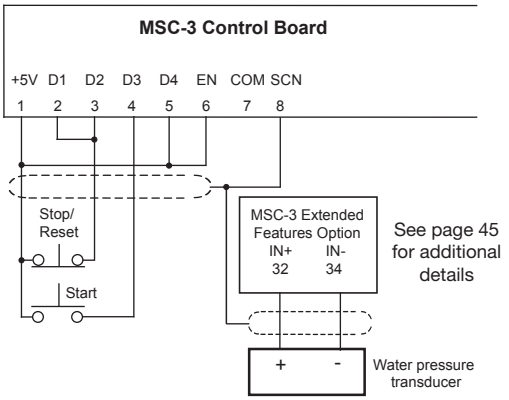
STEP 1 Complete the power wiring according to the instructions on pages 9 to 18

STEP 2 Connect the control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not 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.

Go to the G00 INPUT/OUTPUT menu and select G10 AI(32,34). Set G100 for the type of transducer signal to be used (mA or voltage). Set G101 Min Input and G102 MAX Input to reflect the range of signal, typically 4-20mA or 0-10V. For more information, see page 89.

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. See the H00 PID Control beginning on page 113 for additional information on PID configuration and tuning.

Menu	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I00 FWD & LATCH = D3(4) (default)	90
		I02 ~STOP = D2(3) (default)	91
		I07 RESET = D1(2) (default	92
		I11 REMOTE = D4(5) (default)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	PID OUTPUT	85
	F10 PRESETS	F100 PRESET 1 = required pressure (as % of transducer full scale)	88
H00PID Control	H06 SV Choice	F100 Preset 1	114
	H07 PV Choice	AI(32,34)	115
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 1 sec	74
		C031 DECEL TIME = 1 sec	74

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 by a switch contact closure.

Procedure

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

STEP 2. Connect your control wiring as shown.

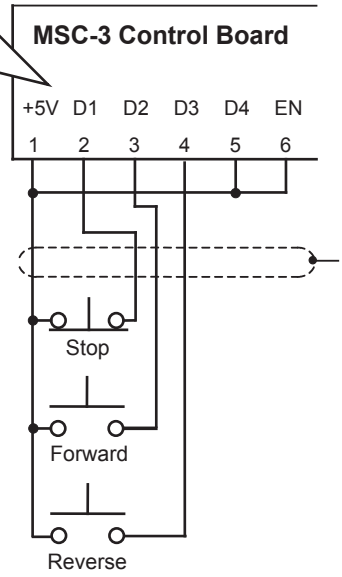
CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 is enabled.

The function of terminals D1...4 are programmable. In this configuration (Terminal config 4), the following functions are assigned to the terminals:

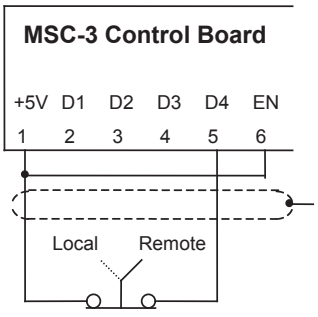
I02	~ STOP	D1
I00	FWD & LATCH	D2
I01	REV & LATCH	D3
I11	REMOTE	D4



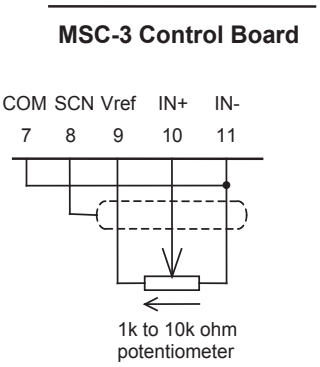
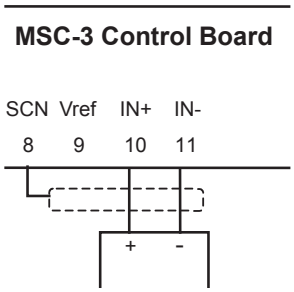
Local / Remote Selection

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



STEP 3 Choose your speed reference and connect it as shown

Speed control from an external potentiometer This is typically used for simple manual speed control. See also Console Reference below.	
Speed control from an external signal Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when AI(10,11) is displayed. Press ESC. Go tot the G00 INPUT/OUTPUT menu and select G02 AI(10,11). Set G020 for the type of input signal (mA or voltage). Set G021 Min Input and G022 Max Input to reflect the range signal, typically 4-20mA or 0-10V. For more information, see page 89	
Preset speed This provides a single fixed speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when PRESET 1 is displayed. Press Enter again. Now set your desired preset speed. Press Enter. No speed reference wiring is necessary.
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.

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

Menu	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I01 REV & LATCH = D3(4)	91
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 Rl2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11) or PRESET or CONSOLE as selected in Step 3.	85
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74

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 pages 9 to 18

STEP 2. Connect your control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet.

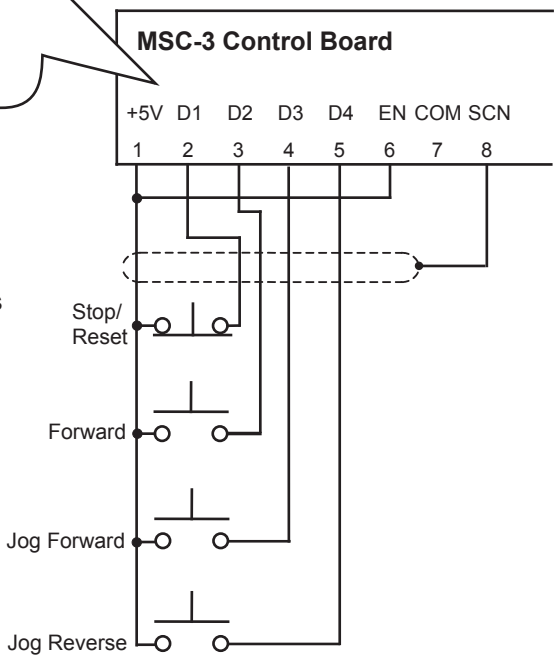
The terminal configuration should not be changed while the MSC-3 is enabled.

The function of terminals D1...4 are programmable. In this configuration the following functions are assigned to the terminals:

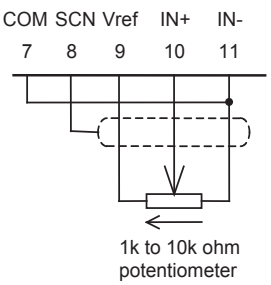
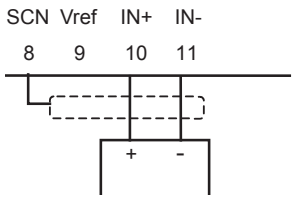
I02	~ STOP	D1
I00	FWD & LATCH	D2
I09	JOGFWD	D3
I10	JOGREV	D4

Note:

The I11 REMOTE function is assigned to “ON” so that the MSC-3 always operates in the REMOTE mode.



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.	**MSC-3 Control Board** 
Speed control from an external signal Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when AI910,11) is displayed. Press ESC. Go tot the G00 INPUT/OUTPUT menu and select G02 AI(10,11). Set G020 for the type of input signal (mA or voltage). Set G021 Min Input and G022 Max Input to reflect the range signal, typically 4-20mA or 0-10V. For more information, see page 89	**MSC-3 Control Board** 
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.

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

Menu	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I09 JOGFWD = D3(4)	93
		I10 JOGREV = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
	D03 REVERSE	ENABLED	80
E00 STOP/START	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11) or PRESET or CONSOLE as selected in Step 3.	85
	F04 JOGFWD REF	F100 PRESET 1	86
	F05 JOGREV REF	F100 PRESET 1	86
	F10 PRESETS	F100 PRESET 1 = 10% (or desired jog sped)	88
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74

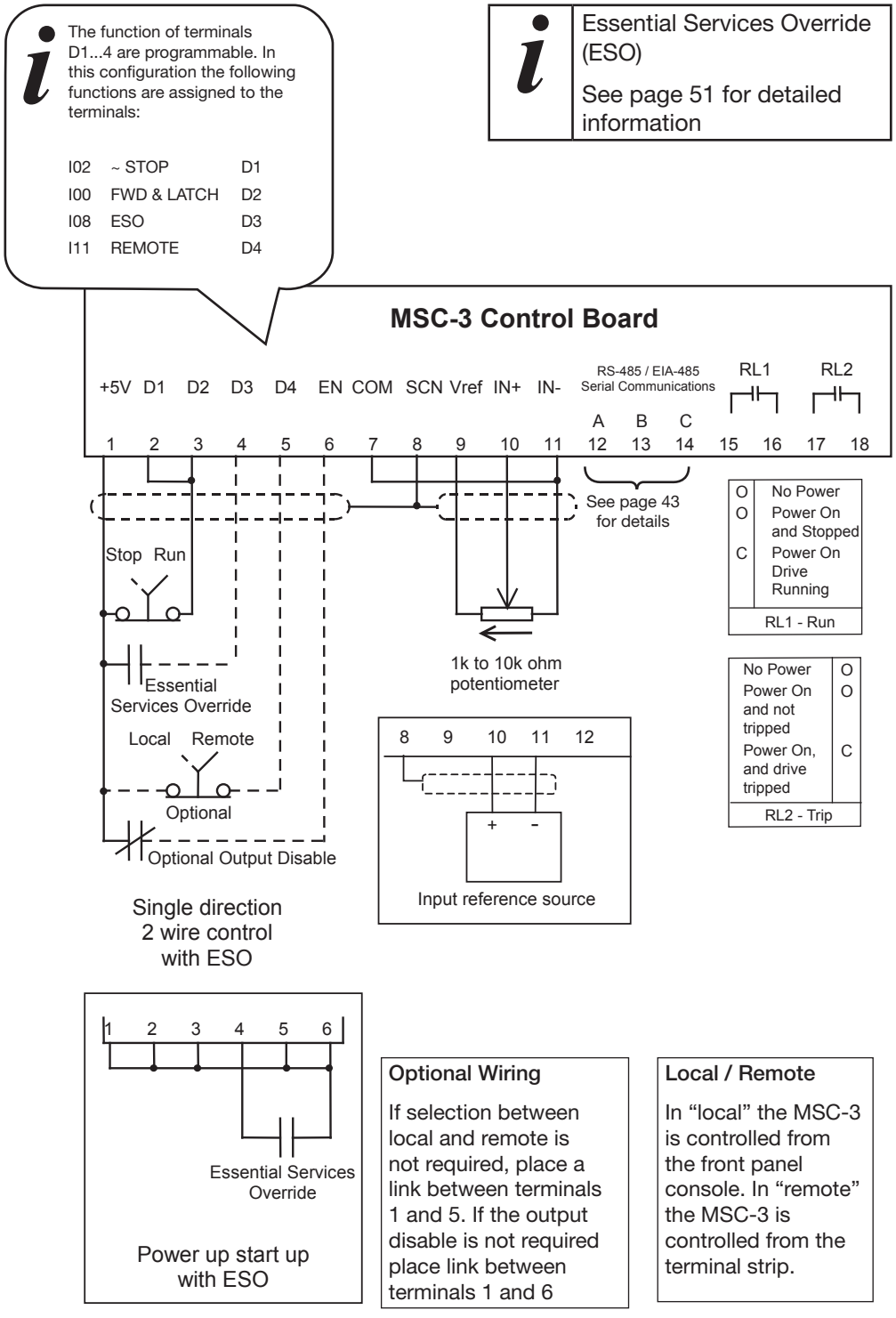
STEP 5 Now connect the wire to terminal 6.

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. Specific setup instructions are provided for the more common HVAC applications in the sections that follow this.



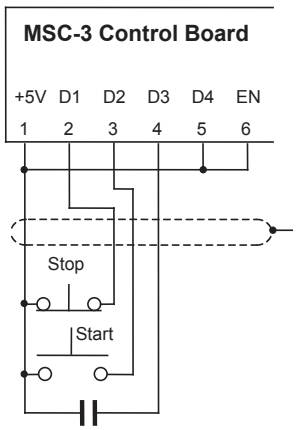
Quick Setup for Config 3.

Features	Forward Operation Local / Remote selection from a contact closure or from the console. See page 102 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 pages 9 to 18

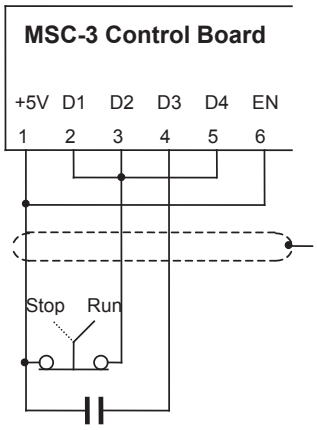
STEP 2. Choose your own control method from one of the following. Connect your control wiring as shown.



ESO (Optional)

Push button control

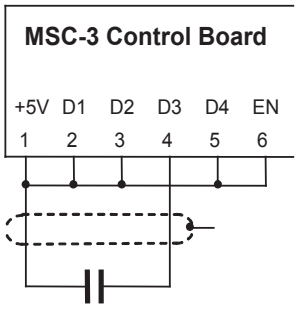
(3 - wire control)



ESO (Optional)

Switch or contact control

(2 - wire control)



ESO (Optional)

Power up start

MSC-3 will start as soon as power is applied

CAUTION

Do not connect the wire to terminal 6 yet.

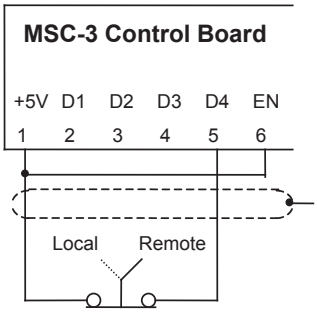
The terminal configuration should not be changed while the MSC-3 is enabled.

Essential Services Override (ESO). See page 51 for detailed information

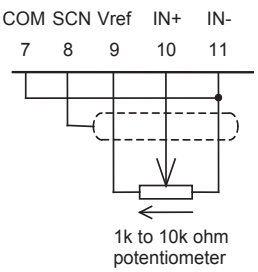
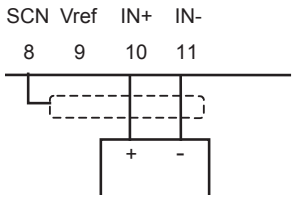
Local / Remote Selection

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 102.

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



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

Speed control from an external potentiometer This is typically used for simple manual speed control. See also Console Reference below.	**MSC-3 Control Board** 
Speed control from an external signal Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when AI910,11) is displayed. Press ESC. Go to the G00 INPUT/OUTPUT menu and select G02 AI(10,11). Set G020 for the type of input signal (mA or voltage). Set G021 Min Input and G022 Max Input to reflect the range signal, typically 4-20mA or 0-10V. For more information, see page 89	**MSC-3 Control Board** 
Preset speed This provides a single fixed speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when PRESET 1 is displayed. Press Enter again. Now set your desired speed. Press Enter. No speed reference wiring is necessary.
Console reference This uses the Up and Down arrows on the front panel to control the speed.	Go to the F00 REFERENCES menu and select F01 REMOTE REF. Press Enter. Use the arrows to display the options. Press Enter when CONSOLE is displayed. No speed reference wiring is necessary.

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

Menu	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 Rl2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11)	85
	F03 ESO REF	F100 PRESET 1	86
	F10 PRESETS	F100 PRESET 1 = 100% (or desired ESO speed)	88
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74
		C034 ESO RAMP = 10 sec	75

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 fill 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 console. Prior to commissioning, you will need to know the type of speed signal that is to be used (0-10V, 4-20mA etc).

Procedure

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

STEP 2 Connect the control wiring as shown.

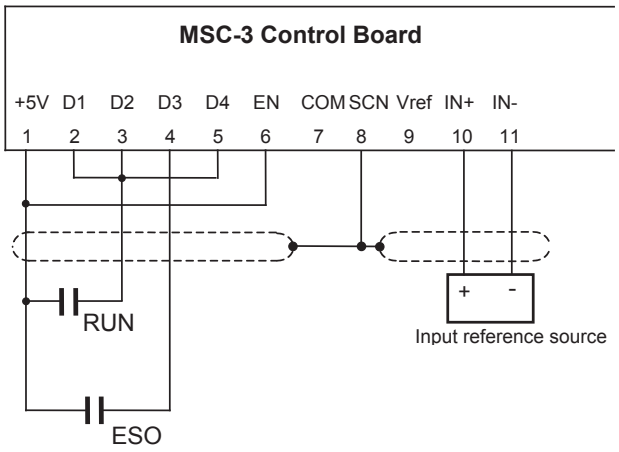
CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 is enabled.

Essential Services Override (ESO)

See page 51 for detailed information



STEP 3 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	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11)	85
	F03 ESO REF	F100 PRESET 1	86
	F10 PRESETS	F100 PRESET 1 = 100% (or desired ESO speed)	88
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74
		C034 ESO RAMP = 10 sec	75

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 console. Prior to commissioning, you will need to know the type of speed signal that is to be used (0-10V, 4-20mA etc).

Procedure

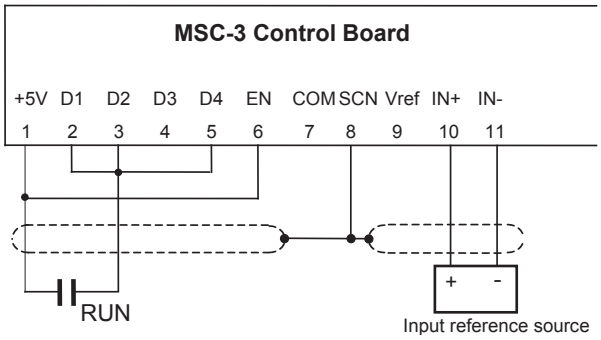
STEP 1 Complete the power wiring according to the instructions on pages 9 to 18

STEP 2 Connect the control and signal wiring as shown. type.

CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 is enabled.



STEP 3 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	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	AI(10,11)	85
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 60 sec	74
		C031 DECEL TIME = 60 sec	74

STEP 4 Now connect the wire to terminal 6.

End of procedure

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-3 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 pages 9 to 18

STEP 2 Connect the control wiring as shown.

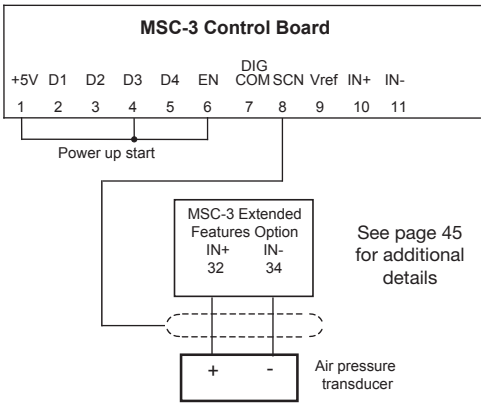
CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 is enabled.

Essential Services Override (ESO)

See page 51 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.

Go to the G00 INPUT/OUTPUT menu and select G10 AI(32,34). Set G100 for the type of pressure transducer signal (mA or voltage). Set G101 Min Input and G02 Max Input to reflect the range of the signal, typically 4-20mA or 0-10V. For more information, see page 105

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	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F03 ESO REF	PID OUTPUT	86
	F10 PRESETS	F100 PRESET 1 Set to % of transducer full scale equivalent to required pressure	88
H00PID Control	H06 SV Choice	F100 Preset 1	114
	H07 PV Choice	AI(32,34)	115
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74
		C034 ESO RAMP = 10 sec	75

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-3 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 pages 9 to 18

STEP 2 Connect the control wiring as shown.

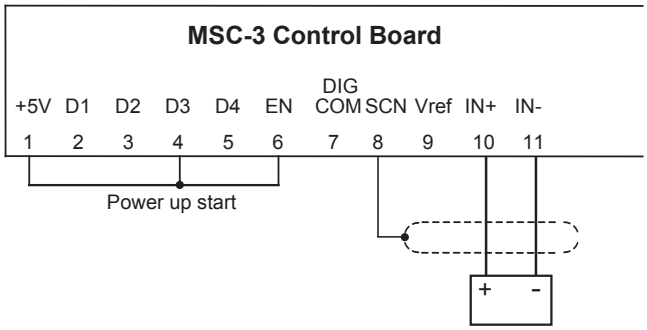
CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 is enabled.

Essential Services Override (ESO)

See page 51 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.

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	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 RI2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F03 ESO REF	AI(10,11)	86
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74
		C034 ESO RAMP = 10 sec	75

Step 5 Now connect the wire to terminal 6.

End of procedure

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-3 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

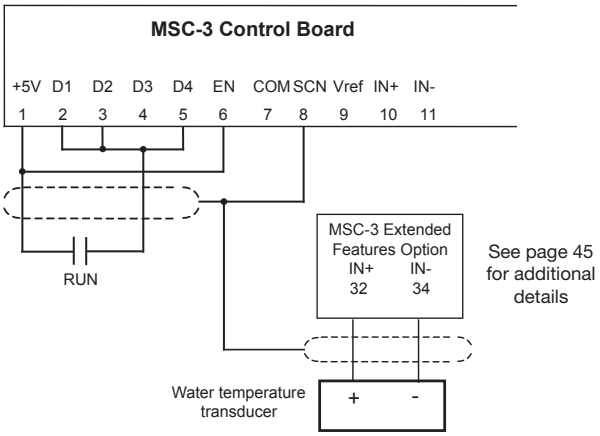
STEP 1 Complete the power wiring according to the instructions on pages 9 to 18

STEP 2 Connect the control wiring as shown.

CAUTION

Do not connect the wire to terminal 6 yet.

The terminal configuration should not be changed while the MSC-3 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.

Go to the G00 INPUT/OUTPUT menu and select G10 AI(32,34). Set G100 for the type of input signal (mA or voltage). Set G101 Min Input and G102 Max Input to reflect the range of the signal, typically 4-20mA or 0-10V. For more information, see page 89.

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	Menu Item	Suggested Setting	Page for detailed information
G00 INPUT/OUTPUT	G01 Inpt fxn CFG (Input terminal configuration)	I02 ~STOP = D1(2)	91
		I00 FWD & LATCH = D2(3)	90
		I08 ESO = D3(4)	93
		I11 REMOTE = D4(5)	93
G00 INPUT/OUTPUT	G03 RL1	G030 RL1 Signal = RUN (default)	98
	G04 Rl2	G040 RL2 Signal = TRIP (default)	100
B00 MOTOR	B01 MOTOR VOLTS	Motor nameplate voltage	71
	B02 MOTOR AMPS	Motor nameplate amps	71
	B03 MOTOR HZ	Motor nameplate frequency	71
	B04 MOTOR RPM	Motor nameplate RPM	72
D00 PROTECTION	D01 CURRENT LIM	Motor nameplate current +10%	78
	D02 I2t Thermal overload	Motor nameplate current	78
E00 STOP/START	E03 AUTO RESTART	E030 ARs ALLOWED = 5	82
	E04 Reset by PF	ENABLED	83
F00 REFERENCES	F01 REMOTE REF	PID OUTPUT	85
	F10 PRESETS	F100 PRESET 1 Set to % of transducer full scale equivalent to required pressure	88
	H01 Prop Band	-300% Note: Negative value gives reverse acting PID	113
H00 PID Control	H06 SV Choice	F100 Preset 1	114
	H07 PV Choice	AI(32,34)	115
C00 PERFORMANCE	C03 RAMP	C030 ACCEL TIME = 10 sec	74
		C031 DECEL TIME = 10 sec	74
		C034 ESO RAMP = 10 sec	75

STEP 5 Now connect the wire to terminal 6.

End of procedure

EIA/RS-485 Communications Wiring

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

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

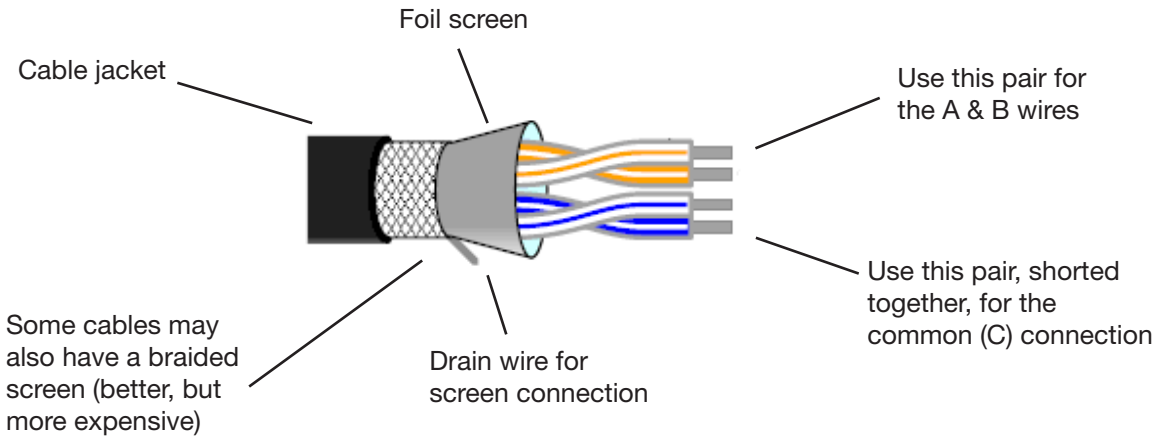
Best practice

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

- Two conductors are used to carry the EIA/RS-485 data as a differential voltage signal. These wires should ideally be twisted together so that any magnetically induced interference voltage will occur equally in both conductors and be rejected by the differential nature of the EIA/RS-485 interface circuit.
- The third conductor is used to keep the common connection (marked as terminal “C” in MSC-3) in all the communications interfaces at the same potential, that is, keep the common mode voltage at each interface within the limits specified by the standard.
- The Shield is connected to earth/ground at one end[2] only and provides protection against capacitive coupling to nearby cables and other electrical noise sources.

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

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

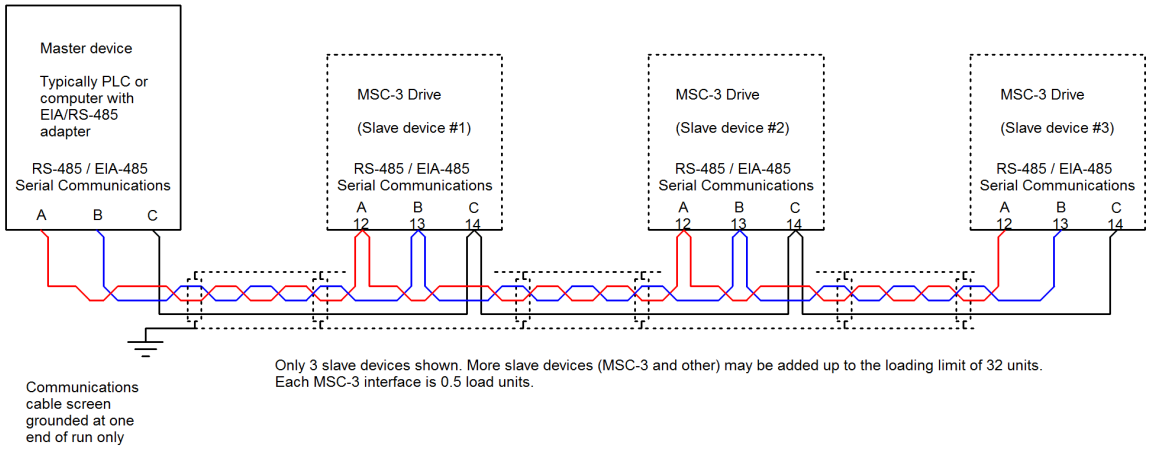


Terminating resistors

For best performance with long cable runs and high data rates a terminating resistor should be fitted at each end of the cable run. Values of 100 or 120 Ohms are commonly used, connected between the A and B terminals of the first and last devices on the cable run. For convenience, the MSC-3 EIA/RS-485 interface incorporates a 120 Ohm terminating resistor that is controlled by menu item G167 TERMINATOR. See page 112 for details. A terminator should not be fitted to, or selected at, intermediate devices on the communications cable.

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

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



Typical EIA/RS-485 wiring arrangement

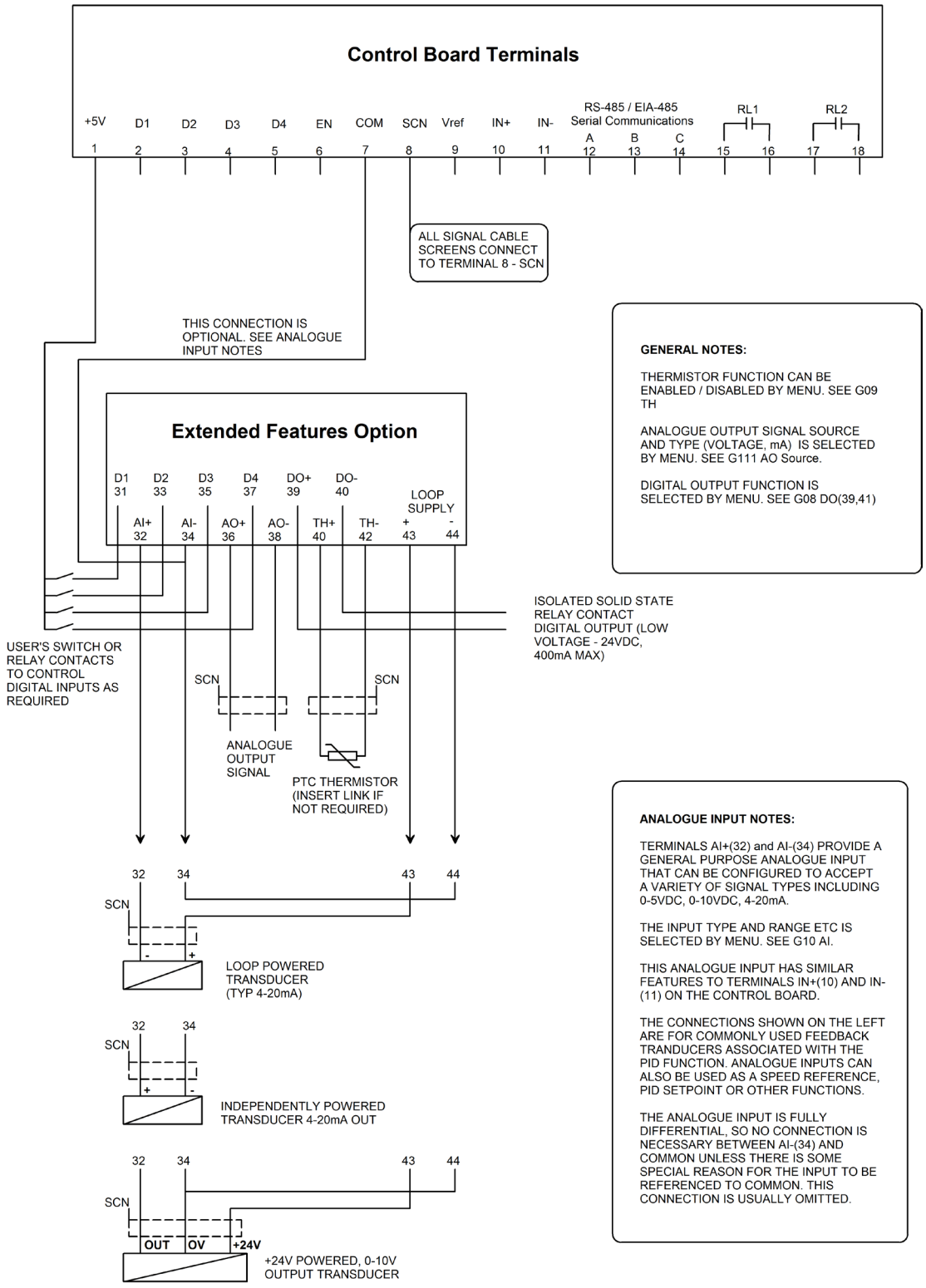
General

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

Shortcuts

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

Extended Features Option Wiring



GENERAL NOTES:

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

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

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

ANALOGUE INPUT NOTES:

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

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

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

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

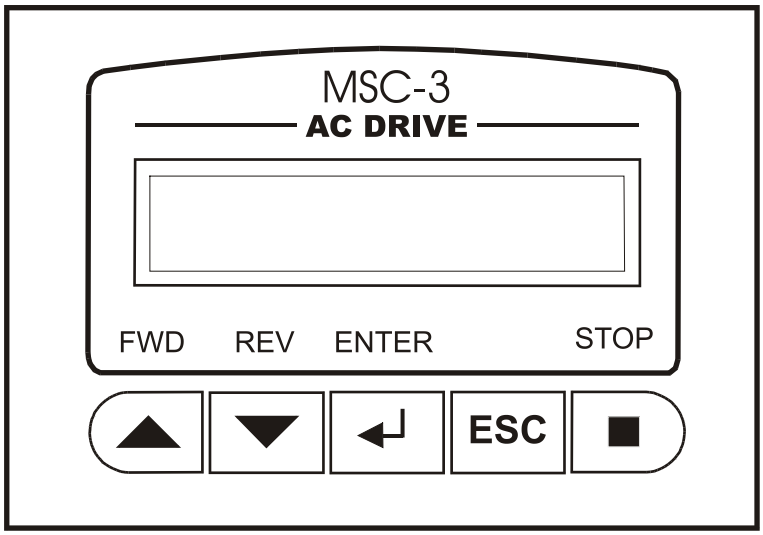
THE ANALOGUE INPUT IS FULLY DIFFERENTIAL, SO NO CONNECTION IS NECESSARY BETWEEN AI-(34) AND COMMON UNLESS THERE IS SOME SPECIAL REASON FOR THE INPUT TO BE REFERENCED TO COMMON. THIS CONNECTION IS USUALLY OMITTED.

MSC-3 Start Up

Connect the input and motor power wiring in accordance with the installation information on pages 9 - 18. Select the terminal configuration you require. 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 B00 MOTOR, C00 PERFORMANCE and G00 INPUT/OUTPUT menus to set up the MSC-3 before running the motor to present 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.

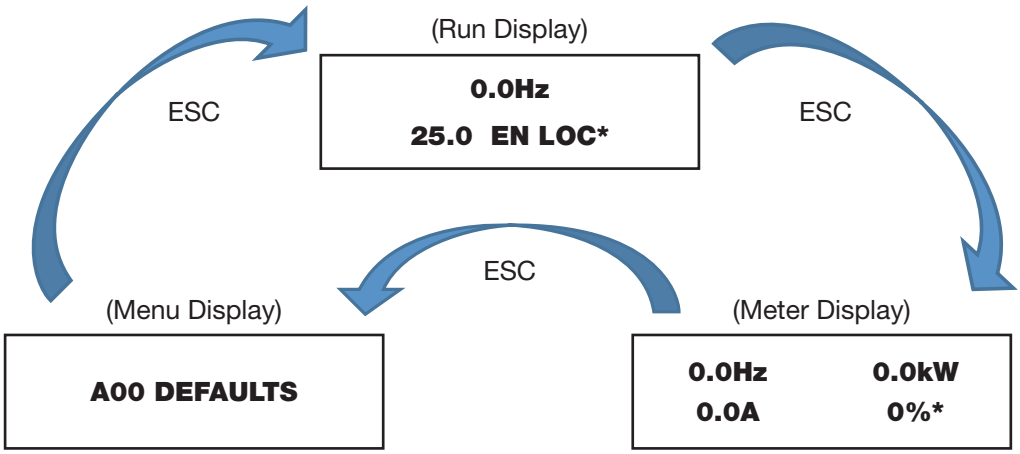


The five pushbuttons and display form a console through which drive features and settings are altered to suit the application. When the MSC-3 is first powered up, the start banner is displayed for approximately 2 seconds. An example of the start banner is shown below. It displays the drive size and software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

R40

Ver 5.0.1

The MSC-3 has three top level displays. These three displays are the Run Display, Meter Display and Menus Display. Each top level display is viewed by pressing **ESC** (ESC) button.



Run Display

The top line of the Run Display contains the run variable. The second line contains the speed reference and the drive status. An example of the Run Display is shown below:

The * at the bottom right of the run display is the indicator for EIA/RS-485 communications activity. See page 62 for details.

The example shows that the desired output speed is 50 Hz and the motor is rotating at 25 Hz in the forward direction in local mode as indicated by the status. TheMSC-3 was started 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 will accelerate or decelerate to the desired speed.

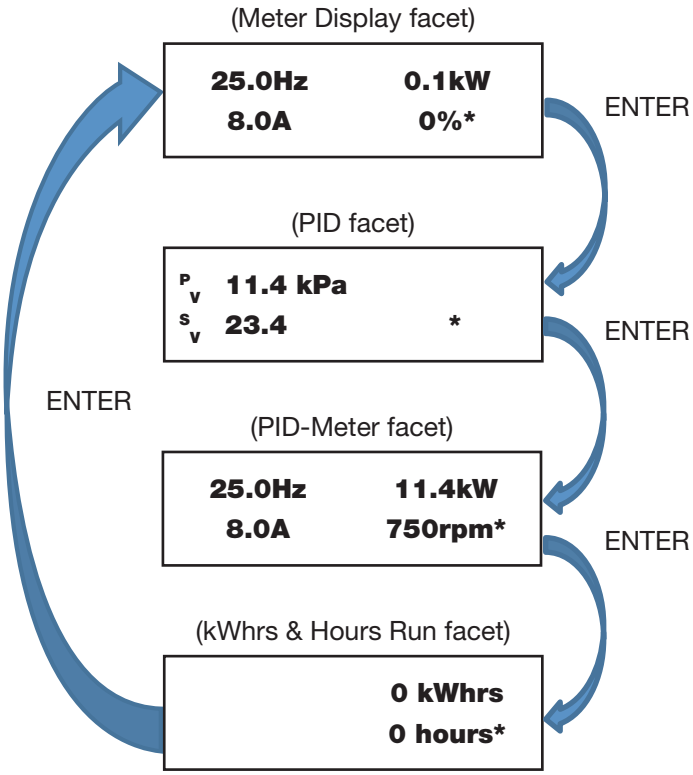
If the motor shaft rotates in the wrong direction remove the input power, wait for the MSC-3 to discharge and swap any two motor phase wires. Re-apply input power and select a direction by pressing ▲ FWD or ▼ REV.

Pressing STOP will stop the motor or reset any trip condition. Pressing ↵ will toggle the drive operation between Local and Remote if the Remote Override feature is enabled. See page 102 for details of the Remote Override feature.

Meter Display

The Meter Display shows other MSC-3 operating values such as output current, output power, motor load as well as motor speed. The PID facet displays the process variable and set point value. The PID-Meter facet helps to relate the motor speed, output power and motor current to the Process variable. The kWhrs & Hours Run facet displays the accumulated kWhrs to the motor and the numbers of hours the motor has been running for. Each Meter Display facet is viewed by pressing the ↵ button.

Note: Each example display is shown with the EIA/RS-485 communication indicator. Refer to the previous section for details.



Menus

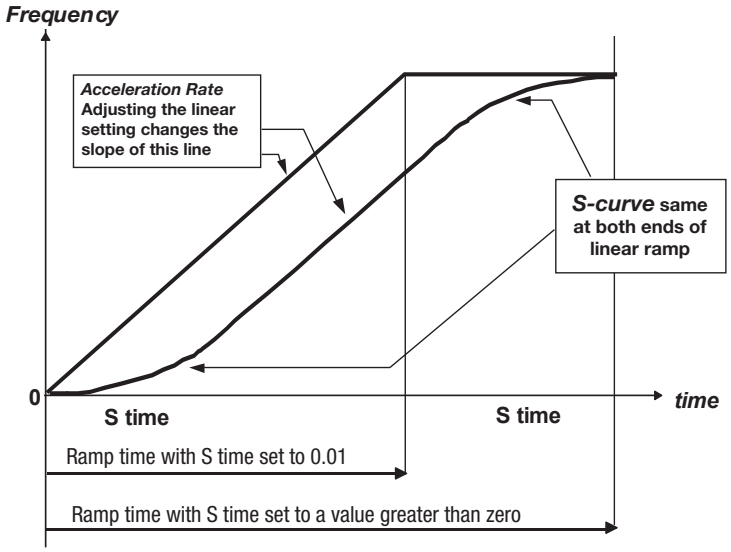
Entry to the Menu Display is identified by:

Use the ▲ and ▼ push buttons to display each menu item. Press the ↵ push button to enter a sub menu or change a parameter. Press ESC to exit a sub menu or abandon a parameter change. The subsequent sections of this document explain the parameters found within menu system.

Major Features

Motor Speed 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



The motor accelerates at a rate of **B03 MOTOR Hz / C030 ACCEL TIME** and decelerates at a rate of **B03 MOTOR Hz / C031 DECEL TIME**. Each of these rates is applied over the **C032 S TIME** interval to create the S-curve in the diagram above.

CAUTION

A separate ramp setting is used during Essential Services Override (ESO) operation.

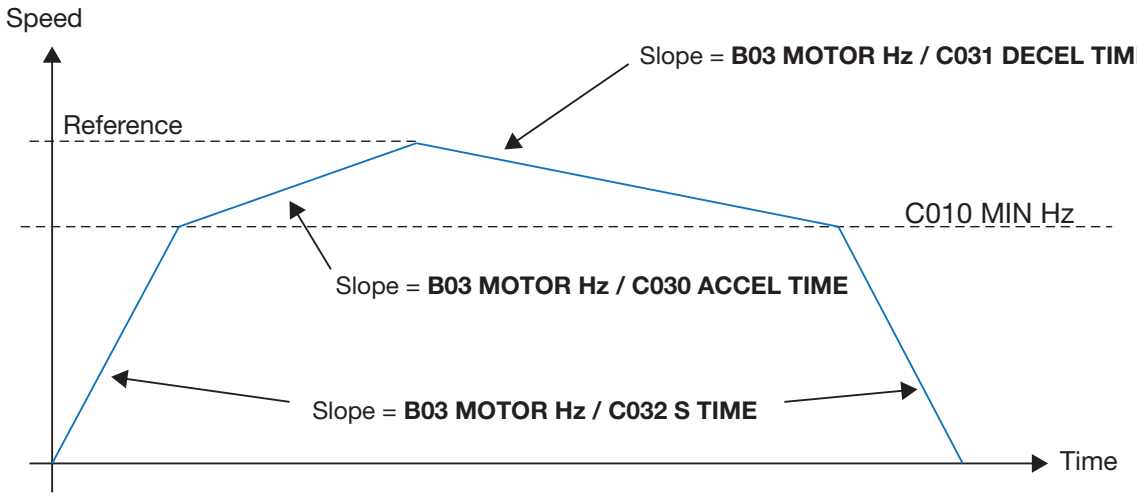
See **C034 ESO RAMP** for details.

Key ramp configuration parameters are:

- B03 MOTOR Hz
- C030 ACCEL TIME
- C031 DECEL TIME
- C032 S TIME
- C033 DUAL RAMP
- C034 ESO RAMP

Dual Ramps

For applications that use a minimum speed, the MSC-3 provides a dual rate acceleration and deceleration. The **C033 DUAL RAMP** option provides this feature. When enabled the rate of acceleration and deceleration in the speed range 0 to **B03 MOTOR Hz** is at a rate of **B03 MOTOR Hz/C032 S TIME.** The diagram below shows the reference as a function of time. Refer to **C033 DUAL RAMP** for details.



Key ramp configuration parameters are:

- C033 DUAL RAMP (function activation)
- C032 S TIME
- C030 ACCEL TIME
- C031 DECEL TIME
- B03 MOTOR Hz

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:

- Heat sink over temperature protection
- I2t 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.

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.

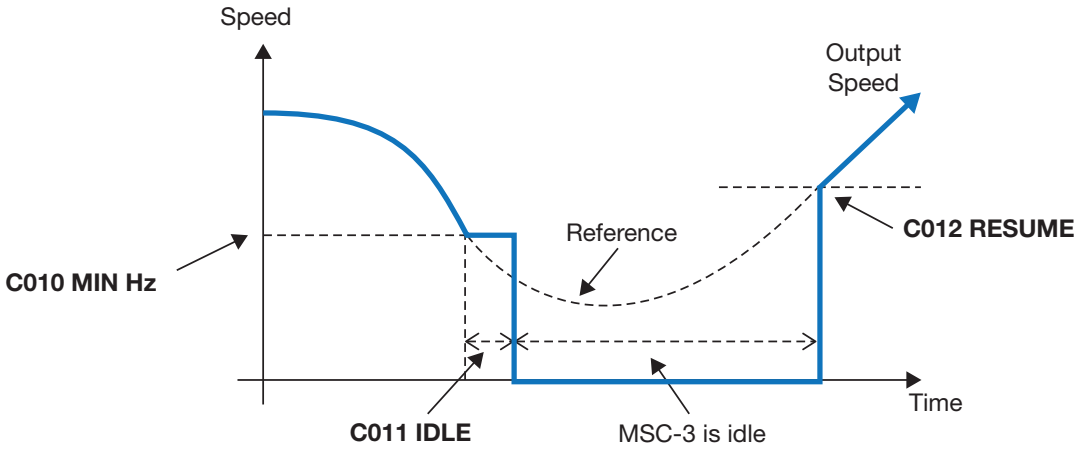
Key ESO configuration parameters are:

- C034 ESO RAMP (function activation)
- F03 ESO Ref (reference selection)
- I08 ESO (input terminal selection)

Minimum Speed Idle Function

The minimum speed idle function will stop operation if the MSC-3 output frequency has been operating with output frequency equal to **C010 MIN Hz** for a specified time interval. The time interval is specified by **C011 IDLE DELAY.** The MSC-3 will restart operation when the reference exceeds the C012 Resume Hz value. The diagram below illustrates the function. The conditions for the MSC3 to enter the idle state are:

- MSC-3 output enabled (the “EN” terminal connected to “+5V” terminal).
- MSC-3 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 button 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.

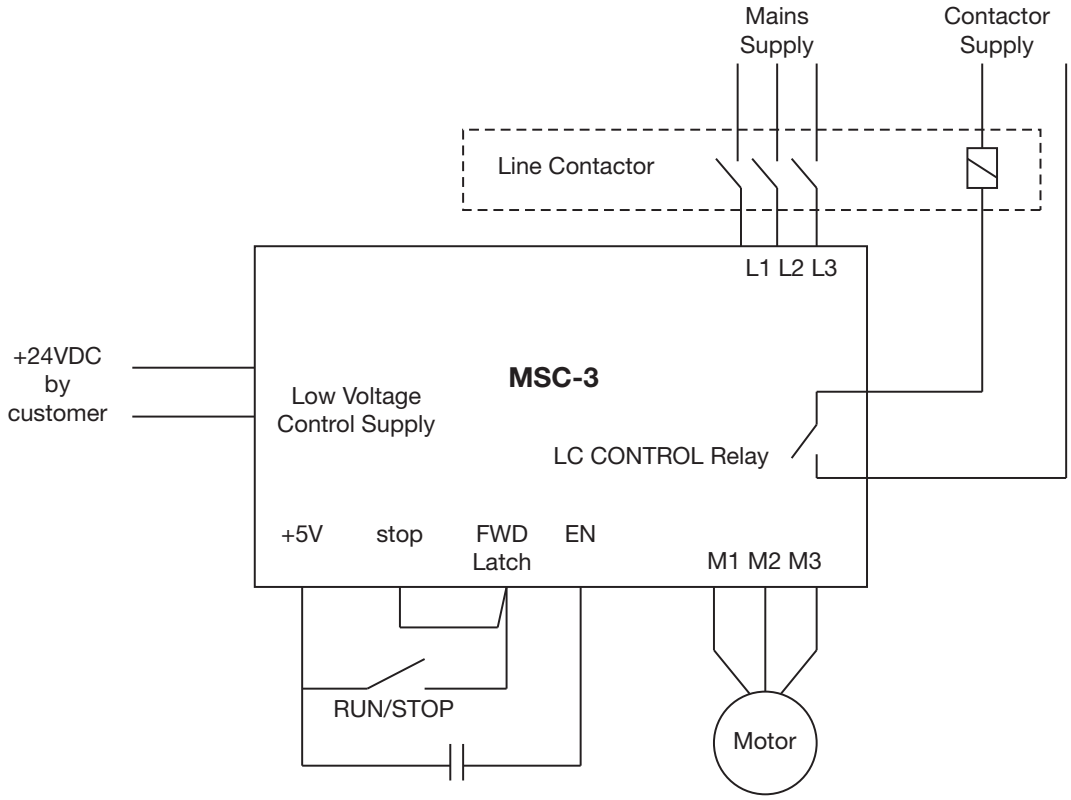


Key configuration parameters are:

- C010 MIN Hz
- C011 IDLE DELAY
- C012 RESUME Hz

Line Contactor Start Control

The MSC-3 can be optionally configured so that it is powered by a **customer supplied** external 24V DC supply independent of the mains power supply. In this mode the MSC-3 is capable of controlling an external line contactor to apply mains power to its own power circuits. The MSC-3 remains operational if either or both 24V DC or mains power is present. In order to control the external line contactor, one of the MSC-3's relays must be configured with the "AUX_PWR" function. The diagram below illustrates the wiring.



IMPORTANT!

To avoid MSC-3 relay contact damage, please ensure the contactor coil ratings do not exceed 2A @ 250Vac.

With 24Vdc applied, the MSC-3 remains idle until it receives a forward or reverse command. The AUX_PWR relay function will then operate the input line contactor charging the MSC-3. When charging is complete the motor is run as required. The AUX_PWR relay will open if:

- The drive experiences a trip,
- The wiring from “+5V” to “EN” of the main terminal strip is opened.
- The motor is run with zero speed for 10 seconds

CAUTION

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

Key configuration parameters are:

- **E06 LC CONTROL** (function activation)
- **> LC CONTROL** (as a relay function to control the external line contactor)

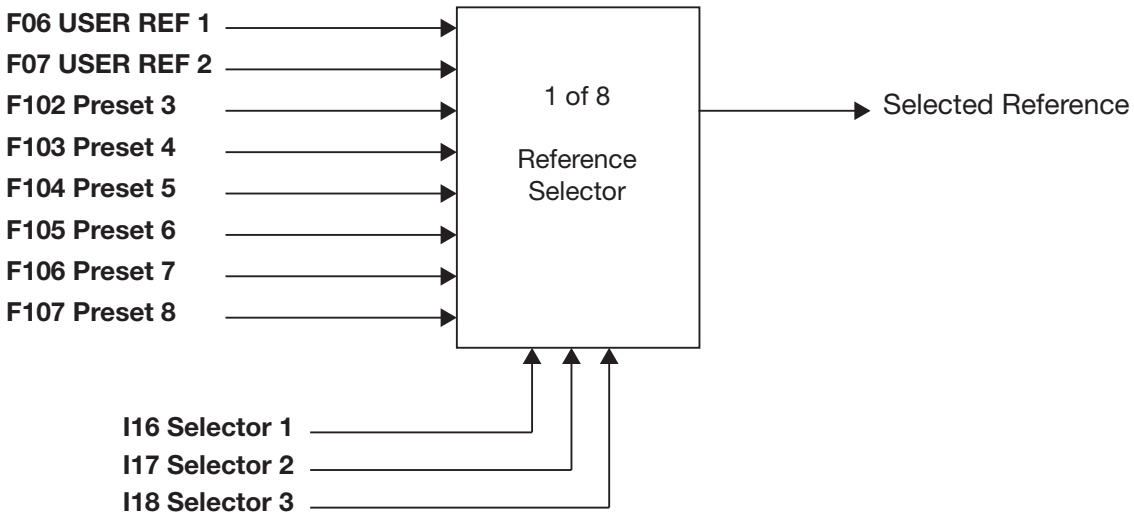
Reference Selector

The reference selector is a multiplexor function that uses three digital inputs to select 1 of 8 reference sources. The High/Low states of the three digital inputs I16 Selector 1, I17 Selector 2 and

I18 Selector 3 make 8 unique combinations. Each combination is assigned a reference source as given in the table below:

I16 Selector 1	I17 Selector 2	I18 Selector 3	Selected Reference
Low	Low	Low	F06 USER REF 1
Low	Low	High	F07 USER REF 2
Low	High	Low	F102 Preset 3
Low	High	High	F103 Preset 4
High	Low	Low	F104 Preset 5
High	Low	High	F105 Preset 6
High	High	Low	F106 Preset 7
High	High	High	F107 Preset 8

The diagram below illustrates this feature:



User References

There are 2 customisable inputs to the reference selector. They are **F06 USER REF 1** and

F07 USER REF 2. Each of these parameters is itself a single reference selection from the list of available speed reference sources.

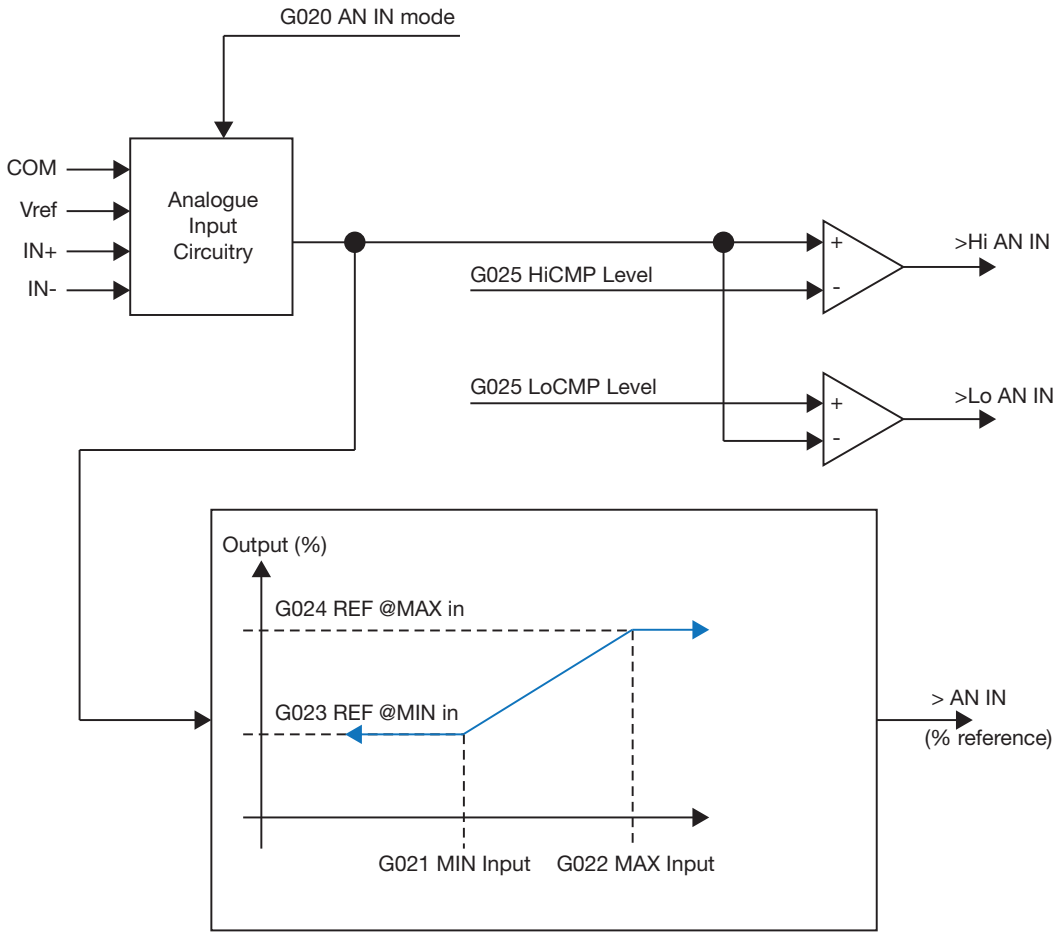
Key configuration parameters are:

- **F06 USER REF 1 and F07 USER REF 2**
- **F100 Preset 1 to F107 Preset 8**
- **I16 Selector 1** to **I18 Selector 3** (input terminal selection)
- **> REF SELECT** (as a speed reference in REMOTE, LOCAL, ESO, etc)

Analogue Inputs and Spanning

The MSC-3 analogue inputs have been designed with the following features:

- Configurable voltage (V) or current (mA) input configuration.
- Easy to configure spanning and translation.
- High and Low compare logic outputs with adjustable thresholds
- The diagram below illustrates the design:



Reference is clamped beyond the range of G023 and G024.

Key configuration parameters are:

- **G020 AN IN mode**
- **G021 MIN input and G022 MAX input**
- **G023 REF @MIN in and G024 REF @MAX in**
- **G025 HiCMP Level and G026 LoCMP Level**

Extended Feature Option Cards

The MSC-3 may be fitted with 1 or 2 extended features cards. Each card provides additional analogue and digital inputs and outputs. The cards may be fitted in either the left or right option card sockets.

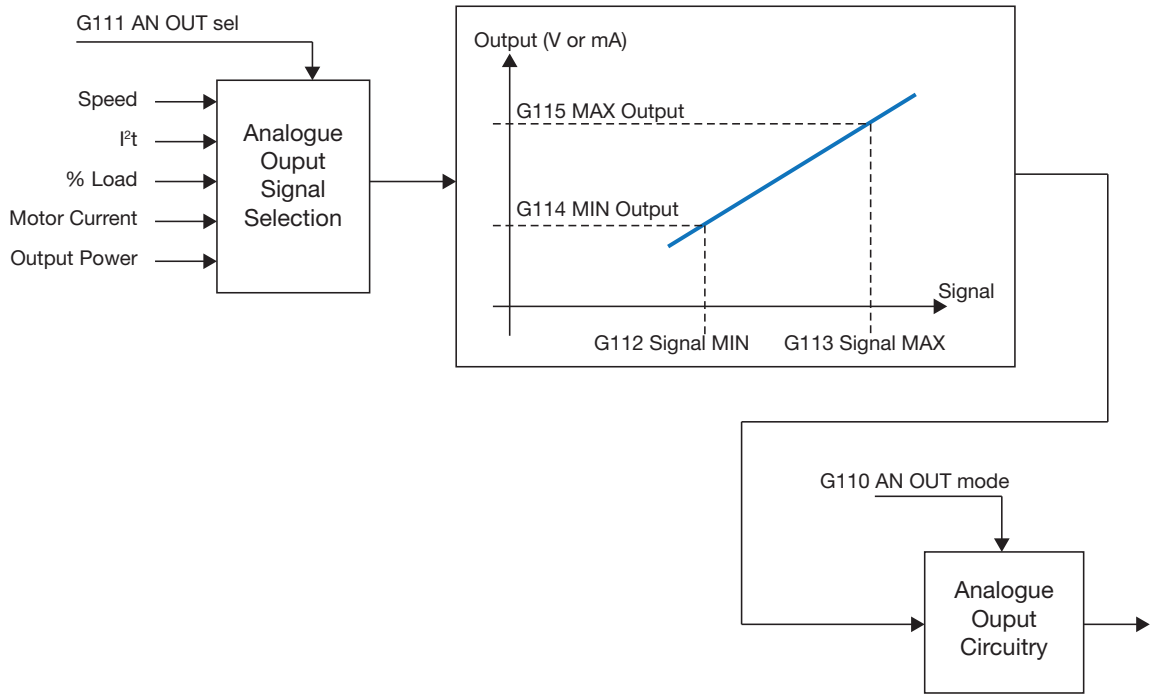
The MSC-3 will detect the presence of the option cards and commence exchanging I/O status data. Additional options will appear in the selection lists and accesses to additional menus are available for extended feature set up.

Extended Feature Analogue Output

Each extended feature card for the MSC-3 makes available a single analogue output for those applications that require feedback of an internal signal. The analogue output is designed with the following features:

- Configurable voltage (V) or current (mA) input configuration.
- Signal source selection
- Easy to configure spanning and translation.

The diagram below illustrates the design:



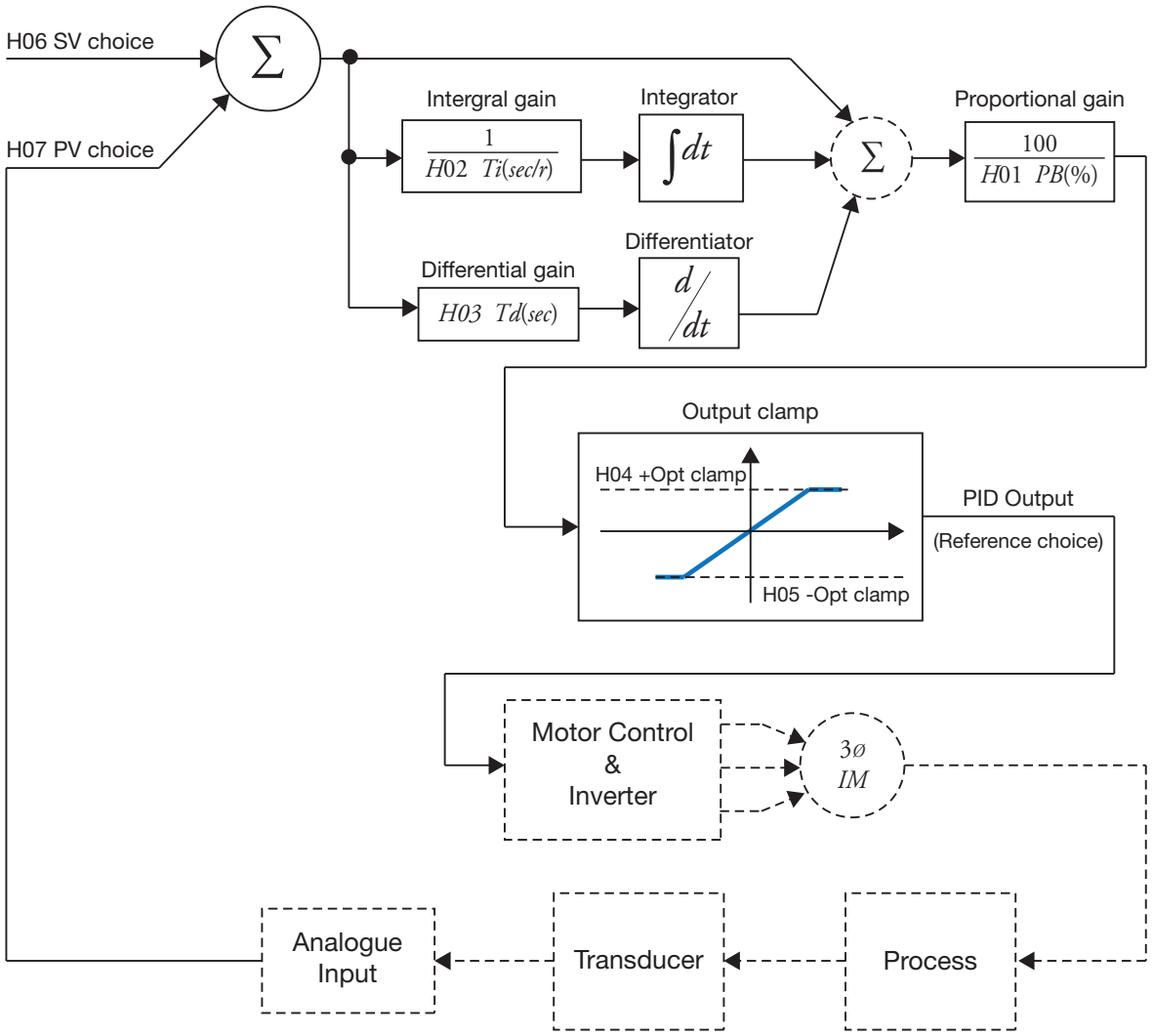
Key (left-hand option connector) configuration parameters are:

- **G110 AN OUT mode** (mA or V selection)
- **G111 AN OUT sel** (signal source selection)
- **G112 Signal MIN** and **G113 Signal MAX**
- **G114 MIN Output** and **G115 MAX Output**

Refer to G150…G155 for Extended Features AN OUT in the right-hand option connector

P.I.D. Controller

PID controllers (also referred to as three-term controllers) are used to stabilise and/or regulate a process at a desired operating point. PID controllers function by finding the difference between the required operating point (the Setpoint Variable or SV) and a measured process quantity (the Process Variable or PV). The difference is called the “error”. In regulator mode, the PID controller operates to reduce the error to zero at which point the measured quantity is equal to the required operating point.



Application examples:

- Stair Pressurisation Control: An air pressure transducer and the PID controller of the MSC-3 are configured to run in essential services override (ESO) mode.
- Cooling Tower Fan Control: A water temperature transducer and the PID controller of the MSC-3 are configured to run typically in remote mode.
- Water Pumping with Automatic Pressure Control: A water pressure transducer and the PID controller of the MSC-3 are configured to run typically in remote mode.

PID features include:

- Three term tuning (PB%, Ti, and Td).
- Output saturation with integrator anti-windup.
- Reference and feedback signal source selections.
- Open loop to closed loop initialisation.
- Process variable spanning and offset available through the selected analogue input.
- Process variable limit alarms available through the selected analogue input.
- Process variable and set point variable display.
- Process variable, motor current, motor power and motor speed display.

Key configuration parameters are:

- **H01 PB (%)**
- **H02 Ti (sec/r)**
- **H03 Td (sec)**
- **H04 +Opt clamp**
- **H05 –Opt clamp**
- **H06 SV choice**
- **H07 PV choice**
- **H08 PID Units** (for PID display)
- **H09 PID Scale** (for PID display)
- **> PID Output** (as a speed reference in REMOTE, LOCAL, ESO, etc)

Additional configuration parameters:

- Refer to the selected analogue input for spanning and offset configuration.
- Refer to the selected analogue input for limit alarm (under and over) configuration.

PID Setup Checklist and Tuning

1. Control Wiring (Assumes factory defaults are loaded)

WARNING!

All wiring must be done while the MSC3 is disconnected from the power supply. Refer to the Control Wiring Diagram for detail

1.1. Select an analogue input for the process variable (PV) measurement. Choices include: AI(10,11), AI(32,34)[4] or AI(52,54)[5] .

1.2. Wire in the transducer that measures the PV to the selected analogue input.

1.3. If required, wire in the set point variable (SV) reference signal to a separate analogue input. No wiring required if an internal preset is to hold the desired SV reference.

1.4. If required, wire in any metering device to an analogue output. Choices include: AO(36,38)[4] or AO(56,58)[5].

1.5. Ensure the signal levels are compatible with the input/output specifications of each feature. Refer to the PID Control Wiring diagram for details.

2. Preparing for PID Control

2.1. After initial power on, alter any MSC3 settings and/or selections.

4. If optional Extended Features card is fitted in the left hand option slot.

5. If optional Extended Features card is fitted in the right hand option slot

2.2. Specifically check the desired maximum motor frequency at which the process may be safely driven. Refer to **C02 MAX Hz** to check the maximum Hz setting.

2.3. Configure the analogue input that you intend to use for the PV signal (feedback transducer), so that it is the correct type (Volts, mA) and signal range (0-10V, 4-20mA etc). See **G02 AI(10, 11)** Config on page 95 for the analogue input on the control board or **G10 AI(32,34)** & **G14 AI(52,54)** on page 105 for the two possible additional analogue inputs on extended features options that may be fitted.

The scaling that is applied for the PV signal (for example 4-20mA represents 0 to 100% of the transducer's pressure range) is also used to interpret the set-point value (SV) setting. To control a pressure to a value that is equivalent to 50% of the pressure transducer range, set the SV to 50%.

For example, you have an air pressure transducer with a range of 0-100 Pa for 4-20 mA. You want to control the pressure to 50 Pa. Configure the analogue input you will use for the pressure transducer (the PV signal) to a minimum input of 4 mA, maximum input of 20 mA, leave the **Ref@Min** in and **Ref@Max** in at their default values of 0% and 100% respectively. A set-value (SV) setting of 50% will then correspond to a pressure of 50 Pa.

2.4. Perform any analogue input adjustments of each analogue input in use.Ensure the chosen analogue input for the PV signal is selected in the **H07 PV** choice menu.

2.5. Ensure the chosen reference for the SV signal is selected in the **H06 SV** choice menu.

2.6. Perform any analogue output adjustments of each analogue output in use.

2.7. Perform any PID parameter adjustments e.g. **H01 PB (%)**, **H02 Ti (sec/r)**, etc.

2.8. To close the loop the running mode reference (Remote, Local, ESO, JOGFWD or JOGREV) must be set to > **PID Output.**

3. Tuning

CAUTION!

The following steps are applicable in most cases. However, running the controller system without defined limits must be done with caution in case excessive speeds result in hazardous conditions or damage.

3.1. PV signal verification: Run the drive/motor/process at known set point and check the feedback signal is correct for the operating point.

3.2. If possible, operate the system at the maximum (safe) operating point and verify that the PV signal is now at the expected level.

3.3. Switch off the integrator by setting **H02 Ti (sec/r)** to zero.

3.4. Closing the loop: After the loop has been closed, observe the PV behaviour. If the system is unstable, increase the **H01 PB (%)** to stabilize the system. In general, increasing the **H01 PB (%)** will stabilize the system. Decreasing **H01 PB (%)** will produce a faster response at the expense of system stability.

3.5. If the system response oscillates momentarily, the system is under damped. An increase of the derivative time H03 Td (sec) can improve damping but an excessive value may increase the systems' response to noise.

3.6. Allow the system to settle. If the PV value does not equal the SV value, then the system has a steady state error. To remove steady state error, set the **H02 Ti (sec/r)** to the maximum. Decrease the **H02 Ti (sec/r)** to remove the steady state error more rapidly.

3.7. Minor adjustments to **H01 PB (%)**, **H02 Ti (sec/r)** and **H03 Td (sec)** may be performed to achieve the desired system response. Use the PID Tuning Summary below for general remedies to common problems.

3.8. Change the **H08 PID** Units and **H09 PID Scale** to represent the signal PV and SV signals correctly on the console display.

4. PID Tuning Summary:

Problem	Remedy
In closed loop the PV does not match the desired operating point	• Check the analogue input reading matches the transducer output signal; • Verify the settings of the selected analogue input for the PV; • Check the running mode reference (Remote, Local, ESO, JOGFWD or JOGREV) is set to > PID Output.
In closed loop operation the system is unstable	Increase the H01 PB (%) or decrease H03 Td (sec).
The system responds too slowly	Decrease the H01 PB (%) or decrease the H02 Ti (sec/r).
The system oscillates momentarily	Increase the H01 PB (%) or decrease the H03 Td (sec).
PV does not equal the SV	A steady state error exists and is removed by using the H02 Ti (sec/r). Start with a large value and then decrease it until a satisfactory response to a SV change is observed.

PID Application Examples

Step by Step procedures for the following applications are shown in the application sections of this manual

Application: Stair pressurisation fan with internal PID

Refer to page 38 of this manual for this application. 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-3. 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).

Application: Cooling tower fan with reverse acting internal PID

Refer to page 41 of this manual for this application. 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-3. Prior to commissioning, you will need to know the type of air pressure transducer signal that is to be used (0-10V, 4-20mA).

Application: Water pumping with automatic pressure control

Refer to page 24 of this manual for this application. This setup is for a typical centrifugal pump application that requires water pressure control using a water pressure transducer and the PID controller function provided by the MSC-3. Prior to commissioning, you will need to know the type of air pressure transducer signal that is to be used (0-10V, 4-20mA).

Communications

There are several communication interfaces for the MSC-3. As standard there is BACnet MS/TP and MODBUS RTU both of which are EIA/RS-485 based.

EIA/RS-485 Communication Indicator

The communication indicator gives a visual signal of the operating condition of EIA/RS-485 communications. The indicator is found in the bottom right hand corner of the display. The indications are:

OFF

Blank

Indicates no EIA/RS-485 protocol is selected and EIA/RS-485 port is off.

No Communication

!

Indicates no communication for the selected EIA/RS-485 protocol.

Communication

*** (flashing)**

Indicates he selected EIA/RS-485 protocol is communicating with the network.

BACnet MS/TP

The MSC-3 BACnet interface implements the standard Application Specific Controller (B-ASC) as described in ASHRAE Standard 135 2004.

BACnet Services Supported

- I-Am
- I-Have
- Read Property
- Write Property

Data Link Layer

The MSC-3 implements the BACnet MS/TP Data Link Layer as a master device. The communication port is EIA/RS-485 compliant and is isolated from ground and other circuits.

MAC ID / Device Object Instance

Set via the front panel. Factory defaults are the same across all drives and must be changed off-line or prior to connection to the network.

By default the MAC ID and Device Object Instance have the same value and can be set independently.

BACnet Set-up and Operation

Setting up the MSC-3 for various applications with BACnet communications is similar to conventional wired control using the terminal strip. The interactions between wired control and BACnet features are as follows:

Local mode

Control of the run function (ie starting and stopping) is from the console. BACnet commands do not influence the starting and stopping of the MSC-3 in local mode. The speed reference used for local operation is determined by the reference source selected by parameter F02 LOCAL REF. See list of speed references for available choices.

Remote mode

Control of the run function (ie starting and stopping) is either from the terminal strip or by BACnet depending on the setting of G166 RUN SIGNALS. Available choices are FROM TERMINALS or

FROM NETWORK. Setting this parameter to FROM TERMINALS allows the terminal strip alone to control the run function. Selecting FROM NETWORK allows BACnet alone to control the run function via binary value objects “Run fwd” and “Run rev”

Reset

Reset commands from all sources (terminal strip, internal MSC-3 functions and BACnet) are honoured at all times.

Network Speed Reference

If the speed reference for the MSC3 in any given mode is to be determined by the network system, the reference to select is COMMS_REF.

Essential services operation (ESO)

ESO mode selection from all sources (wired terminal or BACnet binary object ESO) is honoured at all times.

CAUTION

Loss of communications is a loss of ESO if an ESO terminal not set up.

Local / remote mode selection

Control of local/remote mode is always from the terminal strip. Operation of the MSC-3 may be monitored via BACnet regardless of the local/ remote mode.

BACnet Quick Set-up Guide

5. Set up all the usual menu items according to the application needs.
6. Set the various BACnet related menu items BEFORE connecting the network. This will avoid disrupting the BACnet network unnecessarily.
   - **G160 Protocol**: Ensure BACnet MS/TP is selected
   - **G161 bits/sec**: Select the baud rate to suit the BACnet system.
   - **G163 MAC/Dev ID**: This value must be unique for every BACnet device on the BACnet MS/TP network segment that the MSC-3 is connected to.
   - **G164 Dev Instance**: This is the Device Instance Number of the BACnet interface. This is a number between 0 and 4,194,302. The number of each BACnet interface must be unique across the entire BACnet installation.
   - **G165 Max Masters**: This is equal to, or greater than the highest master MAC ID number on the BACnet MS/TP network segment that the MSC-3 is connected to. For best BACnet MS/TP performance, this should be set as low as possible.
   - **G166 RUN SIGNALS**: This parameter determines if run commands are taken from the MSC-3 terminals or from the BACnet interface.

- **G167 Terminator**: If necessary each MSC-3 is capable of terminating the EIA-485 network. Setting this parameter to ENABLED will terminate the line.
- **G169 Serial No**.: Each BACnet device has a name, which is required to be unique. To ensure that there are no duplicated names, the MSC-3 serial number is used as part of the device object name.

7. Connect the MSC3 to the BACnet network.

BACnet Status Indicators

Several displays are available in the service menu to check network activity and state.

MODBUS RTU (EIA/RS-485)

The MSC-3 MODBUS RTU interface implements MODBUS as described in Modbus-IDA.ORG documents “MODBUS over Serial Line specification and implementation guide V1.02” and

“MODBUS Application Protocol Specification V1.1b”.

MODBUS Memory Model

The MODBUS memory model for the MSC-3 has separate blocks for Discrete Inputs, Coils, Input registers and holding registers. See the MODBUS appendix for details on addresses and sizes of each block.

Supported MODBUS Function Codes

- Function Code 01: Read Coils
- Function Code 02: Read Discrete Inputs
- Function Code 03: Read Holding Registers
- Function Code 04: Read Input Registers
- Function Code 05: Write Single Coil
- Function Code 06: Write Single Register
- Function Code 07: Read Exception Status
- Function Code 08: Diagnostics, Sub Codes 0,2,10…18,20
- Function Code 15: Write Multiple Coils
- Function Code 16: Write Multiple Holding Registers
- Function code 43: Read device Identification, Sub Code 14

See the MODBUS appendix for details on function codes and sub codes.

MODBUS Exceptions

Except for broadcast messages, when a master device sends a query to the MSC-3 drive it expects a normal response. One of four possible events can occur from the master’s query:

1. If the MSC-3 receives the query without a communication error, and can handle the query normally, it returns a normal response.
2. If the MSC-3 does not receive the query due to a communication error, no response is returned.
3. If the MSC-3 receives the query, but detects a communication error (parity or CRC), no response is returned..
4. If the MSC-3 receives the query without a communication error, but cannot handle it (for example, if the request is to read a non-existent coil or register), the MSC-3 will return an exception response informing the master of the nature of the error.

See the MODBUS appendix for details on function codes and sub codes.

MODBUS Setup and Operation

Setting up the MSC-3 for various applications with MODBUS communications is similar to conventional wired control using the terminal strip. The interactions between wired control and MODBUS features are as follows:

Local mode

Control of the run function (ie starting and stopping) is from the console. MODBUS commands do not influence the starting and stopping of the MSC-3 in local mode. The speed reference used for local operation is determined by the reference source selected by parameter F02 LOCAL REF. See list of speed references for available choices.

Remote mode

Control of the run function (ie starting and stopping) is either from the terminal strip or by MODBUS depending on the setting of G166 RUN SIGNALS. Available choices are FROM TERMINALS or

FROM NETWORK. Setting this parameter to FROM TERMINALS allows the terminal strip alone to control the run function. Selecting FROM NETWORK allows the MODBUS network alone to control the run function via binary value objects “Run fwd” and “Run rev”

Reset

Reset commands from all sources (terminal strip, internal MSC-3 functions and MODBUS) are honoured at all times.

Network Speed Reference

If the speed reference for the MSC3 in any given mode is to be determined by the network system, the reference to select is COMMS_REF.

Essential services operation (ESO)

ESO mode selection from all sources (wired terminal or MODBUS ESO coil) is honoured at all times.

CAUTION

Loss of communications is a loss of ESO if an ESO terminal not set up.

Local / remote mode selection

Control of local/remote mode is always from the terminal strip. Operation of the MSC-3 may be monitored via MODBUS regardless of the local/ remote mode.

MODBUS Quick Set-up Guide

1. Set up all the usual menu items according to the application needs.
2. Set the various MODBUS related menu items BEFORE connecting the network. This will avoid disrupting the MODBUS network unnecessarily.
   - **G160 Protocol**: Ensure **MODBUS RTU** is selected
   - **G161 bits/sec**: Select the baud rate to suit the MODBUS system.
   - **G162 Parity**: Select the parity to suit the MODBUS system
   - **G163 MAC/Dev ID**: This value must be unique for every MODBUS device on the BACnet MS/TP network segment that the MSC-3 is connected to.
   - **G166 RUN SIGNALS**: This parameter determines if run commands are taken from the MSC-3 terminals or from the MODBUS interface.

- **G167 Terminator**: If necessary each MSC-3 is capable of terminating the EIA-485 network. Setting this parameter to **ENABLED** will terminate the line.
- **G168 Comms Lost Time**: Check the time interval is greater than the system scan interval.
- **G169 Serial No.**: Each MODBUS device has a name, which is required to be unique. To ensure that there are no duplicated names, the MSC-3 serial number is used as part of the device object name.

3. Connect the MSC3 to the MODBUS network.

MODBUS Status Indicators

Several displays are available in the service menu to check network activity and state.

A00 DEFAULTS Menu

This menu provides several choices regarding save and load of parametric defaults including security against unintended changes and default Run display.

A factory default is preloaded to serve as an initial configuration for the MSC-3. Commissioning personnel may make changes as required by the application. When all changes have been made, the option to save the new setup is provided by saving the active set of parameters to the “Commissioned defaults”.

Saving a current set of parameters to commissioned defaults allows further parametric changes to be made for testing or temporary operations purposes. When these conditions are no longer required, the commissioned defaults may be reloaded. Alternatively factory defaults may be loaded.

This menu also provides the means to invoke the upload or download of parameters between the MSC-3 and a computer via a USB connection. Refer to the “Enable Upload/Download connection” section for details.

A01 Menu Lock

Available Choices: UNLOCKED

LOCKED

Press ↵ once to begin.

Use the ▲/ ▼ buttons to enable or disable the menu lock.

Press ↵ to confirm the choice.

This feature protects the entire menu mode with a code so that settings and configurations are protected from unauthorised or unintentional changes.

Menu Lock Code Entry

When the A01 MENU LOCK is enabled, each time the menu mode is entered the following message will appear:

- The code to access the menus is fixed to “1470”. Press the ↵ button once to begin.
- Use the ▲ & ▼ buttons to set each code digit and ↵ to set to the next digit.
- After all digits have been entered correctly, the first menu will appear.

A02 Def. Display

A02 Def. Display
> METER DISPLAY

Available Choices:
> SPEED-REF DISP
> METER DISPLAY
> PID DISPLAY
> PID-METER DISP
> kWhrs & Run hrs

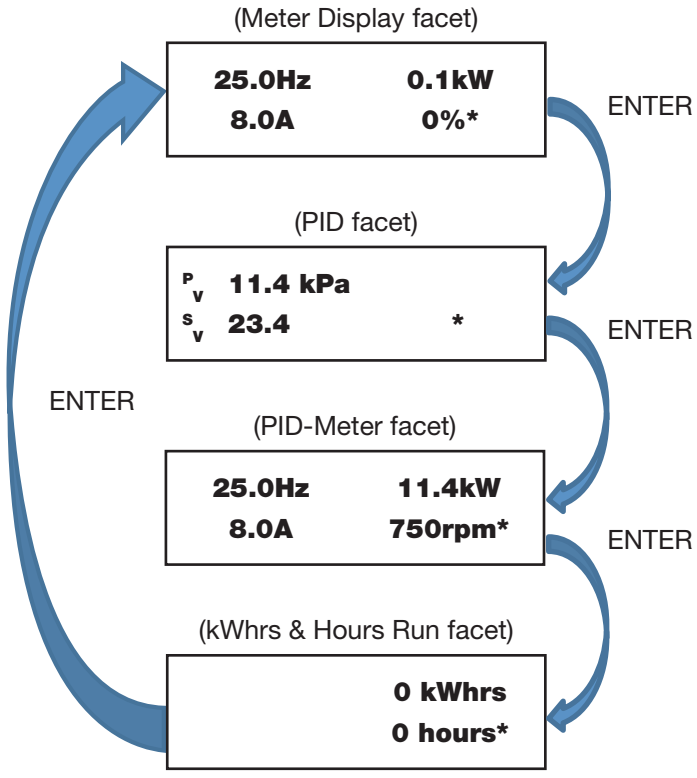
- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to choose a default display.
- Press ↵ to confirm the choice.

The selected display will show when the MSC3 is powered on or when a menu is on show and left unattended for 2 minutes.

Meter Display

The Meter Display shows other MSC-3 operating values such as output current, output power, motor load as well as motor speed. The PID facet displays the process variable and set point value. The PID-Meter facet helps to relate the motor speed, output power and motor current to the Process variable. The kWhrs & Hours Run facet displays the accumulated kWhrs to the motor and the numbers of hours the motor has been running for. Each Meter Display facet is viewed by pressing the ↵ button.

Note: Each example display is shown with the EIA/RS-485 communication indicator.



A03 Run Display

A03 Run Display

This menu allows for Run Display configuration. Menus within provide a mechanism to select the run display format, alter the run display scaling and change the displayed units.

A030 Run Display Format

A030 Run Display
Format > 999.9

Available Choices: > 9999
> 999.9
> 99.99
> 9.999

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to choose a display format.
- Press ↵ to confirm the choice.

The selected format will be used when the run display is on show.

A031 Run Display Scale

A031 Run Display
Scale > 50.0

Range: 1.000...9999.9

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to choose a display format.
- Press ↵ to confirm the choice.

The set scale will be used when the run display is on show. The decimal point location is determined by A030 Run Display Format setting.

A032 Run Display Units

A032 Run Display
Units > Hz

Available characters: 0…9,
A…Z, a…Z,
punctuation characters,
+, -, *, /, |, #, $, ^, &, !, ~,
{}, [], ()

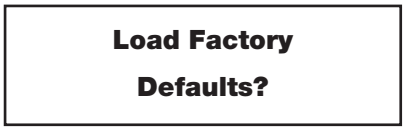
- Press ↵ and the character to enter begins to flash
- Press ▲ & ▼ to move through the list of available characters
- Press ↵ to select the displayed character; the cursor moves to the next character OR the edit completes
- Press the **ESC** button to abandon changes

The **A032 Run Display Units** are displayed when the run display is on show. A total of 8 characters may be displayed as units.

Load Factory Defaults?

This menu allows the factory default parameters to be reinstalled.

The MSC-3 must be in **LOCAL mode and the motor stopped** before loading factory defaults.



- Pressing the ↵ button will cause the following message to appear:

The message is intended as a warning and an opportunity to confirm that terminal wiring is suited to the factory default settings, otherwise unexpected drive operation may result.

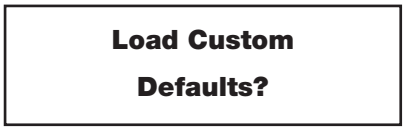
- Pressing the ↵ button will cause the following message to appear:

- Press ↵ again to load factory defaults as the current set of parameters OR
- Press **ESC** to continue with the existing set of parameters

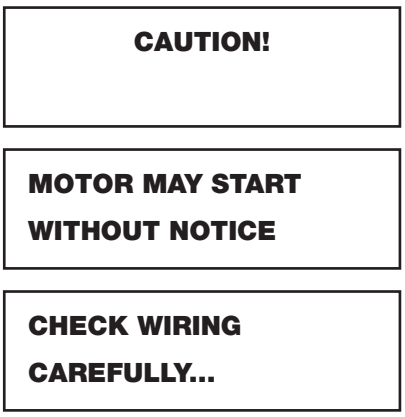
Load Custom Defaults?

Typically when the MSC-3 is first commissioned for operation parametric changes are made to suit the application. Once the desired operational configuration is settled, it is recommended that all parameters are stored to Custom defaults. This menu allows custom default parameters to be reinstalled to regain original operating characteristics.

The MSC-3 must be in **LOCAL mode and the motor stopped** before loading custom defaults.



- Pressing the ↵ button will cause the following message to appear:



The message is intended as a warning and an opportunity to confirm that terminal wiring is suited to the factory default settings, otherwise unexpected drive operation may result.

- Pressing the ↵ button will cause the following message to appear:

- Press ↵ again to load factory defaults as the current set of parameters OR
- Press **ESC** to continue with the existing set of parameters

Save Custom Defaults?

It is recommended to save newly configured parameters after an MSC-3 is first set up for an application. Called “Custom Defaults”, new and existing parameters form a known configuration that serve as a reference for future changes to the MSC-3 and its application. This menu provides a way to save the current set of parameters as the “Custom Defaults”.

By loading custom defaults the MSC-3 may be restored to a known configuration after many parametric changes have been made.

- Press ↵ to store the current set of parameters as commissioned defaults OR
- Press **ESC** to abandon parameter storage.

Upload/Download Connection

To facilitate MSC-3 configuration and software update an upload / download connection may be established to a computer. The connection provides a convenient transfer of configuration and software code files. To minimise hazardous operation the upload / download connection operates off-line. As a result the MSC-3 must be in **LOCAL mode and the motor stopped** before prior to connecting.

B00 MOTOR Menu

This menu allows for the entry of motor nameplate information. Press ▲ / ▼ buttons to view and modify motor volts, motor amps, motor Hz and motor rpm.

B01 MOTOR VOLTS

Range: 200...1000V (model dependant)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The value entered is taken from the motor nameplate and is an important parameter of the motor control algorithm

B02 MOTOR AMPS

Range: 22.5%...171% of the MSC-3 current rating (model dependant)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The value entered is taken from the motor nameplate and is an important parameter of the motor control algorithm. In general the adjustment range is 22.5%...171% of MSC-3 rated current. However the actual range of values is model dependant.

B03 MOTOR Hz

Range: 30...200 Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The value entered is taken from the motor nameplate and is an important parameter of the motor control algorithm.

B04 MOTOR RPM

Range: 500...60 x B03 MOTOR Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The value entered is taken from the motor nameplate and is an important parameter of the motor control algorithm. Note the maximum value is x60 the current **B03 MOTOR Hz** value.

C00 PERFORMANCE Menu

Parameters found within this menu allow motor performance characteristics to be set. Parameters include the minimum and maximum speed of the motor, motor speed ramp times, motor slip compensation and acoustic performance.

C01 MINIMUM Hz

Parameters found in this menu set the performance of features related to minimum output Hz including the minimum speed idle function.

C010 MIN Hz

Range: 0…**C02 MAX Hz** - 5Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

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 **C010 MIN Hz** and the **C02 MAX Hz** setting. For example, if **C020 MAX Hz** is set to 45Hz, then the largest allowed value for **C010 MIN Hz** is 40Hz.

It is possible to use the full span of an analogue input to adjust the speed reference from **C010 MIN Hz** through to **C02 MAX Hz**. Refer to the **G02 AN IN Config** menu for details.

C011 IDLE DELAY

C011 IDLE DELAY
0 secs

Range: 0…600secs

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C011 IDLE DELAY** sets the time interval of operation at minimum speed before the MSC-3 enters the idle state. Refer to “Minimum Speed Idle Function” for details.

C012 RESUME Hz

C012 RESUME Hz
0 Hz

Range: 0…200 Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C012 RESUME Hz** is the speed reference threshold above which the MSC-3 resumes normal operation from being idle. If the value for **C012 RESUME Hz** is less than the **C010 MIN Hz** value, the idle function is disabled and the MSC3 will operate at or above the **C010 MIN Hz** speed indefinitely. . Refer to “Minimum Speed Idle Function” for details.

C02 MAX Hz

C02 MAX Hz
50 Hz

Range: C010 MIN Hz+5Hz…200 Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C012 RESUME Hz** is the speed reference threshold above which the MSC-3 resumes normal operation from being idle. If the value for **C012 RESUME Hz** is less than the **C010 MIN Hz** value, the idle function is disabled and the MSC3 will operate at or above the **C010 MIN Hz** speed indefinitely.

C03 RAMP

The MSC-3 has a programmable Ramp with adjustable acceleration, deceleration and S-curve rates. Individual parameters are provided for the linear and curved portions of the ramp. These parameters are found within the C03 Ramp menu.

C030 ACCEL TIME

C030 ACCEL TIME
10.0 sec

Range: 0.5…600.0 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C030 ACCEL TIME** is the time taken for the motor to go from zero speed up to motor rated speed (assuming minimum **C032 S TIME**). An MSC-3 with **B03 MOTOR Hz** set to 50 Hz and

C030 ACCEL TIME set to 10.0 seconds will take 10 seconds to go from 0 Hz to 50 Hz.

C031 DECEL TIME

C031 DECEL TIME
10.0 sec

Range: 0.5…600.0 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C031 DECEL TIME** is the time taken for the motor to go from motor rated speed down to zero speed (assuming minimum **C032 S TIME**). An MSC-3 with **B03 MOTOR Hz** set to 50 Hz and

C031 DECEL TIME set to 10.0 seconds will take 10 seconds to go from 50 Hz to 0 Hz.

C032 S TIME

C032 S TIME
0.01 sec

Range: 0.01…40.00 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **C032 S TIME** is the time taken for the motor to reach the limit of acceleration (as set by the rated speed and the **C030 ACCEL TIME** or **C031 DECEL TIME**). Using the **C032 S TIME** ensures smooth speed increases and decreases. A long **C032 S TIME** interval will yield a smoother speed transition, however the **C032 S TIME** will extend the overall ramping time. The ramp time is approximately equal to the **C032 S TIME** plus **C030 ACCEL TIME** or **C031 DECEL TIME**.

C033 DUAL RAMP

C033 DUAL RAMP
> DISABLED

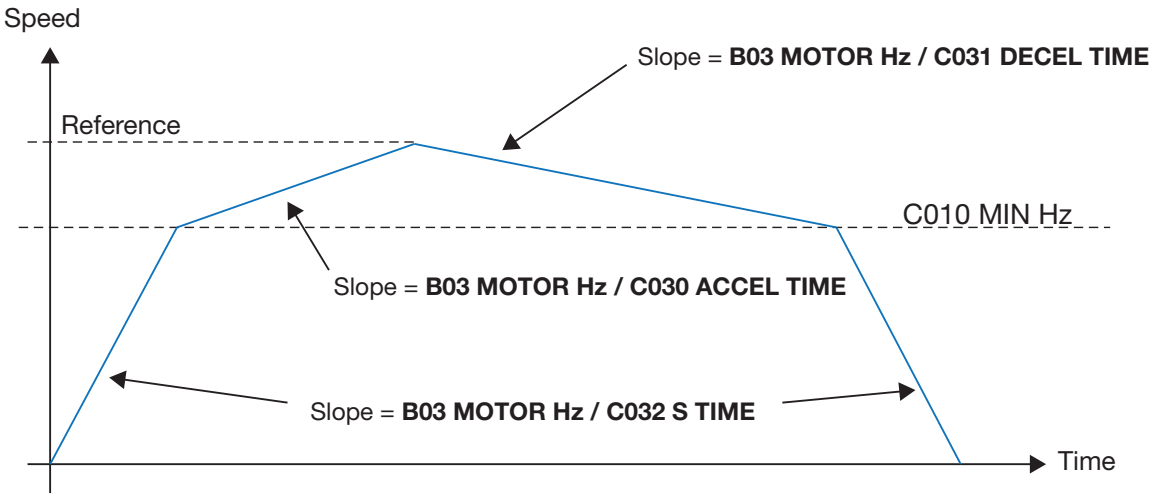
Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable the menu lock.
- Press ↵ to confirm the choice.

When this feature is enabled, the **C032 S TIME** parameter specifies the acceleration and deceleration below the **C010 MIN Hz** setting. Above the **C010 MIN Hz** setting, the acceleration and deceleration times are as per **C030 ACCEL TIME** and **C031 DECEL TIME** respectively. Note that there is no

C032 S TIME when this feature is enabled. The following graph demonstrates this feature.



C034 ESO RAMP

C034 ESO RAMP
10.0 sec

Range: 0.5…600.0 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

When the drive is operating in ESO mode it will use the **C034 ESO RAMP** setting for acceleration and deceleration instead of the **C030 ACCEL TIME** and **C031 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 **C032 S TIME**). A MSC-3 with the **B03 MOTOR Hz** set to 50 Hz and an **C034 ESO RAMP** set to 10 seconds will take 10 seconds to go from 0Hz to 50Hz.

C04 FLUX PLUS

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.

C040 FLUX PLUS

C040 FLUX PLUS
0.0%

Range: 0 to 150% of adjustment range

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

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.

C041 HiSpd Flux+

C041 HiSPD FLUX+
DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable the high speed flux plus.
- Press ↵ to confirm the choice.

When 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 then enable **C041 HiSpd Flux+.**

C05 SLIP COMP %

C05 SLIP COMP%
0.0%

Range: 0 to 150% of slip speed

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

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 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% will make the shaft speed equal the synchronous speed. Flux Plus may be used in conjunction with Slip Comp to provide increase output torque at low speeds.

C06 AUDIBLE FREQ

C06 AUDIBLE FREQ
2kHz

Available Choices: 2kHz
4kHz
8kHz
16kHz
AUTO

- Press ↵ once to begin the selection.
- Use the ▲ / ▼ buttons to select the audible frequency.
- Press ↵ to confirm the choice.

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 produce more heat in the drive. For most efficient operation select 2 kHz.

D00 PROTECTION Menu

Motor and system protective feature parameters are found within this menu. Protective features include: current limit, I2t, reverse operation, DC input, single phase input and skip speed.

D01 CURRENT LIM

D01 CURRENT LIM
40.0 Amps

Range: 22...125% of the MSC-3 current rating (model dependant)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

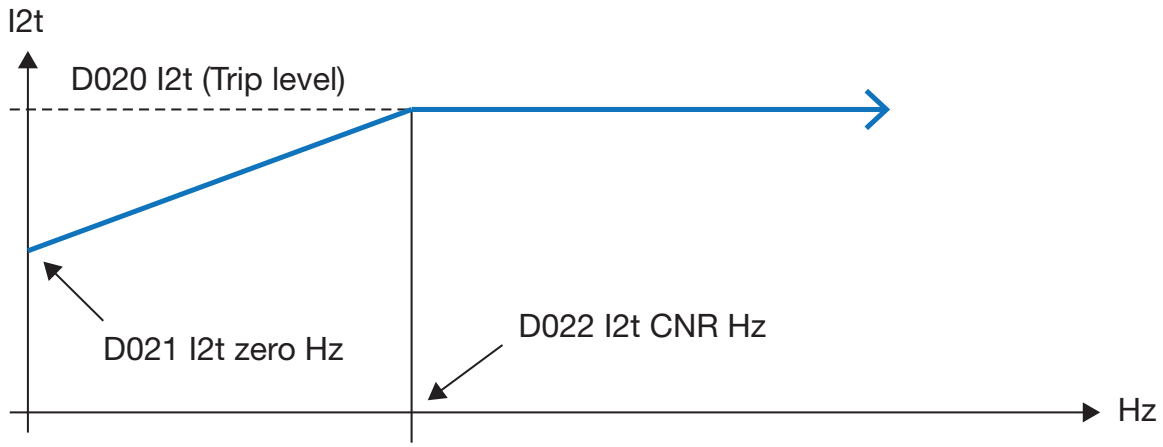
This sets the maximum output current of the MSC-3. If excessive load is applied to the motor, the drive will only apply this amount of current to the motor until the overload condition is removed. Current limiting is achieved by reducing the speed of the motor. The Current Limit value cannot be set higher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

D02 I2t

The I2t feature estimates the heating of the motor according to the motor load. When the estimated heating exceeds I2t setting, the drive will trip on I2t. For a motor running at 110% of its I2t current this will take approximately two minutes. The time to trip will shorten the further the motor current exceeds the I2t value.

If power is removed from the drive after an I2t 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 I2t feature has the ability to set the trip threshold as a function of output frequency. This allows the I2t to protect motors that have reduced cooling at low speeds because they are not externally cooled. The diagram below is an example of the I2t trip threshold profile.



I2t Speed Profile

D020 I2t

D020 I2t
40.0 Amps

Range: 18...100% of the MSC-3 current rating (model dependant)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

This sets the upper thermal overload limit in amps. An “I2t” trip is generated if the output current is higher than this value for a sufficient amount of time depending on the overload class selected.

D021 I2t zero Hz

D021 I2t zero Hz
40.0 Amps

Range: 18...D020 I2t value

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

This sets the trip threshold when the speed is zero. This value cannot be set higher than the D020 I2t value.

D022 I2t CNR Hz

D022 I2t CNR Hz
10 Hz

Range: 2...200Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The D022 I2t cnr Hz value sets the frequency above which the profile uses the trip threshold as set by D020 I2t. Below this frequency the I2t value is set by the slope on the I2t profile.

D03 REVERSE

D03 REVERSE
> DISABLED

Available Choices: ENABLED

DISABLE

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable reverse operation.
- Press ↵ to confirm the choice.

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.

D04 DC INPUT

D04 INPUT
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable DC input operation.
- Press ↵ to confirm the choice.

This feature allows the MSC-3 to operate from a DC Input supply. The DC Supply voltage should be at least 1.414 times higher than the motor voltage.

D05 1 Phase Inpt

D05 1 Phase Inpt
> DISABLED

Available Choices: ENABLED

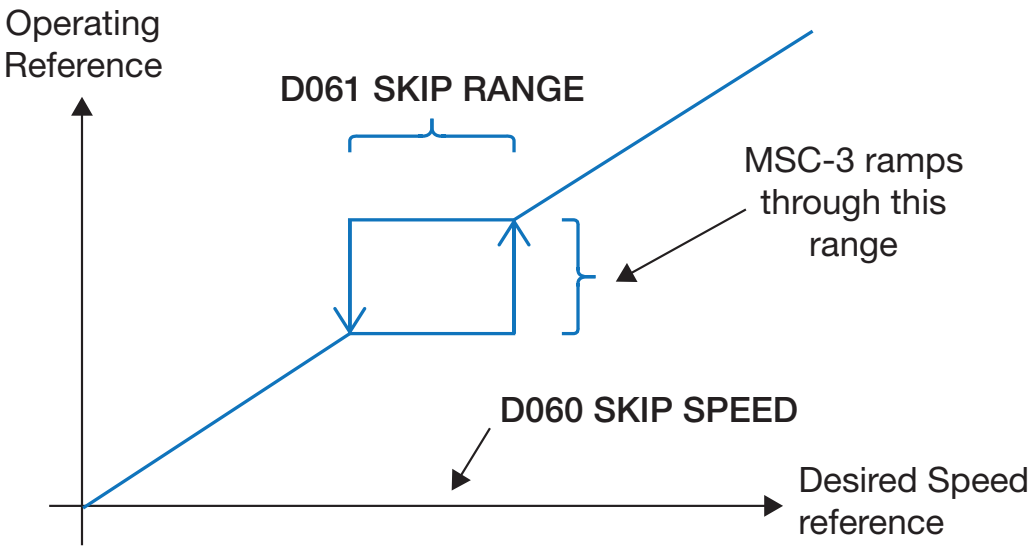
DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable DC input operation.
- Press ↵ to confirm the choice.

This feature allows the MSC-3 to operate from a single phase electrical supply.

D06 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 MSC-3 a means to avoid operation at these speeds. The MSC-3 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.



D060 SKIP SPEED

D060 SKIP SPEED
30 Hz

Range: 0...200Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

This sets the centre or main frequency to skip.

D061 SKIP RANGE

D061 SKIP RANGE
0 Hz

Range: 0...200Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

This sets the frequency range either side of the D060 Skip Speed.

E00 STOP/START Menu

This section sets the motor stopping and starting modes. Features include ramping or coasting to a stop, dynamic breaking, auto-restart, reset by power fail, motor resynchronisation and auxiliary power mode

E01 COAST STOP

E01 COAST STOP
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable coast stop operation.
- Press ↵ to confirm the choice.

Enabling **E01 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 **E01 COAST STOP,** the motor shaft is stopped in a controlled manner in a time governed by **C03 RAMP** settings.

E02 DYNAMIC BRK

E02 DYNAMIC BRAKE
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable dynamic brake operation.
- Press ↵ to confirm the choice.

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.

E03 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 **E030 ARs ALLOWED**. If the fault is cleared and the drive runs without tripping for the **E031 AR 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.

E030 ARs ALLOWED

E030 ARs ALLOWED
0

Range: 0...15 attempted restarts

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

This number indicates how many times the MSC-3 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 deactivate Auto Restart.

E031 AR CLR TIME

E031 AR CLR TIME
1200 secs

Range: 1...1200 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the MSC-3 operates for the **E031 A/R CLR TIME** without any trips, the number of restarts is reset to the value of **E030 A/Rs ALLOWED.** Set the **E031 A/R CLR TIME** to 6 secs for infinite auto restarts

E04 Reset by PF

E04 Reset by PF
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable reset by power fail operation.
- Press ↵ to confirm the choice.

When enabled trips may be cleared without any extra wiring simply by turning the power off and straight back on again before the drive powers down completely.

E05 Motor Resync

E05 Motor Resync
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable reset by power fail operation.
- Press ↵ to confirm the choice.

When enabled, the MSC-3 will scan for the motor shaft speed. When detected, a smooth transition into operation begins. The motor resynchronisation function avoids current limit braking.

E06 LC CONTROL

E06 LC CONTROL
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable reset by power fail operation.
- Press ↵ to confirm the choice.

This function mobilises internal logic to control an external mains supply contactor. The external contactor is driven whenever a motor start is required and so must be used in conjunction with **> LC CONTROL** relay function. See the **Line Contactor Start Control** feature for details.

F00 REFERENCES Menu

Items found in this menu allow for speed reference choices for the MSC-3 operating modes remote, local ESO jog forward and jog reverse. Additionally other reference selections and parametric configuration are found within this menu. Some reference choices and parameters are related to connected option cards. If an option card is not fitted, its reference choices will not appear in any lists and its parameters will not be visible.

F01 REMOTE

F01 REMOTE REF
> AN IN

Available Choices:
> AI(10,11)
> CONSOLE
> PID OUTPUT
> AI(32,34) (Extended Features card fitted on the left-hand side)
> AI(52,54) (Extended Features card fitted on the right-hand side)
> COMMS REF
> F100 PRESET1
> F101 PRESET2
> F102 PRESET3
> F103 PRESET4
> F104 PRESET5
> F105 PRESET6
> F106 PRESET7
> F107 PRESET8
> REF SELECT
> ZERO REF

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

When the drive is operating in remote mode the MSC-3 will take its speed reference from the selected reference source.

F02 LOCAL

F02 LOCAL REF
> CONSOLE

Available Choices: (See the list for **F01 REMOTE**)

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

When the drive is operating in local mode the MSC-3 will take its speed reference from the selected reference source.

F03 ESO

Available Choices: (See the list for **F01 REMOTE**)

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

When the drive is operating in ESO mode the MSC-3 will take its speed reference from the selected reference source.

F04 JOGFWD

Available Choices: (See the list for **F01 REMOTE**)

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

When the drive is operating in jog forward mode the MSC-3 will take its speed reference from the selected reference source.

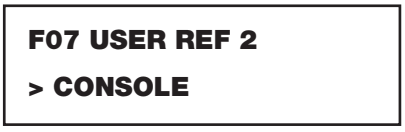
F05 JOG REV

Available Choices: (See the list for **F01 REMOTE**)

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

When the drive is operating in jog reverse mode the MSC-3 will take its speed reference from the selected reference source.

F06 USER REF 1 and F07 USER REF 2



Available Choices: (See the list for **F01 REMOTE**)

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

These 2 parameters are the customisable inputs to the reference selector. When the digital inputs **I16 Selector 1**, **I17 Selector 2** and **I18 Selector 3** are all Low, the reference assigned to **F06 USER REF 1** is selected.

When the digital inputs **I16 Selector 1** and **I17 Selector 2** are both Low and **I18 Selector 3** is High, the reference assigned to **F07 USER REF 2** is selected.

F08 CONSOLE CFG

The console as a reference uses the ▲ and ▼ buttons as well as the **I05 UP** and **I06 DOWN** input terminals to modify the reference's value. 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-3 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-3 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-3 is re-powered.

F080 PERSISTENT

F080 PERSISTENT
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable persistent console reference operation.
- Press ↵ to confirm the choice.

When **F080 PERSISTENT** is enabled console reference operates in Persistent mode. This mode ensures the console reference value, prior to loss of power supply, is restored when power is reapplied.

If disabled the console reference operates in Power-On Reset mode.

F081 STOP RESET

F081 STOP REST
> DISABLED

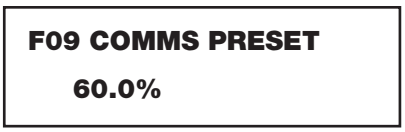
Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable stop reset console reference operation.
- Press ↵ to confirm the choice.

When **F081 STOP RESET** is enabled the console reference value is set to zero whenever the MSC-3 is commanded to stop the motor.

F09 COMMS PRESET



Range: -100.0...100.0 % of **C03 MAX Hz**

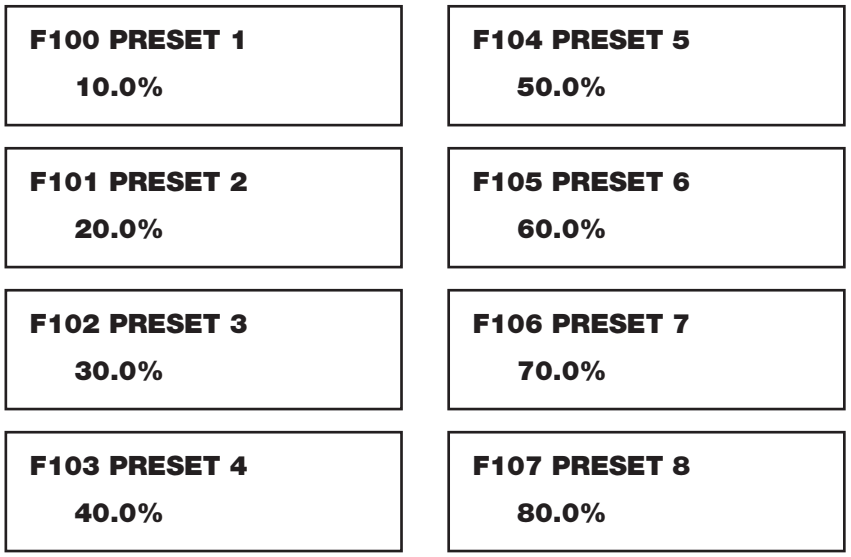
- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **F09 COMMS PRESET** parameter is the power-on value for the > **COMMS REF** reference. The **> COMMS REF** is the reference by the operating communication network protocol.In the event that communications is lost, the COMMS REF reference will automatically revert to the **F09 COMMS PRESET** parameter value. See **G168 Comms Lost Time** on page 112 for further details. Setting **G168 Comms Lost Time** to zero disables the detection of communications loss.

F10 PRESETS

There are 8 preset references for the MSC-3. Most are used in conjunction with the Reference Selector. Each preset is expressed as a percentage of **C03 MAX Hz**.

F100 PRESET1 to F107 PRESET8



Range: -100.0...100.0 % of C03 MAX Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

G00 INPUT/OUTPUT Menu

Easily the menu containing the most configuration parameters, the **G00 INPUT/OUTPUT** menu is where all terminal strip configurations are found.

G01 Inpt fxn CFG

This menu provides a way to map a finite set of physical digital inputs to an internal set of input functions. This allows the input function to be controlled by a selected physical input terminal. In most cases the inputs levels and edges are available for selection. For example digital input D1 is found at terminal 2 and is identified as D1(2). The choices are:

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

For all the sub menus of G01 Inpt fxn CFG the available choices are:

ON, OFF

EN(6), ~EN(6), /EN(6), EN(6)\

D1(2), ~D1(2), /D1(2), D1(2)\

D2(3), ~D2(3), /D2(3), D2(3)\

D3(4), ~D3(4), /D3(4), D3(4)\

D4(4), ~D4(4), /D4(4), D4(4)\

D1(31)1, ~D1(31)1, /D1(31)[1], D1(31)\[1]

D2(32)1, ~D2(32)1, /D2(32)[1], D2(32)\[1]

D3(33)1, ~D3(33)1, /D3(33)[1], D3(33)\[1]

D4(34)1, ~D4(34)1, /D4(34)[1], D4(34)\[1]

D1(51)1, ~D1(51)1, /D1(51)[1], D1(51)\[1]

D2(52)1, ~D2(52)1, /D2(52)[1], D2(52)\[1]

D3(53)1, ~D3(53)1, /D3(53)[1], D3(53)\[1]

D4(54)1, ~D4(54)1, /D4(54)[1], D4(54)\[1]

TMR1, ~TMR1, TMR2, ~TMR2

Hi AI(10,11), ~Hi AI(10,11), Lo AI(10,11), ~Lo AI(10,11)

Hi AI(39,40)[1], ~Hi AI(39,40)[1], Lo AI(39,40)[1], ~Lo AI(39,40)[1]

Hi AI(59,60)[1], ~Hi AI(59,60)[1], Lo AI(59,60)[1], ~Lo AI(59,60)[1]

[1] Only visible if extended features card fitted

Duplicate Selections

It is possible to select the same input terminal for several input functions. In some cases a single digital input feeding several input functions may not be desirable. When an input terminal is selected for the 2nd (or 3rd, 4th,…) time, the MSC3 presents a warning message and question asking to remove all existing uses for the selected terminal.

For example the default setup is

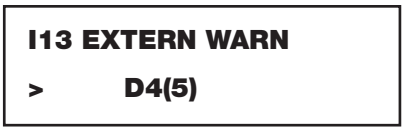
I07 RESET = D1(2)

I02 ~STOP = D2(3)

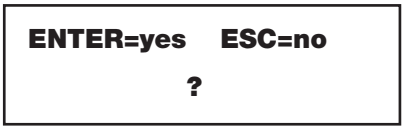
I00 FWD & LATCH = D3(4)

I11 REMOTE = D4(5)

The operator decides to have **EXTERNAL WARNING** activated by D4(5). That is:



When the operator presses the ENTER push button to make the selection, the following sequence of messages is displayed:



If the operator presses **ENTER** for "yes", the outcome will be:

I07 RESET = D1(2)

I02 ~STOP = D2(3)

I00 FWD & LATCH = D3(4)

I11 REMOTE = OFF

I13 EXTERN WARN = D4(5)

All previous selections of D4(5) are set to OFF

If the operator presses **ESC** for "no", the outcome will be:

I07 RESET = D1(2)

I02 ~STOP = D2(3)

I00 FWD & LATCH = D3(4)

I11 REMOTE = D4(5)

I13 EXTERN WARN = D4(5)

Previous selectios of D4(5) remain

I00 FWD & LATCH

I00 FWD & LATCH
> D3(4)

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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.

I01 REV & LATCH

I01 REV & LATCH
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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. **D03 REVERSE** must be Enabled for the motor to run backwards.

I02 ~STOP

I02 ~STOP
> D2(3)

Available Choices: See the list of the G01 Inpt fxn CFG menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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 **I00 FWD & LATCH** and **I01 REV & LATCH** to stop the motor. This function is ignored in LOCAL mode.

I03 FWD

I03 FWD
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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.

I04 REV

I04 REV
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

The **I04 REV** (non-latching) function disregards the state of the **I02 ~STOP** input and the drive will not stop while **I04 REV** input is held and the Enable input is wired to +5V. Both **I03 FWD** & **I04 REV** inputs must be wired to +5 to activate bipolar operation. **D03 REVERSE** must be **Enabled** for the motor to run backwards.

I05 UP

I05 UP
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

When this input is active the CONSOLE reference increases. The CONSOLE reference must be the active reference for this input to have an effect.

I06 DOWN

I06 DOWN
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

When this input is active the CONSOLE reference decreases. The CONSOLE reference must be the active reference for this input to have an effect.

I07 RESET

I07 RESET
> D1(2)

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.

- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

When this input is active a reset of one or more trip conditions is attempted.

I08 ESO

I08 ESO
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

While this input is held the MSC-3 will operate in Essential Services Override (ESO). Refer to the ESO feature description on page 51 for details.

I09 JOG FWD

I09 JOGFWD
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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.

I10 JOGREV

I10 JOGREV
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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. **D03 REVERSE** must be **Enabled** for the motor to run backwards.

I11 REMOTE

I111 REMOTE
> D4(5)

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

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.

I12 EXTERN ALARM

I12 EXTERN ALARM
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

Contact closure on this input registers a trip and the status message “EX ALARM” is displayed.

I13 EXTERN WARN

I13 EXTERN WARN
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

Contact closure on this input displays the status message “EX WARN”.

I14 T1 Input

I14 T1 Input
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

Making or braking contact closure on this input activates (or deactivates) timer #1.

See G07 TIMER CONFIG for timer behaviour.

I15 T2 Input

I15 T2 Input
> OFF

Available Choices: See the list of the **G01 Inpt fxn CFG** menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.

- Press ↵ to confirm the choice. **ESC** to abandon the change.

Making or braking contact closure on this input activates (or deactivates) timer #2.

See G07 TIMER CONFIG for timer behaviour.

I16 Selector 1, I17 Selector 2 and I18 Selector 3

I16 Selector 1	**I17 Selector 2**	**I18 Selector 3**
> OFF	**> OFF**	**> OFF**

Available Choices for each function: See the list of the G01 Inpt fxn CFG menu

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select a digital signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

These inputs form a unique combination for the reference selector. See the Reference Selector feature description for details

G02 AI(10,11) Config.

The MSC-3 is equipped with a single analogue input as standard and can be configured to receive either: 0 to 5V, 0 to 10V or 0 to 20mA. Additionally the input has a customisable span as well as a high and low compare thresholds.

G020 Input Type

G020 Input Type
> Volts

Available Choices: > Volts

> mAmps

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select volts or milliamps input operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

The analogue input is configurable for voltage or milliamp input. This selection will configure the input circuitry for either voltage input or current (mA) input without any need to access MSC-3 hardware. See the Analogue Inputs and Spanning feature for details.

G021 MIN Input

G021 MIN Input
> 0.0V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G020 AN IN** mode is configured for > Volts then **G021 MIN input** will be displayed with units of volts (V) otherwise **G021 MIN input** will be displayed with units of milliamps (mA). In either case the minimum input for spanning is determined by this parameter. See the Analogue Inputs and Spanning feature for details.

G022 MAX Input

G022 MAX Input
> 10.0V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G020 AN IN** mode is configured for > Volts then **G022 MAX input** will be displayed with units of volts (V) otherwise **G022 MAX input** will be displayed with units of milliamps (mA). In either case the maximum input for spanning is determined by this parameter. See the Analogue Inputs and Spanning feature for details.

G023 Ref @MIN in

G023 Ref @MIN In
0.0%

Range: -100.0...100.0 % of C03 MAX Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

Regardless of how the analogue input is configured the minimum reference for input spanning is determined by this parameter. The **G023 Ref @MIN** in parameter corresponds to the

G021 MIN input to define the input spanning configuration. See the Analogue Inputs and Spanning feature for details.

G024 Ref @MAX in

G024 Ref @MAX In
100.0%

Range: -100.0...100.0 % of C03 MAX Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR

- Press **ESC** to abandon the value change.

Regardless of how the analogue input is configured the maximum reference for input spanning is determined by this parameter. The **G024 Ref @MAX** in parameter corresponds to the **G022 MAX input** to define the input spanning configuration. See the Analogue Inputs and Spanning feature for details.

G025 Hi Compare Level

G025 Hi Compare
Level: 8.0V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G020 Input Type** is configured for > Volts then **G025 Hi Compare Level** will be displayed with units of volts (V) otherwise **G025 Hi Compare Level** will be displayed with units of milliamps (mA). In either case the high level compare threshold is determined by this parameter. When the input rises above this level, the compare output will be true (high). See the Analogue Inputs and Spanning feature for details.

G026 LoCMP Level

G026 Lo Compare
Level: 2.0V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G020 Input Type** is configured for > Volts then **G026 Lo Compare Level** will be displayed with units of volts (V) otherwise **G026 Lo Compare Level** will be displayed with units of milliamps (mA). In either case the low level compare threshold is determined by this parameter. When the input falls below this level, the compare output will be true (high). See the Analogue Inputs and Spanning feature for details.

G03 RL1(15,16)

As standard the MSC-3 is equipped with 2 relays each with a single normally open contact. This menu allows configuration of Relay #1 (RL1 on the terminal strip). Configuration parameters include: a relay signal function selection, relay signal inversion option and delay on and off interval specifications.

Relay Output Functions

Function	Indication when energised
RUN	Running either forward or reverse
TRIP	A trip has stopped the output of the drive
ESO	Running in Essential Services Override
PROOF	Enabled and not tripped
ZERO SPD	The motor is at zero speed
AT SPEED	The motor speed is equal to the reference speed
UNDER SPD	The motor speed is below the G050 UNDER SPEED threshold
OVER SPD	The motor speed is above the G051 OVER SPEED threshold
ON	The relay is energised
OPT ALARM	The drive output current is more than 12.5% of motor rated current
A/R FAIL	All specified restarts have been used
FWD	Motor is running in the forward direction
REV	Motor is running in the reverse direction
ENABLED	MSC-3 is enabled
I2t TRIP	I2t thermal motor overload has activated
OVER TEMP	MSC-3 is too hot for safe operation
LOAD WARN	Motor load is above the preset characteristic line
AUX_PWR	Energise the Line Contactor to charge the MSC-3 power circuits
Hi AI(10, 11)	The reading from the standard analogue input is above G025 HiCMP Level
Lo AI(10, 11)	The reading from the standard analogue input is below G026 LoCMP Level
Hi AI(39, 40)[1]	The analogue input (left extended features card) is above G105 HiCMP Level
Lo AI(39, 40)[1]	The analogue input (left extended features card) is below G106 LoCMP Level
Hi AI(59, 60)[1]	The analogue input (right extended features card) is above G145 HiCMP Level
Lo AI(59, 60)[1]	The analogue input (right extended features card) is below G146 LoCMP Level
T1 Output	The output of timer 1
T2 Output	The output of timer 2

[1] Only visible if extended features card fitted

G030 RL1 Signal

Available choices: (See the list for Relay Output Functions)

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the output function for relay #1 operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

G031 RL1 Sense

G031 RL1 Sense
> DIRECT

Available Choices: > DIRECT

> INVERT

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select direct or inverted relay operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu allows relay #1 to be inverse acting for those applications that need inverted contact behaviour.

G032 RL1 TON

G032 RL1 TON
0 secs

Range: 0...600 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the activation of a relay to assist with signal interlock for example. This parameter sets the relay on delay for relay #1

G033 RL1 TOFF

G033 RL1 TOFF
0 secs

Range: 0...600 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR

- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the de- activation of a relay to assist with signal interlock for example. This parameter sets the relay off delay for relay #1

G04 RL2(17,18)

As standard the MSC-3 is equipped with 2 relays each with a single normally open contact. This menu allows configuration of Relay #2 (RL2 on the terminal strip). Configuration parameters include: a relay signal function selection, relay signal inversion option and delay on and off interval specifications.

G040 RL2 Signal

G040 RL2 Signal
> RUN

Available choices: (See the list for Relay Output Functions)

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the output function for relay #2 operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

G041 RL2 Sense

G041 RL2 Sense
> DIRECT

Available Choices: > DIRECT
> INVERT

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select direct or inverted relay operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu allows relay #2 to be inverse acting for those applications that need normally closed contact behaviour.

G042 RL2 TON

G042 RL2 TON
0 secs

Range: 0...600 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR

- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the activation of a relay to assist with signal interlock for example. This parameter sets the relay on delay for relay #2

G043 RL2 TOFF

Range: 0...600 seconds

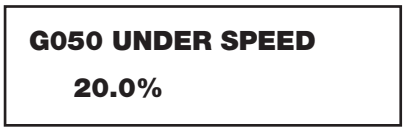
- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the de- activation of a relay to assist with signal interlock for example. This parameter sets the relay off delay for relay #2

G05 RLY CONFIGS

Several of the relay functions require parameters for their operation. Parameters include under and over speed thresholds and calibration points for the percentage load warning output function.

G050 UNDER SPEED

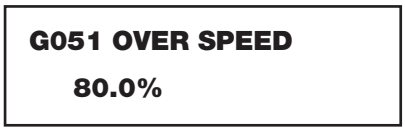


Range: 0.0...100.0 % of (C03 MAX Hz)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **G050 UNDER SPEED** parameter is a motor frequency compare threshold. When the motor frequency is below this value, the relay will energise. For example the **> UNDER SPEED** relay function has been assigned to relay #2 **(G040 RELAY #2 = UNDER SPEED)** and **G050 UNDER SPEED** is set to 20%. When the output frequency goes below 20%, relay 2 will energise.

G051 OVER SPEED



Range: 0.0...100.0 % of (C03 MAX Hz)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The **G051 OVER SPEED** parameter is a motor frequency compare threshold. When the motor frequency is above this value, the relay will energise. For example the **> OVER SPEED** relay function has been assigned to relay #2 **(G040 RELAY #2 = OVER SPEED)** and **G051 OVER SPEED** is set to 80%. When the output frequency goes above 80%, relay 2 will energise.

G052 %L WARNING

G052 %L WARNING

Available Choices: > Low Speed Cal

> High Speed Cal

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select low or high speed calibration.
- Press ↵ to calibrate. **ESC** to abandon the change.

This menu calibrates the %load V speed characteristic curve of fans and pumps. The calibrated characteristic is used as the compare threshold to warn of possible failures in motor and load mechanics. The output of the %load warning feature is available as a relay function. The procedure for calibration is:

1. Run the MSC-3 at half of full speed
2. Find the **G052 %L WARNING** menu, press ↵ and select **> Low Speed CAL**
3. Press ↵ again to calibrate at low speed
4. Run the MSC-3 at or near full speed
5. Return to the **G052 %L WARNING** menu, press ↵ and select **> High Speed CAL**
6. Press ↵ again to calibrate at high speed
7. Ensure **>% LOAD WARNING** function is assigned to one of the available relays

G06 REMOTE OVRD

G060 REMOTE OVRD
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable remote override operation.
- Press ↵ to confirm the choice.

When **G06 REMOTE OVRD** is enabled, the ↵ push button on the console can toggle between LOCAL and REMOTE mode of operation. Refer to the **I11 REMOTE** feature for details of LOCAL and REMOTE operation.

G07 TIMER CONFIG

Timer parameters such as timer intervals and timer type are configured within this menu. Refer to the **G01 Inpt fxn CFG** menu timer signal source assignments. The output of timers, are available as signal sources as well.

G070 T1 Interval & G072 T2 Interval

G070 T1 Interval	**G072 T2 Interval**
0 secs	**0 secs**

Range: 0...600 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

These values set the timing interval for each of the timers. The timing interval begins according to the mode of the timer. See **G071 T1 mode** & **G073 T2 mode** below for details.

G071 T1 mode & G073 T2 mode

G071 T1 Mode	**G073 T2 Mode**
> Delay ON	**> Delay OFF**

Available Choices: > Delay ON

> Delay OFF

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the timer mode is **> Delay ON**, timing begins when the rising edge of the timer's signal source is detected and continues while ever the signal source is held on. The output of the timer is held off during the timing interval and is held on when timing is complete AND the timer signal source is maintained on.

If the timer mode is **> Delay OFF**, timing begins when the falling edge of the timer's signal source is detected and continues while ever the signal source is held off. The output of the timer is held on during the timing interval and is held off when timing is complete AND the timer signal source is maintained off.

The timing interval is controlled by **G070 T1 Interval** & **G072 T2 Interval** timer. See **G070 T1 Interval** & **G072 T2 Interval** above for details.

G08 DO(39,41) & G12 DO(59,61)

An extra digital output is available when the MSC-3 is fitted with an extended features option. Configuration parameters maintained by the subsequent menus include: signal function selection, signal inversion option and delay on and off interval specifications. Either one or two extended features options may be fitted. The first mentioned item in each case refers to the extended features option fitted to the left-hand connector and the second to the extended features option fitted to the right-hand connector, if any.

G080 DO Signal & G120 DO Signal

Available choices: (See the list for Relay Output Functions)

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the output function for the digital output operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

G081 DO Sense & G121 DO Sense

Available Choices: > DIRECT

> INVERT

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select direct or inverted digital output operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu allows the digital output to be inverse acting for those applications that need normally closed contact behaviour.

G082 DO TON & G122 DO TON

Range: 0...600 seconds

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the activation of the digital output to assist with signal interlock for example. This parameter sets the on delay for the digital output.

G083 OFF DO TOFF & G123 DO TOFF

Range: 0...600 seconds

- Press ↵ to edit the value.

- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

In some instances it is desirable to delay the de- activation of the digital output to assist with signal interlock for example. This parameter sets the off delay for the digital output.

G09 TH(40,42) & G13 TH(60,62)

A thermistor input is available when the MSC-3 is fitted with an extended features card.

Available Choices: ENABLED

DISABLED

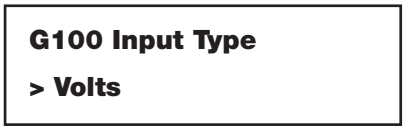
- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable thermistor input.
- Press ↵ to confirm the choice.

The **G09 TH(40,42)** parameter enables thermal protection provided by an external thermistor, thermal switch or thermal overload. An OT_THERM trip is generated when the resistance between the **TH+** and **TH-** terminals is greater than approximately 3300 ohms.

G10 AI(32,34) & G14 AI(52,54)

An extra analogue input is available when the MSC-3 is fitted with an extended features option. This extra analogue input can be configured to receive either: 0 to 5V, 0 to 10V or 0 to 20mA. Additionally the input has a customisable span as well as a high and low compare thresholds.

G100 Input Type & G140 Input Type



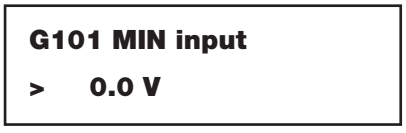
Available Choices: > Volts

> mAmps

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select volts or milliamps input operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

The analogue input is configurable for voltage or milliamp input. This selection will configure the input circuitry for either voltage input or current (mA) input without any need to access MSC-3 hardware. See the Analogue Inputs and Spanning feature for details.

G101 MIN Input & G141 MIN Input



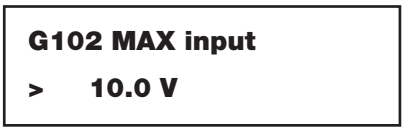
Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.

- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G100 Input Type** is configured for **> Volts** then **G101 MIN input** will be displayed with units of volts (V) otherwise **G101 MIN input** will be displayed with units of milliamps (mA). In either case the minimum input for spanning is determined by this parameter. See the Analogue Inputs and Spanning feature for details.

G102 MAX Input & G142 MAX Input



Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G100 Input Type** is configured for **> Volts** then **G102 MAX** input will be displayed with units of volts (V) otherwise **G102 MAX input** will be displayed with units of milliamps (mA). In either case the maximum input for spanning is determined by this parameter. See the Analogue Inputs and Spanning feature for details.

G103 Ref @MIN in & G143 Ref @ MIN in

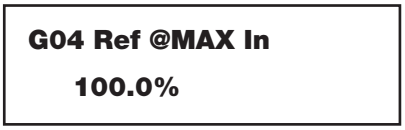
Range: -100.0...100.0 % of C03 MAX Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

Regardless of how the analogue input is configured the minimum reference for input spanning is determined by this parameter. The **G103 Ref @MIN** in parameter corresponds to the

G101 MIN input to define the input spanning configuration. See the Analogue Inputs and Spanning feature for details.

G104 Ref @MAX in & G144 Ref @ MAX in



Range: -100.0...100.0 % of C03 MAX Hz

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR

- Press **ESC** to abandon the value change.

Regardless of how the analogue input is configured the maximum reference for input spanning is determined by this parameter. The **G104 Ref @MAX** in parameter corresponds to the

G102 MAX input to define the input spanning configuration. See the Analogue Inputs and Spanning feature for details.

G105 Hi Compare Level & G145 Hi Compare Level

G105 Hi Compare
Level: 8.0 V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the G100 Input Type is configured for > Volts then G105 Hi Compare Level will be displayed with units of volts (V) otherwise G105 Hi Compare Level will be displayed with units of milliamps (mA). In either case the high level compare threshold is determined by this parameter. When the input rises above this level, the compare output will be true (high). See the Analogue Inputs and Spanning feature for details.

G106 Lo Compare Level & G146 Lo Compare Level

G106 Lo Compare
Level: 2.0 V

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the **G100 Input Type** is configured for **> Volts** then **G106 Lo Compare Level** will be displayed with units of volts (V) otherwise **G106 Lo Compare Level** will be displayed with units of milliamps (mA). In either case the low level compare threshold is determined by this parameter. When the input falls below this level, the compare output will be true (high). See the Analogue Inputs and Spanning feature for details.

G11 AO(36,38) & G15 AO(56,58)

An analogue output is available when the MSC-3 is fitted with an extended features option. This extra analogue output can be configured for either: 0 to 5V, 0 to 10V or 0 to 20mA output. Additionally the output has customisable parameters for translation and scaling.

G110 Output Type & G150 Output Type

G110 Output Type
> Volts

Available Choices: > Volts

> mAmps

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select volts or milliamps input operation.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

The analogue output is configurable for voltage or milliamp output. This selection will configure the output circuitry for either voltage input or current (mA) output without any need to access MSC-3 hardware. See the Extended Feature Analogue Output feature for details.

G111 AO Source & G151 AO Source

```
G111 AO Source
>     0.0 V
```

Available choices:

Signal Choices	Description
SPEED	Estimated motor speed, units of “rpm”.
I2t	Thermal overload level, units of “Amps”.
% LOAD	Motor loading, units of “%”.
CURRENT	Motor current, units of “Amps”.
POWER	Inverter output power, units of “kW”.

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the output signal source.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

G112 Signal min & G152 Signal min

```
G112 Signal MIN
>     0.0
```

Range: 0.0...1000.0 in the units of the selected signal

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The G112 Signal MIN parameter is the minimum signal input used for spanning and has units of the signal source selected by G111 AN OUT sel. See the Analogue Outputs feature for details.

G113 Signal max & G153 Signal max

```
G113 Signal MAX
>     1000.0
```

Range: 0.0...1000.0 in the units of the selected signal

- Press ↵ to edit the value.

- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The G113 Signal MAX parameter is the maximum signal input used for spanning and has units of the signal source selected by G111 AN OUT sel. See the Analogue Outputs feature for details.

G114 MIN Output & G154 MIN Output

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the G110 AN OUT mode is configured for > Volts then G114 MIN Output will be displayed with units of volts (V) otherwise G114 MIN Output will be displayed with units of milliamps (mA). In either case the minimum output for spanning is determined by this parameter. See the Analogue Output feature for details.

G115 MAX Output & G155 MAX Output

Range: 0.0...10.0 V or 0.0 to 20 mA

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

If the G110 AN OUT mode is configured for > Volts then G115 MAX Output will be displayed with units of volts (V) otherwise G115 MAX Output will be displayed with units of milliamps (mA). In either case the maximum input for spanning is determined by this parameter. See the Analogue Output feature for details.

G16 EIA/RS-485

The MSC-3 has as standard EIA/RS-485 communications with the following features:

Choice of protocol: BACNET / MODBUS.

Selectable data rates.

Selectable parity checking.

Hardware Isolation.

Optional line termination included.

G160 Protocol

G160 Protocol
> none

Available choices: none
MODBUS
BACnet

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the communications protocol.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu selects the communications protocol to use. Please refer to the relevant appendix for details, descriptions and capabilities of each protocol.

G161 bits/sec

G161 Bit rate
> 9200 bits/sec

Available choices: 115200 bits/sec
76800 bits/sec
57600 bits/sec
38400 bits/sec
19200 bits/sec
9600 bits/sec
4800 bits/sec
2400 bits/sec
1200 bits/sec

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the communication bit rate.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu selects the communications bit rate to use for the selected protocol.

G162 Parity

G162 Parity
> no parity

Available choices: no parity
EVEN parity
ODD parity

- Press ↵ once to begin input selection.
- Use the ▲ / ▼ buttons to select the communication parity.
- Press ↵ to confirm the choice. **ESC** to abandon the change.

This menu selects the communications parity to use for the selected protocol. The parity bit is appended to the data bits (positioned after the data bits are transferred).

When EVEN parity is selected, a “1” is appended when there is an even number of ones in the data bits. A”0” is appended otherwise.

When ODD parity is selected, a “1” is appended when there are an odd number of ones in the data bits. A”0” is appended otherwise.

When no parity is selected, no additional bit is appended and only data bits are transferred.

G163 MAC/Dev ID

Range: 1...The value of G165 Max Masters (BACnet)

1...247 (MODBUS)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

Each device on an EIA/RS-485 network requires a unique Media Access Control Identification address code (MAC ID). The MAC ID is used to identify the MSC-3 on the communication network. It is necessary change this value from the factory default when the MSC-3 is first set up.

G164 Dev Inst.

Range: 1...4194302 (BACnet only)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

Necessary for BACnet applications only, the device instance uniquely identifies an MSC-3 in a complete system across all network segements. It is necessary change this value from the factory default when the MSC-3 is first set up.

G165 Max Masters

Range: 1...127 (BACnet only)

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

Necessary for BACnet applications only, G165 Max Masters is a parameter for the BACnet MS/TP connection logic. The value of G165 Max Master specifies the highest allowable MAC ID for master devices. This value should be the same as that found in other MS/TP masters on the network segment.

G166 RUN SIGNALS

G166 RUN SIGNALS
> FROM TERMINALS

Available Choices: FROM TERMINALS

FROM NETWORK

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to select the source of run command signals.
- Press ↵ to confirm the choice.

This parameter determines explicitly where the FWD and REV command signals are sourced. Set G166 RUN SIGNALS to FROM TERMINALS when hardwired dedicated switches or push buttons are required to start the MSC-3. Set G166 RUN SIGNALS to FROM NETWORK when commands sent through the communication network are required to start the MSC-3.

G167 Terminator

G167 Terminator
> DISABLED

Available Choices: ENABLED

DISABLED

- Press ↵ once to begin.
- Use the ▲ / ▼ buttons to enable or disable communication network termination.
- Press ↵ to confirm the choice.

The MSC-3 has a “no-touch” communication cable termination capability. Set G167 Terminator to ENABLED to make the line termination active. Set G167 Terminator to DISABLED to make the line termination in-active.

G168 Comms Lost Time

G168 Comms Lost
Time: 10 secs

Range: 1...600 secs

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The MSC-3 will determine a loss of communications if no data exchange takes place for the interval specified by G168 Comms Lost Time parameter.

For MODBUS, any data packet addressed to the MSC-3 and free of transmission errors will reset the timer and the timing interval will begin again.

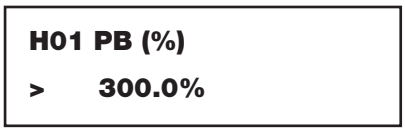
For BACnet, a token pass addressed to the MSC-3 and free of transmission errors will reset the timer and the timing interval will begin again.

Setting **G168 Comms Lost Time** to zero disables the detection of communications loss. See also **F09 COMMS PRESET** on page 88.

H00 PID Control

This menu is the entry point for the PID controller menus where adjustments can be made. Parameters that may be viewed or adjusted are: the Proportion Band, the integrator gain, the differential gain, the output clamp limit values, the process and set point variable choices and PID scale and units for the PID display.

H01 PB (%)

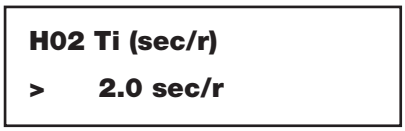


Range: -1000.0...1000.0 %

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The H01 PB (%) value is the proportion of input required to generate 100% at the output of the PID control (assuming no integrator (I) or differentiator (D) components). For example H01 PB (%) is 300.0%, the gain is 100/300 = 0.333. That is 3 units of input will generate 1 unit of output

H02 Ti (sec/r)



Range: 0.0...40.0 sec/r

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The H02 Ti (sec/r) value is the time needed by the integrator (I) to “repeat” the value at its input. For example the error signal is 10 units (units not specified); H02 Ti (sec/r) is set to 2.0 sec/r; the present value of the integrator is 0; after 2 seconds the present value of the integrator is 10 units.

A low H02 Ti (sec/r) value attempts to regulate the process variable quickly. However if excessively low, over shooting and under shooting will be more prominent.

A high H02 Ti (sec/r) value diminishes over shooting and under shooting. However regulation takes longer to achieve.

H03 Td (sec)

```
H03 Td (sec)
>      0.0 sec/r
```

Range: 0.0...5.0 sec/r

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The H03 Td (sec) value determines the estimated component added to the PID output

A low H03 Td (sec) contributes a small corrective component and appears to dampen the systems response. If too low, it affects may be unnoticeable.

A high H03 Td (sec) value may improve the response to a step input, but may also destabilise the system.

H04 +Opt clamp & H05 –Opt clamp

```
H04 +Opt clamp
>      100.0 %
```

```
H05 -Opt clamp
>      0.0 %
```

Range: -100.0...100.0 %

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The H04 +Opt clamp and H05 -Opt clamp values determine the upper and lower limit thresholds for PID output saturation. The PID output will never exceed these values. When the PID output is being clamped the integrator anti-windup activates to prevent the integrator from accumulating error continuously.

H06 SV choice

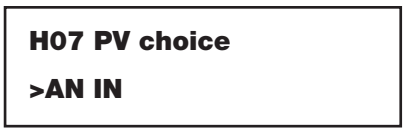
```
H06 SV choice
> F100 PRESET1
```

Available Choices: (See the list for F01 REMOTE)

- Press ↵ once to begin a selection.
- Use the ▲ / ▼ buttons to select the set point reference.
- Press ↵ to confirm the choice.

The H06 SV choice is the reference value the PID controller regulates the process variable to. Invalid reference choices will not appear in the reference list.

H07 PV choice



Available Choices: > AN IN

> LHS AN IN (if left-hand Extended Features card fitted)

> RHS AN IN (if right-hand Extended Features card fitted)

- Press ↵ once to begin a selection.
- Use the ▲ / ▼ buttons to select a reference.
- Press ↵ to confirm the choice.

The H07 PV choice is the analogue input on which the process variable is measured. Refer to the menus of the selected analogue input for spanning, offset and limit alarm configurations.

H08 PID Units

Available characters: 0…9,

A…Z, a…Z,

punctuation characters,

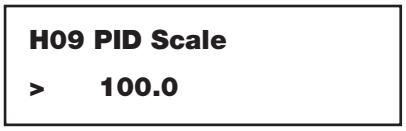
+, -, *, /, |, #, $, ^, &, !, ~,

{}, [], ()

- Press ↵ and the character to enter begins to flash
- Press ▲ & ▼ to move through the list of available characters
- Press ↵ to select the displayed character; the cursor moves to the next character OR the edit completes
- Press the **ESC** button to abandon changes

The H08 PID Units are displayed on the PID run display and a total of 8 characters may be displayed as units.

H09 PID Scale



Available Range: 1.0…1000.0

- Press ↵ to edit the value.
- Press ▲/ ▼ to make changes to the value.
- Press ↵ to accept the new value OR
- Press **ESC** to abandon the value change.

The H09 PID Scale is used to scale the SV and PV values for the PID run display only and does not affect the PID control loop.

S00 SERVICE

The S00 SERVICE menu is a collection of displays and menus specifically for service and service personnel and so summarised description of each display and menu follows

Version display

R40
Ver 5.0.0h

This display reveals the software version in operation without having to restart the drive.

"Motor OL" (I2t) display

I2t used	**0.0A**

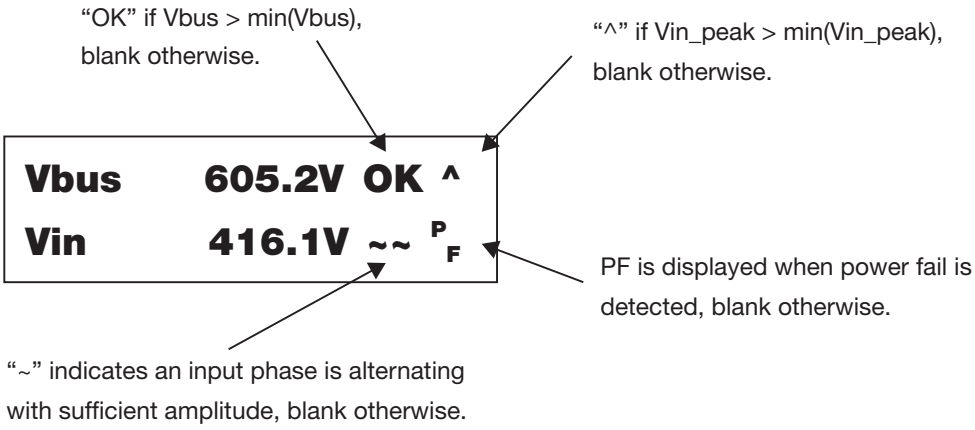
This display reveals the state of the thermal overload protection feature.

Mains input display

Vab	**415.3 Vac**
Vbc	**416.1 Vac**

This display reveals the Vab & Vbc mains input magnitude measurement.

Vbus display



This display reveals the Vbus measurement with: relay pull in condition; bus charge peak condition, mains zero crossing condition and power failure indication.

S04 FAN OVERRIDE

S04 FAN OVERRIDE
> DISABLED

Available Choices: ENABLED
DISABLED

Press ↵ once to begin.

Use the ▲ / ▼ buttons to enable or disable fan override.

Press ↵ to confirm the choice.

The MSC-3 internal cooling fans will be forced ON while ever the S04 FAN OVERRIDE parameter is set to ENABLED. When DISABLED, the fans will operate according to internal temperature measurements.

Temperature sensor display

The temperature sensor menu contains a set of displays that show the reading of each sensor within the MSC3 chassis. Press Enter to gain access to these displays.

An example of one such display is:

***T1**	**33.2 degC**
Ths	**33.2 degC**

For chassis A,B and C this is the only temperature display as only one sensor measures the internal heat sink temperature.

For chassis D there are several temperature sensors not all are mounted on the internal heat sinks. In the example given below there are 2 temperature sensors. The displays for sensor T1 and sensor T2 are:

***T1**	**33.2 degC**
Ths	**33.2 degC**

T2	**35.7 degC**
Ths	**33.2 degC**

The * symbol before T1 indicates that T1 is used in the calculation of the heat sink temperature Ths. In this example T2 is not involved. The heat sink temperature is the maximum value of all sensors displayed with the * symbol.

Digital Input Display

This display makes it possible to view the state of the digital input terminals without the hazards of removing the cover of the drive. An activated input is represented by a “1” and a deactivated input is represented by a “0”. The state of each digital input terminal is displayed on the bottom line:

DI (2,3,4,5,6)
0,0,0,0,1

In this example terminals 2, 3, 4 and 5 are currently deactivated. Terminal 6 however is activated. Terminal 6 is the “EN” (or Enable) input.

Analogue Input Display

This display makes it possible to view the state of the analogue input without the hazards of removing the cover of the drive. The value displayed is either “mA” or “V” depending on the configuration of the input.

AI (10,11)	**5.09V**

This example tells that the configuration is for a voltage input and the value measured is 5.09V

Relays Display

This display makes it possible to view the state of the relays. An energised relay is represented by a “1” and a de-energised relay is represented by a “0”.

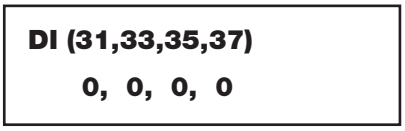
RL1 (15,16)	**0**
RI2 (17,18)	**0**

This example reveals that both relays should be de-energised.

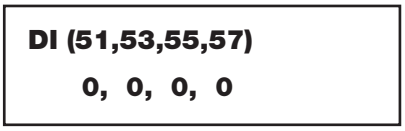
Extended Features Digital Input Display

Refer to the “Extended Features Cards” section for setup information. When one or more extended features cards are fitted extra displays, values and choices appear throughout the menu system. Like the standard digital and analogue I/O, the state of the I/O found on the Extended Feature cards are viewable. In the case of extended feature card, an activated input is represented by a “1” and a deactivated input is represented by a “0”.

An example input display of an Extended Features Card fitted to the left hand side option connector is:



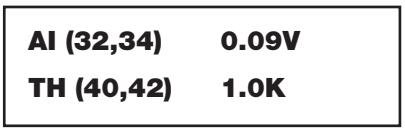
An example input display of an Extended Features Card fitted to the right hand side option connector is:



Extended Features Analogue Input Display

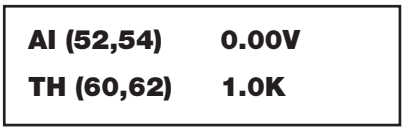
Refer to the “Extended Features Cards” section for setup information. When one or more extended features cards are fitted extra displays, values and choices appear throughout the menu system. Like the standard digital and analogue I/O, the state of the I/O found on the Extended Feature cards are viewable. The state of the analogue and thermistor input are revealed on the Extended Features Analogue Input Display.

An example input display of an Extended Features Card fitted to the left hand side option connector is:



In this example the analogue input is configured as a voltage input. An example input display of an Extended Features Card fitted to the right hand side option connector is:

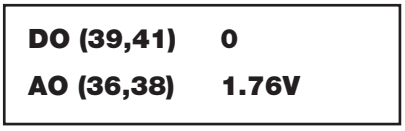
In this example the analogue input is configured as a voltage input.



Extended Features Output Display

Refer to the “Extended Features Cards” section for setup information. When one or more extended features cards are fitted extra displays, values and choices appear throughout the menu system. Like the standard digital and analogue I/O, the state of the I/O found on the Extended Feature cards are viewable. The state of the analogue output and digital output are revealed in the Extended Features Output Display.

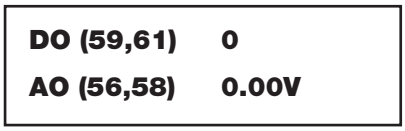
An example output display of an Extended Features Card fitted to the left hand side option connector is:



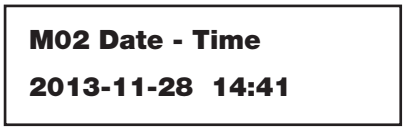
An activated digital output is represented by a “1” and a de-activated digital output is represented by a “0”. In this example the digital output is de-activated.

In this example the analogue output is configured as a voltage output and it is currently outputting 1.76V

An example output display of an Extended Features Card fitted to the right hand side option connector is:



M02 Date – Time



This display reveals the date and time of MSC-3 time keeping. The format for the date and time is:

“20yy-mm-dd hh:mm”.

kWhr & Hours Run

This is a menu for pass code access to additional menus that manage the kWhrs and Hours Run accumulating meters

- Press the ↵ button once to begin pass code entry. The following display will appear:

- The code to access the menus is fixed to “1470”. Press the ↵ button once to begin.
- Use the ▲ & ▼ buttons to set each code digit and ↵ to set to the next digit.
- After all digits have been entered correctly, the first menu will appear.

kWhr

- Press the ↵ button once to begin. The cursor and first digit will blink.
- Use the ▲ & ▼ buttons to set each digit and ↵ to set to the next digit.
- After all digits have been entered, the cursor will disappear.

Hours Run

- Press the ↵ button once to begin. The cursor and first digit will blink.
- Use the ▲ & ▼ buttons to set each digit and ↵ to set to the next digit.
- After all digits have been entered, the cursor will disappear.

System Settings

The menu contained within are intended for service personnel only and so are pass code protected. Please contact your local service agent for further details.

Appendix A: BACnet Protocol – Application Layer Description

Objects and Properties Supported

Property	Object Type			
	Device	Binary Value (BV)	Analog Value (AV)	Accumulator (ACC)
Object Identifier	✓	✓	✓	✓
Object Name	✓	✓	✓	✓
Object Type	✓	✓	✓	✓
Description*	✓			
Location*	✓			
System Status	✓			
Vendor Name	✓			
Vendor Identifier	✓			
Model Name	✓			
Firmware Revision	✓			
Application Software Version	✓			
Protocol Version	✓			
Protocol Revision	✓			
Protocol Services Supported	✓			
Protocol Object Types Supported	✓			
Object List	✓			
Max APDU Length Accepted	✓			
Segmentation Supported	✓			
APDU Timeout	✓			
Number APDU Retries	✓			
Max Master	✓			
Maximum Info Frames	✓			
Device Address Binding	✓			
Database Revision	✓			
Present Value		✓	✓	✓
Status Flags		✓	✓	✓
Event State		✓	✓	✓
Out of Service		✓	✓	✓
Units			✓	✓
Priority Array		✓	✓	
Relinquish Default		✓	✓	
Active Text		✓		
Inactive Text		✓		
Max Present Value				✓

* Device Object Description and Location are R/W

Analog Values

Instance ID	Object Name	Description	Units	Present Value Access
AV0	Cpreset	Speed reference	%	C
AV1	Preset	Preset analog value for general use	%	C
AV2	Accel time	Acceleration time 0 - max speed	seconds	C
AV3	Decel time	Deceleration time max speed - 0	seconds	C
AV4	S time	S characteristic of acceleration and deceleration	seconds	C
AV5	Current limit	Current limit	Amps	C
AV6	AR allowed	Number of auto restarts allowed	-	C
AV7	AR clear time	Running time without trip to clear auto start counter	minutes	C
AV8	Under speed	Set point for under speed alarm	%	C
AV9	Over speed	Set point for over speed alarm	%	C
AV10	Speed	Motor speed	RPM	R
AV11	Speed	Motor speed	%	R
AV12	Frequency	VFD output frequency	Hz	R
AV13	Load	Load torque	%	R
AV14	Current	Motor phase current	Amp	R
AV15	DC Volts	DC bus voltage	Volt	R
AV16	Power	Power to motor	kW	R
AV17	AC Volts	AC Line Voltage	Volt	R
AV18	Temp	Heatsink temperature	Degree C	R
AV19	I2T used	Amount of the thermal capacity of the motor used	%	R

Accumulators

Instance ID	Object Name	Description	Units	Present Value Access
ACC0	kWh	kWh consumed by the motor	kWh	R
ACC1	Hours	Run Number of motor operation hours	hours	R

Present Value Access:

R = Read only

W = Writeable

C = Commandable

Commandable objects support priority arrays and relinquish defaults.

Binary Values

Instance ID	Object Name	Description	Active Text	Inactive Text	Present Value Access
BV0	Run fwd	Run FWD Command	Active	Inactive	C
BV1	Run rev	Run REV Command	Active	Inactive	C
BV2	Reset	Reset Command	RESETTING	Inactive	W
BV3	ESO	ESO Mode	ESO ACTIVE	Inactive	C
BV4	Remote	Remote Status	Remote	Local	R
BV5	Enabled	Enable Status	Enabled	Disabled	R
BV6	Switching	Switching Status	Switching	Output Off	R
BV7	Powered up	Power Up Status	Powered Up	Warming Up	R
BV8	Buscharged	Bus Charged Status	Bus Charged	Charging	R
BV9	Ramping to stop	Ramping Status	Ramping to Stop	Clear	R
BV10	Coasting	Coasting Status	Coasting	Clear	R
BV11	ARfailed	Auto Restart Status	AUTO RESTART FAILED	Ready	R
BV12	OPTSC	Output Short Status	OUTPUT SHORT	Clear	R
BV13	Overvoltage	Over Voltage Trip	OVERVOLTAGE	Clear	R
BV14	Overcurrent	Over Current Trip	OVERCURRENT	Clear	R
BV15	DC low	DC Low Trip	DC LOW	Clear	R
BV16	Power fail	Power Fail Trip	POWER FAIL	Clear	R
BV17	Over temp	Over Temp Trip	OVERTEMPERATURE	Clear	R
BV18	I2t trip	I2t Trip	I2t TRIP	Clear	R
BV19	Tripped	Trip Status	TRIPPED	Clear	R
BV20	Vlimit	Voltage Limit	Active	Inactive	R
BV21	Climit	Current Limit	Active	Inactive	R
BV22	Zero speed	At Zero Speed	Zero Speed	Turning	R
BV23	At speed	At Speed Status	At Commanded speed	Speed Changing	R
BV24	Run	Run Status	Running	Stopped	R

Present Value Access:

R = Read only

W = Writeable

C = Commandable

Commandable objects support priority arrays and relinquish defaults.

Appendix B: MODBUS Protocol - Application Layer Description

Memory Model

Discrete Inputs (read only)

Address	Discrete Input ID	Discrete Input Set	Discrete Input Cleared
0	Remote	Remote mode operation	Local mode operation
1	Enable	MSC-3 is enabled	MSC-3 is disabled
2	Switching	MSC-3 output in ON	MSC-3 output is OFF
3	Power Up	MSC-3 is fully powered	MSC-3 is in the process of powering up
4	BusCharged	DC bus is charged	DC bus is charging
5	Ramping	Ramp to stop mode	
6	Coasting	Coast to stop mode	
7	AutoRestartFail	Failed to auto restart after a trip	
8	OutputShortTrip	Hardware detected output short circuit	
9	OverVoltageTrip	Hardware detected over voltage trip	
10	OverCurrentTrip	Over current trip detected	
11	DCLowTrip	Low DC bus voltage trip detected	
12	PowerFailTrip	input power failure trip detected	
13	OverTempTrip	Power hardware over temperature trip detected	
14	I2tTrip	Over current trip detected	
15	Tripped	one or more trips detected	
16	Voltage Limit	MSC-3 operating at or near max DC bus voltage	
17	Current Limit	MSC-3 operating at or near max output current	
18	At-Zero-Speed	Motor is at zero speed	
19	At-Speed	Motor is at commanded speed	
20	RunStatus	MSC-3 is running the motor and not tripped	

Coils (read/write)

Address	Coil ID	Coil Set	Coil Cleared
0	FWD[1]	Start the motor turning or continue in the forward direction.	Ramp or Coast to zero speed.
1	REV[1,2]	Start the motor turning or continue in the reverse direction.	Ramp or Coast to zero speed.
2	Reset	Issue a trip reset	
3	ESO	Start or run the motor under ESO conditions.	Run under pre-existing conditions
4	Coast2Stop	When stopping the motor and load stops by its own.	When stopping the motor is ramped down to zero speed

[1] **G166 RUN SIGNALS** must be set to **FROM NETWORK** for this operation.

[2] **D03 REVERSE** must be **ENABLED** for this operation

Input Registers (read only)

Address (Size)	Register ID	Description	Scaling	Units
0 (2)	kWhrs	Accumulated motor kilowatt hours		kWhrs
2 (2)	HoursRun	Accumulated motor run time		Hours
4 (1)	SpeedRPM	Motor speed in rpm		rpm
5 (1)	Speed%	Motor speed as a % of C02 MAX Hz	÷ 10	%
6 (1)	Frequency	Output frequency	÷ 10	Hz
7 (1)	Load	% motor load	÷ 10	%
8 (1)	Current	Output current	÷ 10	A
9 (1)	DCvolts	DC bus voltage	÷ 10	V
10 (1)	Power	Output power	÷ 10	kW
11 (1)	ACvolts	AC line voltage	÷ 10	V
12 (1)	Temperature	MSC-3 power hardware temperature		ºK
13 (1)	I2tused	Thermal capacity		A
14 (1)	PID ref	PID reference	÷ 10	%
15 (1)	PID feedback	PID feedback	÷ 10	%
16 (1)	ANIN	Analogue input reading	÷ 10	mA or V
17 (1)	opANIN L	Extended features analog input reading (left)	÷ 10	mA or V
18 (1)	opANIN R	Extended features analog input reading (right)	÷ 10	mA or V

The "Scaling" instruction of this table will covert a raw signed 16 bit integer to a decimal value in the given units.

Holding Registers (read)

Address	Holding Register ID	Description	Scaling	Units
0	**COMMS_REF**	Network supplied speed reference	÷ 10	%
1	**F100 PRESET 1**	Network supplied preset speed reference	÷ 10	%
2	**C030 ACCEL TIME**	Speed ramp acceleration time	÷ 10	sec
3	**C031 DECEL TIME**	Speed ramp deceleration time	÷ 10	sec
4	**C032 S TIME**	Speed ramp S-curve time	÷ 10	sec
5	**D01 CURRENT LIM**	Output current limit specification	÷ 10	A
6	**E030 ARs ALLOWED**	Number of auto re-starts allowed		
7	**E031 AR CLR TIME**	Re-start count reset time interval		
8	**G050 UNDER SPEED**	Under speed compare threshold	÷ 10	%
9	**G051 OVER SPEED**	Under speed compare threshold	÷ 10	%

The "Scaling" instruction of this table will covert a raw signed 16 bit integer to a decimal value in the given units.

Holding Registers (write)

Address	Holding Register ID	Minimum	Maximum	Scaling	Units
0	**COMMS_REF**	-100.0	100.0	x 10	%
1	**F100 PRESET 1**	-100.0	100.0	x 10	%
2	**C030 ACCEL TIME**	0.5	600.0	x 10	sec
3	**C031 DECEL TIME**	0.5	600.0	x 10	sec
4	**C032 S TIME**	0.01	40.00	x 10	sec
5	**D01 CURRENT LIM**	22% of model current rating	125% of model current rating	x 10	A
6	**E030 ARs ALLOWED**	0	15		
7	**E031 AR CLR TIME**	0	1200		
8	**G050 UNDER SPEED**	-100.0	100.0	x 10	%
9	**G051 OVER SPEED**	-100.0	100.0	x 10	%

The "Scaling" instruction of this table will convert a decimal value in the given units to a raw signed 16 bit integer.

Function Codes

- Function Code 01: Read Coils
- Function Code 02: Read Discrete Inputs
- Function Code 03: Read Holding Registers
- Function Code 04: Read Input Registers
- Function Code 05: Write Single Coil
- Function Code 06: Write Single Register
- Function Code 07: Read Exception Status
- Function Code 08: Diagnostics, Sub Codes 0,2,10…18,20
- Function Code 15: Write Multiple Coils
- Function Code 16: Write Multiple Holding Registers
- Function code 43: Read device Identification, Sub Code 14

The function codes supported are explained in detail in the document entitled “MODBUS Application Protocol Specification V1.1b”. Available from http://www.modbus.org. Implementation options and constraints of the MSC-3 are explained in the following sections.

Function Code 01: Read Coils

Request:		
Function code	1 byte	1
Starting address	2 bytes	0 to 4
Quantity of coils	2 bytes	1 to 5

Response:		
Function code	1 byte	1
Byte count	1 byte	1
Coil status	1 byte	MSC-3 coils states

Error:		
Function code	1 byte	129 (128+function code, 0x81)
Exception code	1 byte	1, 2 or 3

Function Code 02: Read Discrete Inputs

Request:		
Function code	1 byte	2
Starting address	2 bytes	0 to 20
Quantity of coils	2 bytes	1 to 21

Response:		
Function code	1 byte	2
Byte count	1 byte	1 to 3
Coil status	1 to 3 bytes	MSC-3 discrete input states

Error:		
Function code	1 byte	130 (128+function code, 0x82)
Exception code	1 byte	1, 2 or 3

Function Code 03: Read Holding Registers

Request:		
Function code	1 byte	3
Starting address	2 bytes	0 to 9
Quantity of registers	2 bytes	1 to 10

Response:		
Function code	1 byte	3
Byte count	1 byte	2 x (Quantity of registers)
Register value(s)	2 x (Quantity of registers) bytes	MSC-3 holding register(s)

Error:		
Function code	1 byte	131 (128+function code, 0x83)
Exception code	1 byte	1, 2 or 3

Function Code 04: Read Input Registers

Request:		
Function code	1 byte	4
Starting address	2 bytes	0 to 18
Quantity of registers	2 bytes	1 to 19

Response:		
Function code	1 byte	4
Byte count	1 byte	2 x (Quantity of registers)
Register value(s)	2 x (Quantity of registers) bytes	MSC-3nput register(s)

Error:		
Function code	1 byte	132 (128+function code, 0x84)
Exception code	1 byte	1, 2 or 3

Function Code 05: Write Single Cell

Request:		
Function code	1 byte	5
Output address	2 bytes	0 to 4
Output value	2 bytes	0x0000 or 0xFF00

Response:		
Function code	1 byte	5
Output address	2 bytes	0 to 4
Output value	2 bytes	0x0000 or 0xFF00

Error:		
Function code	1 byte	133 (128+function code, 0x85)
Exception code	1 byte	1, 2 or 3

Function Code 06: Write Single Register

Request:		
Function code	1 byte	6
Register address	2 bytes	0 to 9
Register value	2 bytes	Data for MSC-3 holding register

Response:		
Function code	1 byte	6
Register address	2 bytes	0 to 9
Register value	2 bytes	Data for MSC-3 holding register

Error:		
Function code	1 byte	134 (128+function code, 0x86)
Exception code	1 byte	1, 2 or 3

Function Code 07: Read Exception Status

Request:		
Function code	1 byte	7

Response:		
Function code	1 byte	7
Output data	1 byte	0 to 255

Function Code 08: Diagnostics, Sub Codes 0, 2, 10...18, 20

Request:		
Function code	1 byte	8
Sub function	2 bytes	0, 0 ⇨ Return query (request) data 0, 2 ⇨ Return diagnostic register 0, 10 ⇨ Clear counters and diagnostic register 0, 11 ⇨ Return network message count 0, 12 ⇨ Return network communication error count 0, 13 ⇨ Return network exception error count 0, 14 ⇨ Return slave message count 0, 15 ⇨ Return slave no response count 0, 16 ⇨ Return slave NAK count 0, 17 ⇨ Return slave busy count 0, 18 ⇨ Return network character overrun count 0, 20 ⇨ Clear overrun counter and flag
Data	2 bytes	Data for MSC-3 MODBUS diagnostics

Response:		
Function code	1 byte	8
Sub function	2 bytes	0,2,10...18,20
Data	2 bytes	

Error:		
Function code	1 byte	136 (128+function code, 0x88)
Exception code	1 byte	1 or 3

Function Code 15: Write Multiple Coils

Request:		
Function code	1 byte	15
Starting address	2 bytes	0 to 4
Quantity of outputs	2 bytes	1 to 5
Byte count	1 byte	1
Output value	1 byte	

Response:		
Function code	1 byte	15
Starting address	2 bytes	0 to 4
Quantity of outputs	2 bytes	1 to 5

Error:		
Function code	1 byte	143 (128+function code, 0x8F)
Exception code	1 byte	1, 2 or 3

Function Code 16: Write Multiple Holding Registers

Request:		
Function code	1 byte	16
Starting address	2 bytes	0 to 9
Quantity of registers	2 bytes	1 to 10
Byte count	1 byte	2 x (Quantity of registers)
Register value	2 x (Quantity of registers)	

Response:		
Function code	1 byte	16
Starting address	2 bytes	0 to 9
Quantity of registers	2 bytes	1 to 10

Error:		
Function code	1 byte	144 (128+function code, 0x90)
Exception code	1 byte	1, 2 or 3

Function Code 43: Read device identification, Sub Code 14

Request:		
Function code	1 byte	43
MEI[1] type	1 byte	14
Read device ID code	1 byte	
Object ID	1 byte	

Response:		
Function code	1 byte	43
MEI[1] type	1 byte	14
Read device ID code	1 byte	1 ⇨ Request Basic Device ID
Conformity level	1 byte	0
More follows	1 byte	0
Next object Id	1 byte	0
Object ID	1 byte	0 ⇨ Vendor name 1 ⇨ Product code 2 ⇨ Major/minor Revision
Object byte count	1 byte	
Object data	"Object byte count" bytes	

[1] MODBUS Encapsulated Interface

Error:		
Function code	1 byte	171 (128+function code, 0xAB)
Exception code	1 byte	1, 2 or 3

Exceptions

The exception codes supported are explained in detail in the document entitled “MODBUS Application Protocol Specification V1.1b”. Exception codes supported by the MSC-3 are:

Exception code	Name
1	ILLEGAL FUNCTION CODE
2	ILLEGAL DATA ADDRESS
3	ILLEGAL DATA VALUE

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

Trip Message	Description
EXTERNAL ALARM	User defined trip input activated
THERMISTOR HOT	The thermistor wired to the Extended Features card indicates the motor is over heated
THERMISTOR SHORT	The thermistor wired to the Extended Features card is short circuit
SUPPLY FAIL	There is a problem with the input power supply. One phase is either partially or totally missing and motor operation will be impaired
BRAKE SHORT	Either an Over Current or a Ground Fault has been detected on the dynamic brake resistor terminals
OVER TEMPERATURE	The MSC-3 is too hot
EARTH FAULT	An earth leakage fault has been detected on the motor terminals
I2t OVERLOAD	An I2t trip has occurred
CHARGE DEFAULT	A rectifier failure has been detected on the mains input terminals
DC BUS LOW	The DC Bus voltage has fallen below its minimum threshold
POWER FAILURE	All input phases on the input power supply are either low or missing
OVER CURRENT	The output current has exceeded the MSC-3's intermittent output current rating
INV OVER TEMP	One or more power devices has exceeded its thermal protection rating
RELAY OPEN	The internal bus charge relay has failed to operate correctly
OVER VOLTAGE	The DC Bus voltage has exceeded its maximum value
OUTPUT SHORT	AN output short circuit has been detected. This is caused by either an Over Current or a Ground Fault on the motor terminals

Run Message	Description
EXT WARN	User defined warning input activated
V LIMIT	The motor is regenerating or the input voltage is too high
C LIMIT	The motor is drawing its maximum overload current
P LIMIT	The motor's absorbed power exceeds the MSC-3 rating when operating from a single phase supply
ESO FWD	The MSC-3 is operating in Essential Services Override mode with FWD rotation
ESO REV	The MSC-3 is operating in Essential Services Override mode with REV rotation
OFF LINE	The MSC-3 has not been given a terminal strip run command in line contactor mode
NO AC!	The MSC-3 has been given a terminal strip run command but has detected no AC input voltage supply
CHARGING	The MSC-3 is waiting for the DC Bus capacitors to be fully charged before running the motor
NOT EN	The MSC-3 is ON but has no enable signal so it is not able to turn a motor
IDLE REM	The MSC-3 is idle in remote mode
FWD REM	The MSC-3 is running in the FWD direction in remote mode
REV REM	The MSC-3 is running in the REV direction in remote mode

EN REM	The MSC-3 has an enable signal but no direction selected in remote mode
IDLE LOC	The MSC-3 is idle in local mode
FWD LOC	The MSC-3 is running in the FWD direction in local mode
REV LOC	The MSC-3 is running in the REV direction in local mode
EN LOC	The MSC-3 has an enable signal but no direction selected in local mode

MSC-3 Specifications

Input Supply Voltage	
MSC-3R	380 to 480Vac, 3Ø
MSC-3J	440 to 600Vac, 3Ø
MSC-3L	208 to 240Vac, 3Ø
All these voltages have a tolerance of -15% to +10%	

Input Frequency
48 to 62 Hz

Output Voltage	
MSC-3R	0 to 480Vac, 3Ø
MSC-3J	0 to 600Vac, 3Ø
MSC-3L	0 to 240Vac, 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
IP30 (NEMA 1) IP66 (NEMA 4)

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 COM
5Vdc Supply,
40mA max current
D1 to D4 and EN Digital Inputs
Logic High 3 to 5Vdc
Logic Low 0 to 2Vdc
Analog Input
Vref and COM
+5Vdc Supply
5mA max current
IN+ and IN-
Differential Input
0 to 5V range
0 to 10V range
0 to 20mA range
4 to 20mA range
Common mode range
± 25 Vdc to COM
Relay Outputs
2 Form A Outputs (single pole normally open contacts)
Contact Rating (Resistive load)
5A@250Vac
5A@30Vdc
Contact Rating (Inductive load)
2A@250Vac
2A@30Vdc

User Parameters	
Motor Voltage	200 to 900V
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.

Model	Max. Supply Short Circuit Rating (Amps rms Symmetrical)	Max. Fuse Size	Fuse Class	Max. Wire Size	Max. Tightening Torque
240V					
MSC-3L3	18,000A, 240V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3L5	18,000A, 240V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3L7	18,000A, 240V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3L11	18,000A, 240V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3L15	18,000A, 240V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3L23	18,000A, 240V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3L30	18,000A, 240V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3L40	18,000A, 240V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3L55†	18,000A, 240V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3L82†	18,000A, 240V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3L109†	18,000A, 240V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3L140†	18,000A, 240V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3L170†	18,000A, 240V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
480V					
MSC-3R3	18,000A, 480V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3R5	18,000A, 480V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3R7	18,000A, 480V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3R11	18,000A, 480V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3R15	18,000A, 480V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3R23	18,000A, 480V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3R30	18,000A, 480V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3R40	18,000A, 480V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3R55†	18,000A, 480V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3R82†	18,000A, 480V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3R109†	18,000A, 480V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3R140†	18,000A, 480V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
MSC-3R170†	18,000A, 480V	200	T	2/0 A.W.G (70mm²)	120 in.lb (13.6Nm)
600V					
MSC-3J3	18,000A, 600V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3J5	18,000A, 600V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3J7	18,000A, 600V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3J11	18,000A, 600V	20	J	10 A.W.G (6mm²)	15.6 in.lb (1.76Nm)
MSC-3J15	18,000A, 600V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3J23	18,000A, 600V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3J30	18,000A, 600V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)
MSC-3J40	18,000A, 600V	60	T	6 A.W.G (16mm²)	16 in.lb (1.8Nm)

- Inverse-time circuit breakers can be used provided that the let-through energy (I^2t) and peak let through current (Ip) is less than that of the maximum fuse rating specified.
- Use Copper Conductors Only.

† Not included in UL listing

MSC-3 Output Current Specifications

Model	Continuous Current for General Purpose Rating (A) Typically variable torque applications	Continuous Current for Extended Duty Rating (A) Typically constant torque applications	Over Load Current (A)[7]
MSC-3*3	3.6	3.1	4.7
MSC-3*5	5.0	4.2	6.3
MSC-3*7	7.2	6.1	9.0
MSC-3*11	10.8	9.1	13.4
MSC-3*15	14.9	12.7	19.0
MSC-3*23	22.5	19.1	28.6
MSC-3*30	30.1	25.6	38.4
MSC-3*40	40.3	34.1	51.1
MSC-3*55	55.0	46.6	69.9
MSC-3*82	82.0	68.9	104.3
MSC-3*109	109	92.0	138.6
MSC-3*140	140	116.9	178.0
MSC-3*170	170	132.6	199.0
MSC-3R220	220	170.0	242.0
MSC-3R260	260	200.0	286.0
MSC-3R315	315	250.0	346.5
MSC-3R360	360	285.0	396.0
MSC-3R390	390	310.0	429.0
MSC-3R430	430	340.0	473.0
MSC-3R490	490	395.0	539.0
* L, R or J for models up to MSC-3 *40. L or R for models MSC-3 *55 and up.			

These currents apply to all ranges MSC-3 at an ambient temperature of 40ºC (104ºF) independent of the input voltage. MSC-3 may be applied at higher ambient temperatures at reduced ratings. Please consult the factory for ratings for ambients above 40ºC (104ºF).

MSC-3 Trouble Shooting Guide

Symptom	Cause	Remedy
Front Display does not illuminate.	Input power wiring not connected properly. Input voltage not within specification.	Check input power wiring, refer to the MSC-3 Electrical Installation Diagram. Measure the input voltage at the MSC-3 input terminals. Check with specifications.
Motor does not rotate when UP button on the Console is pressed.	Enable signal is not active.	Check that the EN terminal is connected to +5V. Check that the ENABLED message is displayed.
	MSC-3 is in REMOTE	Check that if you have a remote terminal it is not at +5V with respect to 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-3. When the load is being accelerated too fast, the MSC-3 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. Fault in motor or motor wiring. Incorrect motor voltage selected.	Check the mechanical drive system. Check that motor is wired correctly. Enter correct MOTOR VOLTAGE from the *MOTOR* menu
	Incorrect motor frequency selected. *FLUX PLUS* is set too high.	Enter correct MOTOR FREQUENCY from the *MOTOR* menu. 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-3 General Specifications for input voltage ratings.
OPT SC message appears	Short circuit on motor terminals.	Check wiring to motor terminals.
	Earth Fault on 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.	See general specification and check the input is within ratings. Check input supply for voltage transients. Fix the external source.
	Motor is overhauling.	Ensure load cannot overdrive the motor. If necessary fit dynamic braking.
OT message	Ventilation problem.	Ensure operating ambient temperature is within specification. Check fans are rotating freely and there is no build up of dust or debris in blades. Visually examine the heatsink fins for build up of dust and debris.
	Drive is constantly overloaded.	Check the MSC-3 continuous current and ambient temperature rating.
Motor is unstable.	*SLIP COMP* is set too high.	Check that MOTOR NAMEPLATE RPM setting is equal to the motor rated speed. Check that NAMEPLATE CURRENT setting is equal to the motor nameplate current. Reduce SLIP COMP setting.
	FLUX PLUS set too high.	Reduce FLUX PLUS setting.
	Incorrect motor voltage selected.	Enter correct MOTOR VOLTAGE from the MOTOR menu.
	Incorrect motor frequency selected.	Enter correct *MOTOR FREQUENCY* from the *MOTOR* menu.
	CURRENT LIMIT is set too low.	Increase *CURRENT LIMIT* setting.
Excessive Motor Heating.	Motor is running at low speeds for long times.	Do not run the motor heavily loaded at low speeds for long periods unless the motor has been suitably de-rated or is force cooled.
	Motor damaged or incorrectly wired.	Check the motor and motor wiring for faults.
	Incorrect motor voltage selected.	Enter correct *MOTOR VOLTAGE* from the *MOTOR* menu.
	Incorrect motor frequency selected.	Enter correct *MOTOR FREQUENCY* from the *MOTOR* menu.

Your MSC-3 Setup Notes

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

Parameter	User	Default	Parameter	User	Default
A01 Menu Lock		UNLOCKED	F07 USER REF 2		CONSOLE
A02 Def. Display		METER DISPLAY	F080 PERSISTENT		DISABLED
A030 Run Display Format		999.9	F081 STOP RESET		DISABLED
A031 Run Display Scale		50.0	F09 COMMS PRESET		60.0
A032 Run Display Units		Hz	F100 PRESET 1		10.0
B01 MOTOR VOLTS		*	F101 PRESET 2		20.0
B02 MOTOR AMPS		*	F102 PRESET 3		30.0
B03 MOTOR Hz		*	F103 PRESET 4		40.0
B04 MOTOR RPM		*	F104 PRESET 5		50.0
C10 MIN Hz		0	F105 PRESET 6		60.0
C011 IDLE DELAY		0	F106 PRESET 7		70.0
C012 RESUME Hz		0	F107 PRESET 8		80.0
C02 MAX Hz		*	I00 FWD & LATCH		D3(4)
C030 ACCEL TIME		10.0	I01 REV & LATCH		OFF
C031 DECEL TIME		10.0	I02 ~STOP		D2(3)
C032 S TIME		0.01	I03 FWD		OFF
C033 DUAL RAMP		DISABLED	I04 REV		OFF
C034 ESO RAMP		10.0	I05 UP		OFF
C040 FLUX PLUS		0.0	I06 DOWN		OFF
C041 HiSpd Flux+		DISABLED	I07 RESET		D1(2)
C05 SLIP COMP %		0.0	I08 ESO		OFF
C06 AUDIBLE FREQ		2kHz	I09 JOGFWD		OFF
D01 CURRENT LIM		*	I10 JOG REV		OFF
D020 I2t		*	I11 REMOTE		D4(5)
D021 I2t zero Hz		*	I12 EXTERN ALARM		OFF
D022 I2t CNR Hz		10.0	I13 EXTERN WARN		OFF
D03 REVERSE		DISABLED	I14 T1 Input		OFF
D04 DC INPUT		DISABLED	I15 T2 Input		OFF
D05 1 Phase Inpt		DISABLED	I16 Selector 1		OFF
D060 SKIP SPEED		30	I17 Selector 2		OFF
D061 SKIP RANGE		0	I18 Selector 3		OFF
E01 COAST STOP		DISABLED	G020 Input Type		Volts
E02 DYNAMIC BRK		DISABLED	G021 MIN Input		0.0
E030 ARs ALLOWED		0	G022 MAX Input		10.0
E031 AR CLR TIME		1200	G023 Ref @MIN in		0.0
E04 Reset by PF		DISABLED	G024 Ref @MAX in		100.0
E05 Motor Resync		DISABLED	G025 Hi Compare Level		8
E06 LC CONTROL		DISABLED	G026 LoCMP Level		2
F01 REMOTE		AI(10,11)	G030 RL Function		RUN
F02 LOCAL		CONSOLE	G031 RL Sense		DIRECT
F03 ESO		F105 Preset 6	G032 ON Delay		0
F04 JOGFWD		F105 Preset 6	G033 OFF Delay		0
F05 JOGREV		F105 Preset 6	G040 RL Function		TRIP
F06 USER REF 1		AI(10,11)	G041 RL Sense		DIRECT

Parameter	User	Default	Parameter	User	Default
G042 ON Delay		0	G155 MAX Output		5.0
G043 OFF Delay		0	G160 Protocol		none
G050 UNDER SPEED		20.0	G161 bits/sec		19200
G051 OVER SPEED		80.0	G162 Parity		Even parity
G06 REMOTE OVRD		DISABLED	G163 MAC/Dev ID		1
G070 T1 Interval		1	G164 Dev Inst.		1
G071 T1 Mode		Delay ON	G165 Max Masters		127
G072 T2 Interval		1	G166 RUN SIGNALS		FROM TERMINAL
G073 T2 Mode		Delay ON	G167 Terminator		DISABLED
G080 DO Function		RUN	G168 Comms Lost Time		10
G081 DO Sense		DIRECT	G169 Serial No.		G1000000
G082 ON Delay		0	H01 PB (%)		300.0
G083 OFF Delay		0	H02 Ti (sec/r)		2.0
G09 TH(37,38)		DISABLED	H03 Td (sec)		0.00
G100 Input Type		Volts	H04 +Opt clamp		100.0
G101 MIN Input		0.0	H05 -Opt clamp		0.0
G102 MAX Input		10.0	H06 SV choice		CONSOLE
G103 Ref @MIN in		0.0	H07 PV choice		AI(10,11)
G104 Ref @MAX in		100.0	H08 PID Units		%
G105 Hi Compare Level		8	H09 PID Scale		100.0
G106 Lo Compare Level		2			
G110 Output Type		Volts			
G111 AO Source		Hz			
G112 Signal min		0.0			
G113 Signal max		50.0			
G114 MIN Output		0.0			
G115 MAX Output		5.0			
G120 DO Function		RUN			
G121 DO Sense		DIRECT			
G122 ON Delay		0			
G123 OFF Delay		0			
G13 TH(37,38)		DISABLED			
G140 Input Type		Volts			
G141 MIN Input		0.0			
G142 MAX Input		10.0			
G143 Ref @MIN in		0.0			
G144 Ref @MAX in		100.0			
G145 Hi Compare Level		8			
G146 Lo Compare Level		2			
G150 Output Type		Volts			
G151 AO Source		Hz			
G152 Signal min		0.0			
G153 Signal max		50.0			
G154 MIN Output		0.0	*Drive Specific		

MSC-3 transportation sizes and weights

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

Model	Enclosure Type	Shipping Dimensions	Weight without Choke	Weight with Choke	Packaging
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Chassis A IP30 / NEMA 1 (No DC Choke)	280 x 300 x 184mm 11 x 11.8 x 7.3in	4Kg		Carton
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Optional DC Bus Choke for Chassis A IP30 / NEMA 1	175 x 335 x 145mm 6.9 x 13.2 x 5.7in		3.6Kg Choke only	
MSC-3*3 MSC-3*5 MSC-3*7 MSC-3*11	Chassis A IP66 / NEMA 4	330 x 387 x 380mm 13 x 15.2 x 15in	7.1Kg	10Kg	
MSC-3*15 MSC-3*23 MSC-3*30	Chassis B All types	540 x 400 x 360mm 21.3 x 15.7 x 14.2in	20Kg	25.6Kg	
MSC-3*40				27.5Kg	
MSC-3*55	Chassis C All types	520 x 750 x 440mm 20.5 x 29.5 x 17.3in	46Kg	72Kg	Pallet
MSC-3*82			48Kg	74Kg	
MSC-3*109			50Kg	76Kg	
MSC-3*140			62Kg	80Kg	
MSC-3*170				78Kg	
MSC-3R220	All Chassis D All types without floor stand	610 x 1260 x 675mm 24.0 x 49.6 x 26.6 in		250Kg	
MSC-3R260				260Kg	
MSC-3R315				270Kg	
MSC-3R360				300Kg	
MSC-3R390				310Kg	
MSC-3R430				320Kg	
MSC-3R490				330Kg	

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.
COM	The common terminal to which all inputs on the MSC-3 are referenced.
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 conveyor
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.
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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