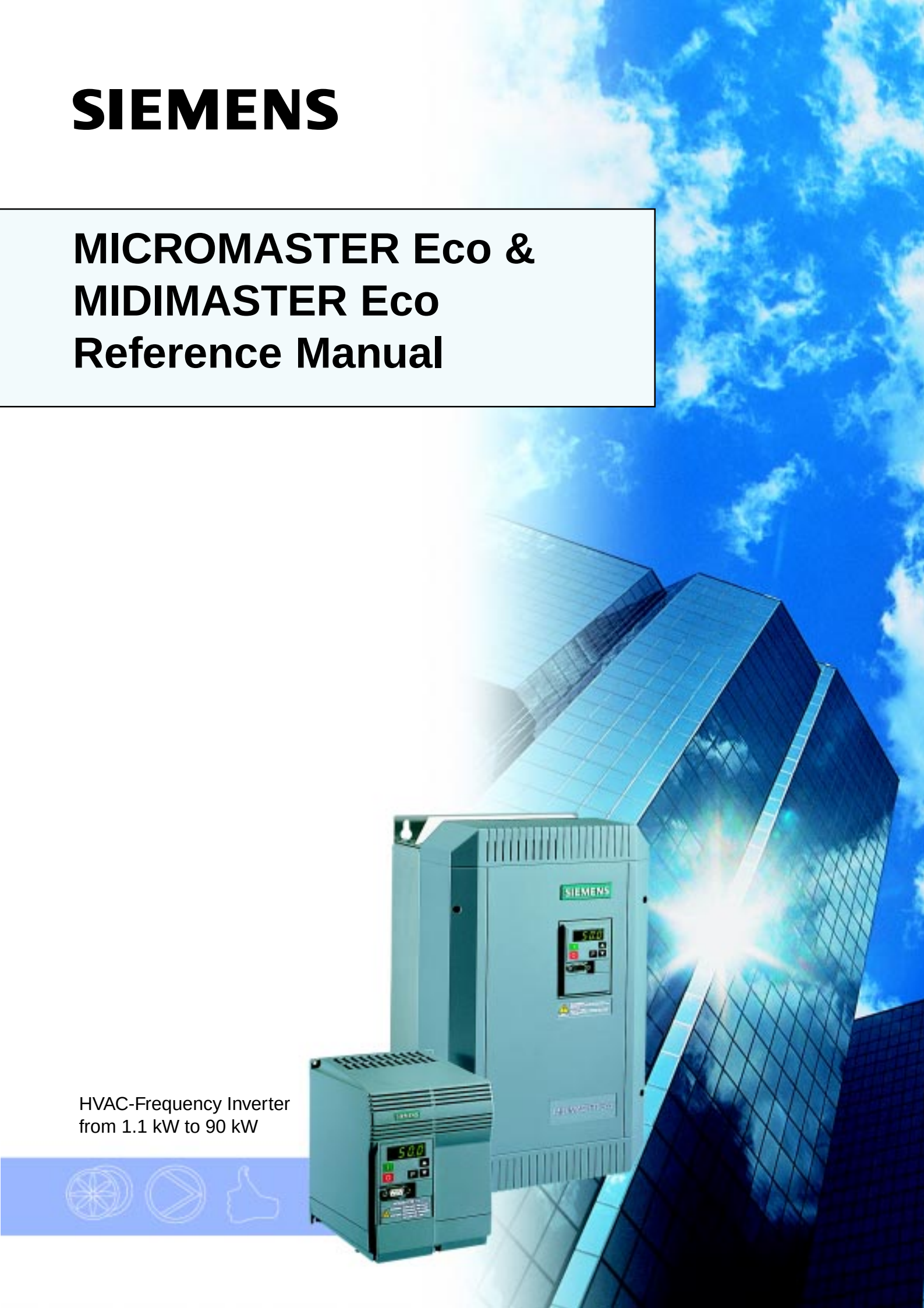
SIEMENS

MICROMASTER Eco & MIDIMASTER Eco Reference Manual



HVAC-Frequency Inverter
from 1.1 kW to 90 kW

CONTENTS

Section 1

1. SAFETY AND COMPLIANCE 1-1

Section 2

2. INTRODUCTION 2-1
   - PRODUCT DESCRIPTION AND APPLICATIONS 2-1
   - Eco OPERATING INSTRUCTION MANUAL 2-1
   - Eco REFERENCE MANUAL 2-1

Section 3

3. PRINCIPLES OF INVERTER OPERATION 3-1
   - INTRODUCTION 3-1
   - VARIABLE SPEED DRIVES 3-1
   - VARIABLE FREQUENCY INVERTER. 3-4

Section 4

4. ADVANTAGES OF THE Eco 4-1
   - ENERGY SAVINGS 4-1
   - CONTROL & REGULATION 4-1
   - PID - INTERNAL 4-1
   - NOISE 4-1
   - WEAR & TEAR 4-2
   - EQUIPMENT RATIONALISATION 4-2
   - OUTSTATION CAPABILITY WITH RS485 SERIAL COMMUNICATION 4-2

Section 5

5. TECHNICAL OVERVIEW & SUMMARY TABLE 5-1
   - STANDARD FEATURES 5-1
   - TECHNICAL FEATURES 5-2

Section 6

6. ENERGY SAVING PROGRAM 6-1
   - ENERGY CONTROL OPTIMIZATION (P077) 6-1

Section 7

7. PULSE WIDTH MODULATION (PWD) OUTPUT METHOD 7-1
   - SWITCHING FREQUENCY FOR LOW MOTOR NOISE 7-1

Section 8

8. Eco SELECTION CRITERIA - SIZE, TYPE ETC. 8-1
   - OVERALL CONSIDERATIONS 8-1
   - SUPPLY SIDE REQUIREMENTS 8-1
   - SUPPLY TOLERANCE 8-1
   - SUPPLY DISTURBANCE 8-2
   - UNGROUNDED SUPPLIES 8-3
   - LOW FREQUENCY HARMONICS 8-3
   - MICROMASTER Eco 8-3
   - MIDIMASTER Eco 8-3
   - EMC FILTER RESTRICTIONS FOR ALL PRODUCTS 8-3
   - MOTOR LIMITATIONS 8-6
   - LOAD CONSIDERATIONS 8-8
   - VARIABLE TORQUE APPLICATIONS 8-9
   - OTHER LOADS 8-10
   - ENVIRONMENTAL CONSIDERATIONS 8-11
   - IP PROTECTION 8-11

Contents

Section 9

9. MECHANICAL INSTALLATION 9-1
SAFETY INFORMATION AND ENVIRONMENTAL REQUIREMENTS 9-2
CLEARANCES AND DIMENSIONS - MICROMASTER Eco 9-3
CLEARANCES AND DIMENSIONS - MIIDMASTER Eco..... 9-5

Section 10

10. ELECTRICAL INSTALLATION..... 10-1
SAFETY INFORMATION AND GENERAL GUIDELINES 10-1
POWER AND MOTOR CONNECTIONS - MIDIMASTER Eco RANGE..... 10-3
POWER AND MOTOR CONNECTIONS - MICROMASTER Eco RANGE..... 10-3
RECOMMENDED FUSES AND RATINGS..... 10-5
DIRECTION OF ROTATION..... 10-6
STAR OR DELTA MOTOR CONNECTION..... 10-6
MULTI-MOTOR CONNECTION 10-6
MOTOR OVERLOAD PROTECTION 10-6
MICROMASTER Eco 10-7
MIDIMASTER Eco..... 10-7

Section 11

11. APPLICATION EXAMPLES 11-1

Section 12

12. EMC GUIDELINES..... 12-1
ELECTRO-MAGNETIC COMPATIBILITY (EMC) 12-1
ELECTRO-MAGNETIC INTERFERENCE (EMI) 12-6
WIRING GUIDELINES TO MINIMISE EFFECTS OF EMI..... 12-7
FRAME SIZES 4 TO 7 12-9

Section 13

13. PROGRAMMING 13-1
KEYPAD..... 13-1
DIP SELECTOR SWITCHES..... 13-1
PARAMETER TYPES 13-2
PARAMETER RANGES..... 13-2
ACCESSING PARAMETERS AND CHANGING VALUES 13-3
DISPLAY MODE PARAMETERS..... 13-3
BASIC MODE PARAMETERS 13-4
EXPERT MODE PARAMETERS 13-6
FAULT CODES 13-24
PID PROCESS CONTROL 13-26
HARDWARE SET-UP 13-26
PARAMETER SETTINGS..... 13-27

Section 14

14. DE-RATING INFORMATION 14-1
THERMAL PROTECTION AND AUTOMATIC DE-RATING.... 14-1
MAXIMUM MOTOR CABLE LENGTHS..... 14-1
MAXIMUM OUTPUT CURRENT AT ELEVATED TEMPERATURES - VARIABLE TORQUE APPLICATIONS ... 14-3
MAXIMUM OUTPUT CURRENT WITH LONG UNSCREENED CABLES - VARIABLE TORQUE APPLICATION 14-4
MAXIMUM OUTPUT CURRENT WITH LONG SCREENED CABLES - VARIABLE TORQUE APPLICATIONS..... 14-5
VOLTAGES AND CURRENT DE-RATING WITH RESPECT TO ALTITUDE..... 14-6

Section 15

15. OPTIONS 15-1
CLEAR TEXT OPERATING PANEL OPE 15-1
EMC FILTERS 15-4
INPUT EMC FILTER ORDER NUMBERS 15-4
INSTALLATION OF FILTERS 15-6
HARMONIC INPUT CHOKES 15-14
INPUT CHOKE ORDER NUMBERS 15-15
4EP THREE-PHASE LINE REACTORS 15-17
OUTPUT CHOKES 15-20
OUTPUT CHOKE ORDER NUMBERS 15-20
INSTALLATION OF OUTPUT CHOKES 15-21
OUTPUT CHOKES (IRON CORE) 15-21
OUTPUT CHOKES (FERRITE CORE) 15-22
OUTPUT REACTORS (FERRITE CORE) 15-23
DV/DT OUTPUT FILTERS 15-24
INSTALLATION OF DV/DT OUTPUT FILTERS 15-25

Section 16

16. SCOPE 16-1
TABLE OF CONTENTS 16-2
1. GENERAL 16-3
2. DESIGN 16-3
3. QUALITY ASSURANCE & STANDARDS 16-4
4. PERFORMANCE REQUIREMENT 16-5
5. BASIC PARAMETER SETTINGS 16-5
6. EXPERT / ADVANCED PARAMETER SETTINGS 16-6
7. PROTECTION FUNCTIONS AND FEATURES 16-6
8. CONTROL SIGNALS 16-7
9. COMMUNICATIONS 16-7
10. HARMONICS ON MAINS SUPPLY SYSTEM 16-8
11. ELECTROMAGNETIC COMPATIBILITY (EMC) 16-8
12. OUTPUT CHOKES 16-9
13. COMMISSIONING & DOCUMENTATION 16-9
14. PREFERENCE 16-9

Section 17

17. YOUR PARAMETER SETTINGS 1
PARAMETER SUMMARY CHART 2

1. SAFETY AND COMPLIANCE

Before installing and putting this equipment into operation, read these safety instructions and warnings carefully. Also read and obey all the warning signs attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace any missing or damaged labels.

Warning

This equipment contains dangerous voltages and controls dangerous rotating mechanical parts. Loss of life, severe personal injury or property damage can result if the instructions contained in this manual are not followed.

Only suitably qualified personnel should work on this equipment, and only after becoming familiar with all safety notices, installation, operation and maintenance procedures contained in this manual.

- Use only permanently-wired input power connections. The equipment must be grounded (IEC 536 Class 1, NEC and other applicable standards)
- Use only Residual Current-operated protective Device (RCD) type B if an RCD is required
- Wait at least five minutes after the power has been turned off, before opening the equipment. The dc-link capacitor remains charged to dangerous voltages even when the power is removed. When working on equipment with covers removed, note that live parts are exposed and do not touch these parts
- Do not connect machines with a three-phase power supply, fitted with EMC filters, to a supply via an ELCB (Earth Leakage Circuit Breaker - see DIN VDE 0160, section 6.5)
- Note that certain parameter settings may cause the inverter to restart automatically once power is restored following an input supply failure.
- Do not use this equipment as an “emergency stop” mechanism (see EN 60204, 9.2.5.4)
- Obey all general and regional installation and safety regulations relating to work on high voltage installations, as well as regulations covering correct use of tools and personal protective equipment
- Note that the following terminals can carry dangerous voltages even when the inverter is inoperative:
  Power supply terminals L/L1, N/L2 and L3 MICROMASTER Eco. L1, L2 and L3 MIDIMASTER Eco
  Motor terminals U, V and W
  DC link terminals B+/DC+ and B- MICROMASTER Eco. DC+ and DC- MIDIMASTER Eco
- This equipment is capable of providing internal motor thermal overload protection in accordance with section 42 of UL508C. Please refer to P074. An external PTC may also be used (refer to electrical installation).
- This equipment is suitable for use in a circuit capable of delivering not more than 100,000 symmetrical amperes (rms), for a maximum voltage of 230/460V* when protected by a time delay fuse*
  * As detailed in sections 9.1 and 10.5 respectively.
- Do not operate the motor with a higher nominal power than the inverter, or a nominal power less than half the inverter. Only operate the inverter when the nominal current in P083 exactly matches the motor rating plate nominal current
- Enter the motor data parameters (P080-P085) and do an auto-calibration (P088) before the motor is started. Unstable/unpredictable motor operation (e.g. Reverse rotation) may result if this is not done. If this instability occurs, the mains supply to the inverter must be disconnected.
- When using the analogue input, the DIP switches must be correctly set and the analogue input type selected (P023) before enabling the analogue input with P006. If this is not done the motor may start inadvertently.

Caution

- Do not allow children or the general public to access of approach this equipment
- Do not install the inverter where it will be subject to shock, vibration, electro-magnetic radiation, water hazards, or atmospheric pollutants such as dust or corrosive gases.
- Keep operating instructions within easy reach and give them to all users
- Use this equipment only for the purpose specified by the manufacturer. Do not carry out any modifications, or fit any spare parts which are not sold or recommended by the manufacturer; this could cause fires, electric shock or other injuries.

EUROPEAN LOW VOLTAGE DIRECTIVE

The MICROMASTER Eco and MIDIMASTER Eco product range complies with the requirements of the Low Voltage Directive73/23/EEC as amended by Directive 93/68/EEC. The units are certified for compliance with the following standards:

EN 60146-1-1	Semiconductor converters - General requirements and line commutated converters	**EN 60204-1**	Safety of machinery - Electrical equipment of machines

EUROPEAN MACHINERY DIRECTIVE

The MICROMASTER Eco and MIDIMASTER Eco product range do not fall under the scope of the Machinery Directive. However, the products have been fully evaluated for compliance with the essential Health & Safety requirements of the directive when used in a typical machine application. A declaration of incorporation is available on request.

EUROPEAN EMC DIRECTIVE

When installed according to the recommendations described in this manual, the MICROMASTER Eco and MIDIMASTER Eco product range fulfil all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN 61800-3

UL and CUL listed power conversion equipment for use in pollutuion degree 2 environment

ISO 9001

Siemens plc operates a quality management system which complies with the requirements of ISO 9001.

2. INTRODUCTION

PRODUCT DESCRIPTION AND APPLICATIONS

The MICROMASTER Eco and MIDIMASTER Eco provides a range of variable frequency speed controllers (inverters) specifically developed for the Heating, Ventilation & Air Conditioning (HVAC) industry.

Key design features include:

- Automatic energy optimisation
- Motor thermal overload protection
- Automatic switching frequency optimisation for minimised acoustic noise generation
- Zero de-rating of motor
- Automatic motor tuning at switch-on
- Earth fault protection
- Short circuit protection
- Built-in chokes allow use of up to 150 metre motor cables

The ability to easily control the speed of pump or fan motors provides superior regulation and control of the process, enabling optimisation of room temperatures and personal comfort levels.

The Eco range combines ease of installation and commissioning with low maintenance and operating costs. In addition, the specific HVAC product functionality (compared with similar products aimed at “Hi-Tech” multiple applications) means that product costs can be minimised, and the user does not pay for features which are not required.

Day-to-day operating costs can be drastically reduced - up to 60% in some applications. Energy consumption and associated emissions are also reduced to the lowest possible levels.

ECO OPERATING INSTRUCTION MANUAL

The Eco Operating Instructions booklet (which should be read in conjunction with this manual) provides basic information on equipment installation and programming, to control the functions of fans and pump motors. It is aimed at HVAC Installation Technicians and Electricians working and commissioning on-site, and is intended to provide a quick, straightforward guide to installing and simple operating of the Eco units.

ECO REFERENCE MANUAL

This Manual - The Eco Reference Manual is intended for use by a wide range of HVAC professionals. For example, the Eco Reference Manual is to be used by Building Automation Engineers to plan their equipment and cabling schedules and estimate their material requirements. It may also be used by HVAC Consultants in order to compile the relevant portions of their tender specification.

The Eco Reference Manual should also be useful to electrical panel builders, building automation control engineers, quantity surveyors / estimators, electrical project managers, and maintenance contractors.

3. PRINCIPLES OF INVERTER OPERATION

INTRODUCTION

This section of the manual is intended to help first-time users of variable speed drives to understand basic principles of operation, and gain some insight into successful installation and application of the MICROMASTER Eco range of Variable Speed Drives.

VARIABLE SPEED DRIVES

A Variable Speed Drive (VSD) system consists of a Motor and some form of speed controller.

History

Early electric VSDs consisted of AC and DC motor combinations which were used as rotating AC to DC converters. The DC supply was used to drive the DC motor at variable speed by controlling the field current in the DC generator to vary the DC voltage to the DC motor.

The first electronic controllers used Thyristor (SCR) Rectifiers which controlled the voltage, and therefore the speed of DC motors. These DC VSDs are still widely used and offer very sophisticated control capability. However, the DC motor is large, expensive and requires periodic brush maintenance.

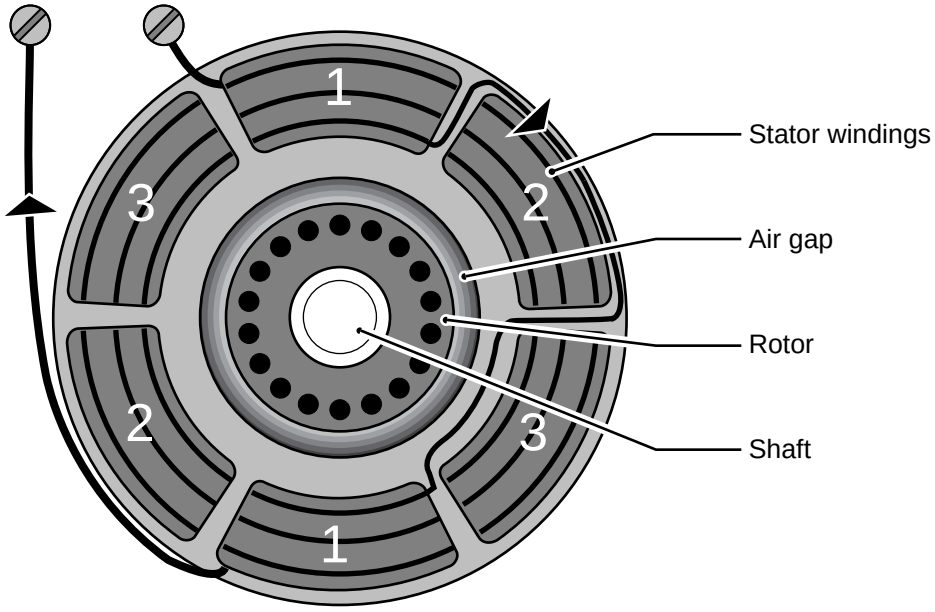
Present day

The AC induction motor is simple, low cost, reliable and widely used throughout the world. In order to control the speed of an AC induction motor a more complex controller, which varies the frequency as well as the voltage, usually called an inverter is required.

Induction motor

In order to understand how an inverter works, it is first necessary to understand how an induction motor works.

An asynchronous induction motor works like a transformer. When the stator (the fixed, outer winding) is connected to a three phase power source, a magnetic field which rotates at the frequency of the supply is set up.



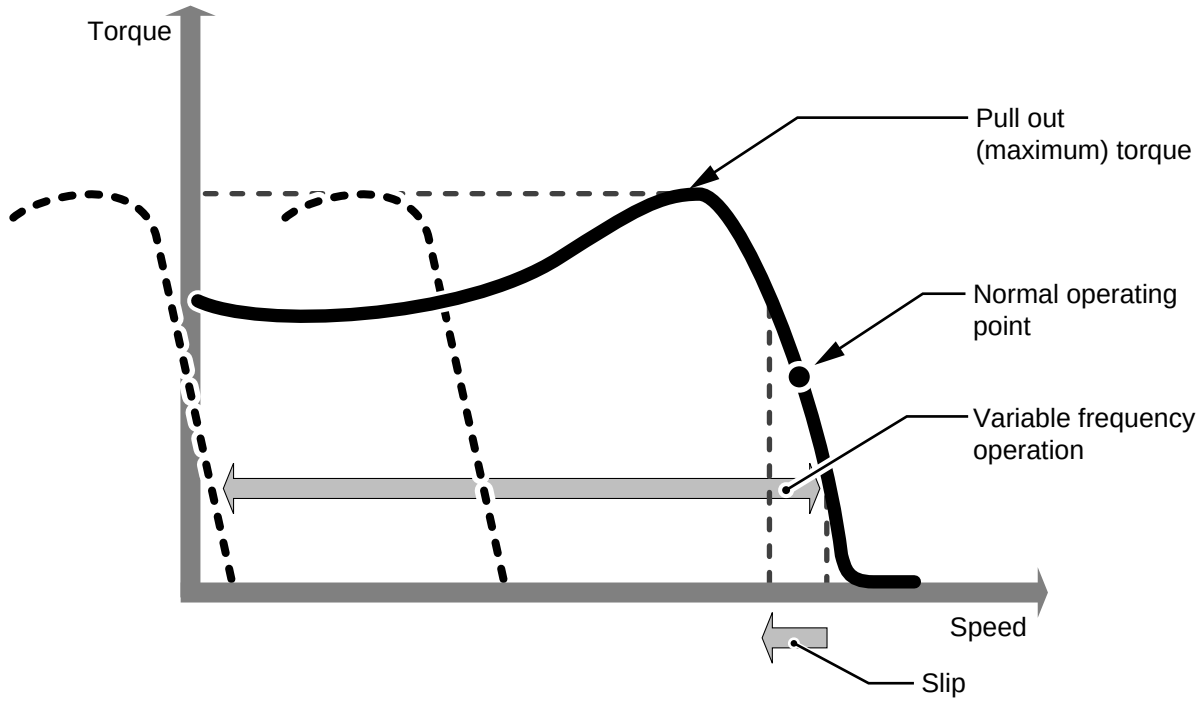
Simplified Induction Motor - Cross Section

This field crosses the air gap between the stator and rotor and causes currents to flow in the rotor windings. This produces a force (torque) on the rotor as the current interacts with the changing magnetic field, and the rotor turns.

If the windings are arranged in several pairs (or poles), the frequency of the rotating field will be less than the applied frequency (e.g. two pole = 50/60Hz = 3000/3600 rpm, but four pole = 50/60Hz = 1500/1800 rpm).

However, if the rotor runs at the same speed as the rotating field, there will be no changing magnetic field, and therefore no torque.

Since rotor currents must be induced in order to create output torque, the rotor always runs a little slower than the rotating field. This difference in speed is known as slip and is generally about 3%.



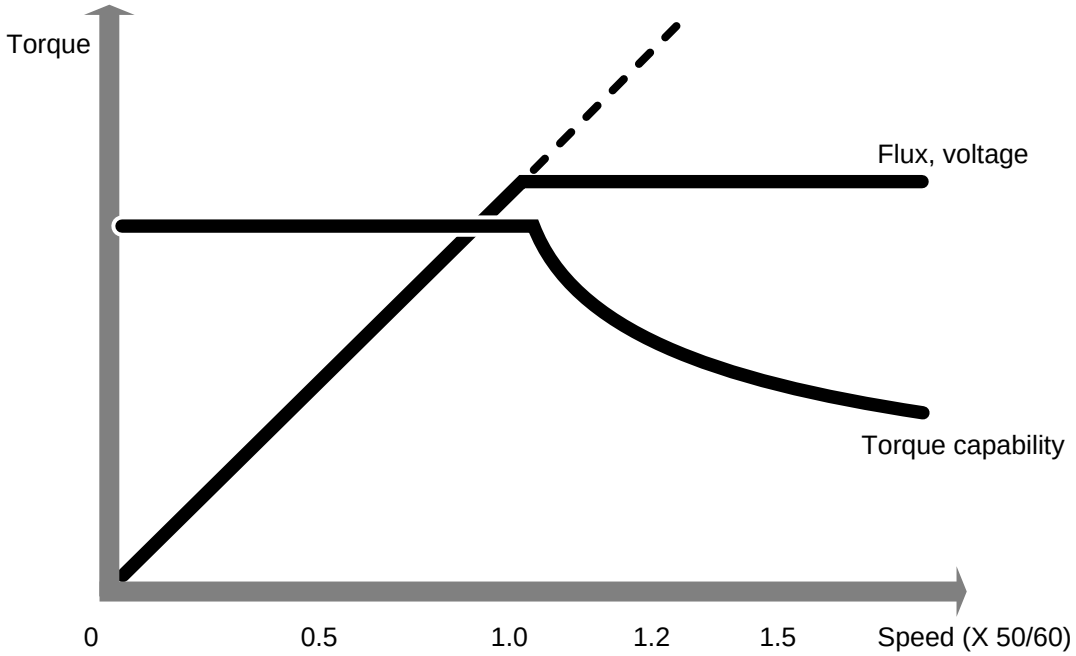
Torque Speed Characteristic of An Induction Motor

The speed of the motor depends on the applied frequency, as well as the winding arrangement, and to some extent on the load.

Therefore in order to control the motor speed it is necessary to control the frequency of the supply.

If the frequency is reduced, the voltage must be reduced, or the stator current and magnetic flux will be too high and the motor's magnetic field will saturate. Hence the voltage must be controlled as well.

If the frequency is increased above normal, more voltage would normally be needed to maintain maximum flux; this is not usually possible, so less torque is available at high speed, (i.e. speeds above the supply frequency).



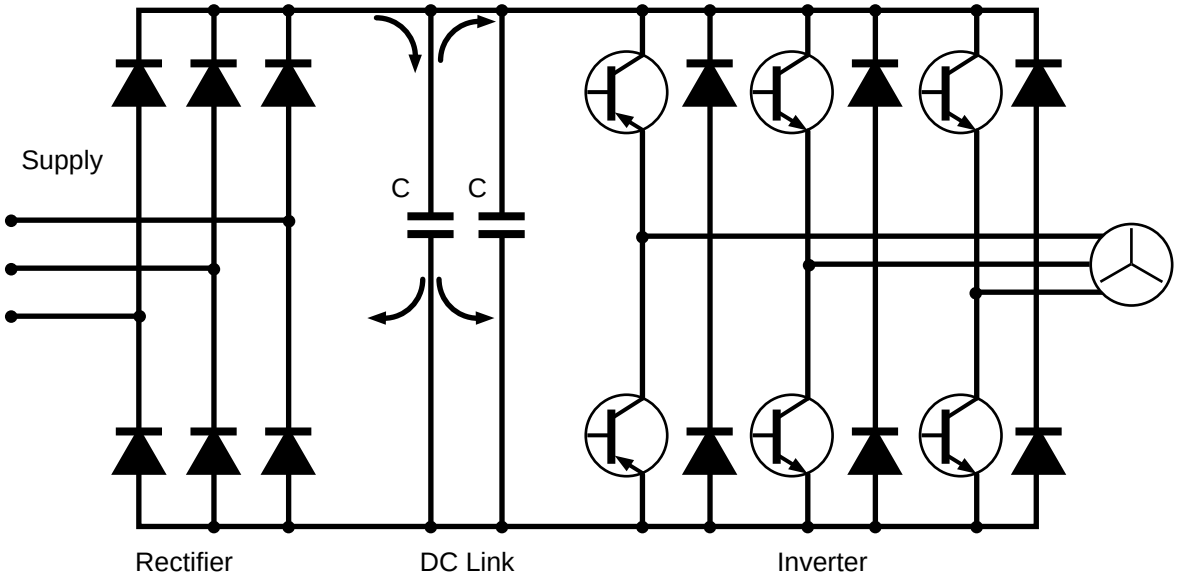
Torque Reduction above Base Speed

Therefore in order to control the speed of a standard AC motor, the applied frequency and voltage must be controlled.

The use of a standard induction motor together with a variable frequency speed controller allows a cost effective speed control system to be built.

VARIABLE FREQUENCY INVERTER.

An electronic converter which converts Direct Current (DC) to Alternating Current (AC) is known as an inverter. Electronic speed controllers for AC motors usually convert the AC supply to DC using a rectifier, and then convert it back to a variable frequency, variable voltage AC supply using an inverter bridge. The connection between the rectifier and inverter is called the DC link. The block diagram of a speed controller (often called an inverter) is shown below:



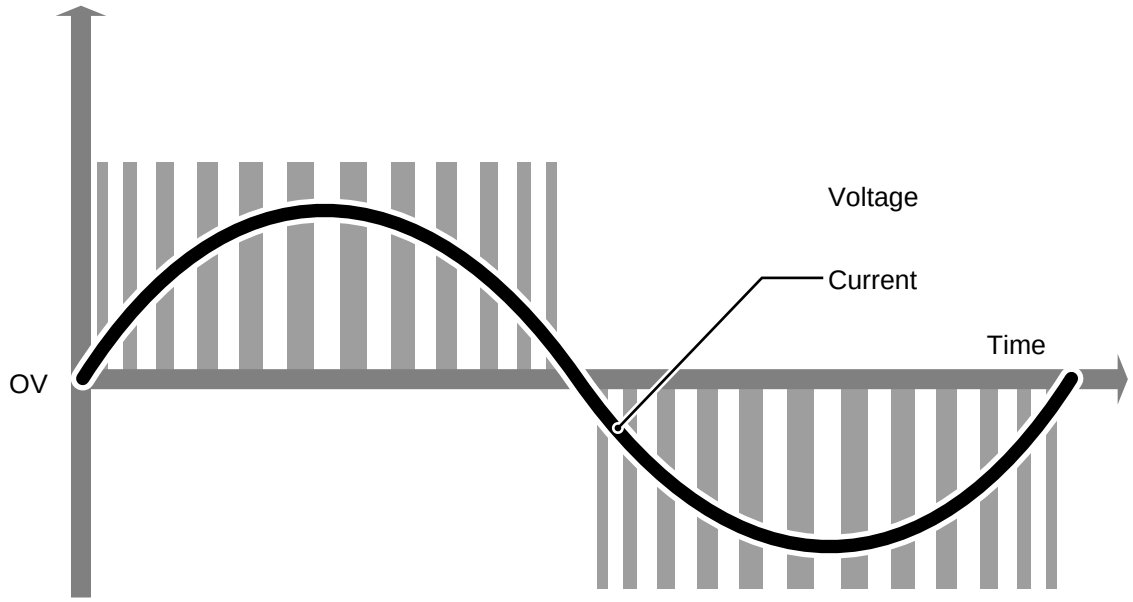
Inverter Block Diagram

The three phase supply is fed into a full wave rectifier which supplies the DC link capacitors. The capacitors reduce the voltage ripple (especially on single phase supplies) and supply energy for short mains breaks. The voltage on the capacitors is uncontrolled and depends on the peak AC supply voltage.

MICROMASTER Eco & MIDIMASTER Eco inverters are available as three phase.

The DC voltage is converted back to AC using Pulse Width Modulation (PWM). The desired waveform is built up by switching the output transistors (Insulated Gate Bipolar Transistors; IGBTs) on and off at a fixed frequency (the switching frequency). By varying the on and off time of the IGBTs the desired current can be generated. The output voltage is still a series of square wave pulses and the inductance of the motor windings results in a sinusoidal motor current. Pulse Width Modulation is shown in the figure below.

DIAGRAM AND TEST RESULTS



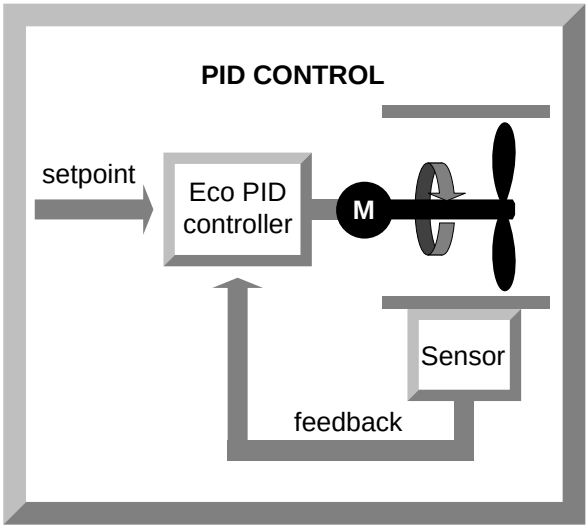
Pulse Width Modulation

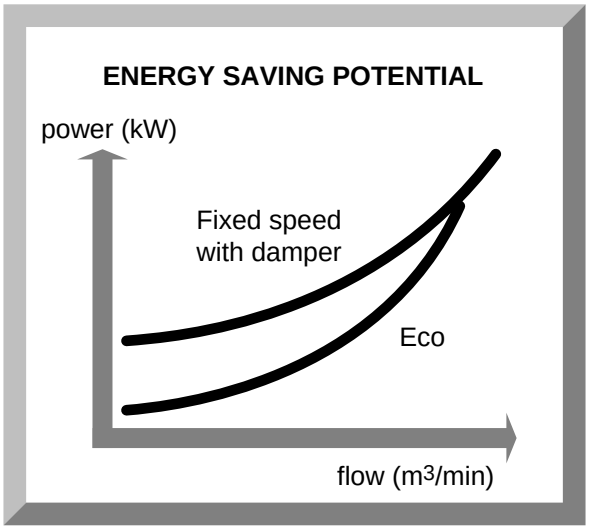
4. ADVANTAGES OF THE ECO

ENERGY SAVINGS

The Eco range provides considerable potential for energy saving in the following areas:

- Air flow requirements are matched precisely to demand.
- Optimum system regulation means less energy/power is required.
- The requirement for changing clean air filters is reduced.





CONTROL & REGULATION

The Eco range enables the following improvements to system control and regulation.

- Finer control of system functions as the Eco accurately follows set points.
- Closed loop process control using a standard Proportional, Integral, Derivative (PID) control loop function.
- Reduced overshoot of pre-set parameters, provides optimised levels of comfort.
- Automatic compensation for system fluctuations - partially blocked filters.

PID - INTERNAL

Closed loop process control using a standard Proportional, Integral, Derivative (PID) control loop function. 15 V, 50 mA supply provided for feedback transducer

NOISE

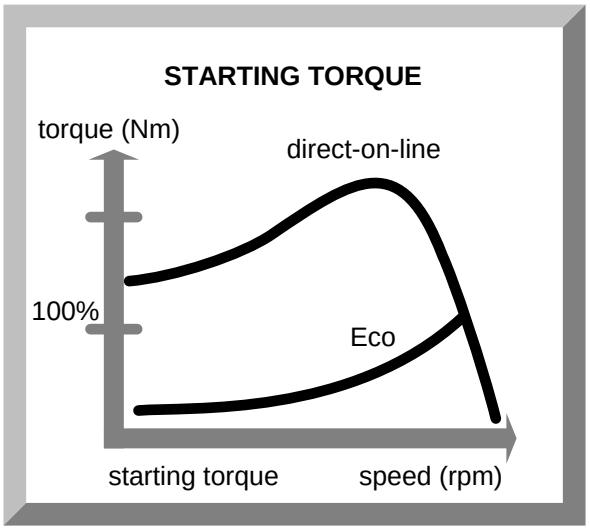
Noise reductions can be achieved by reduction in:

- Motor and fan rpm.
- Air flow velocity
- Balance dampers are set in a more open position.
- Periodic on/off actions create a higher and more irritating noise level than continuous running

WEAR & TEAR

Eco inverters can make possible greatly reduced maintenance and running costs:

- Fewer stop/start sequences means that mechanical stresses are reduced.
- Equipment life is extended, and a smaller number of components require reduced degree of maintenance
- Reduced airflow means reduced cleaning.
- Reduction in replacement of maintenance consumables such as fan belts, motor bearings and fan bearings.



EQUIPMENT RATIONALISATION

Using Eco inverters can significantly reduce the number of system components and often enable valuable space to become available:

- Mechanical components which may be eliminated include dampers, actuators, (and outstations by using serial communication).
- Reductions in the use of electrical contactors, control and overload relays, terminals and PID modules can be achieved. Also, control panel complexity is reduced, as is wiring and labour costs.

OUTSTATION CAPABILITY WITH RS485 SERIAL COMMUNICATION

Remote control capability via RS485 serial link using the USS protocol with the ability to control up to 31 inverters via the USS protocol.

5. TECHNICAL OVERVIEW & SUMMARY TABLE

The MICROMASTER Eco and MIDIMASTER Eco inverters are intended for use anywhere in the world and therefore support a wide range of mains voltages:

3 phase 208 - 240V±10%

3 phase 380 - 500V±10%

3 phase 525 - 575V±15% (MIDIMASTER Eco only)

STANDARD FEATURES

- Easy to install program and commission.
- Fast Current Limit (FCL) for reliable trip-free operation.
- to 50°C temperature range (0 to 40°C for MIDIMASTER Eco).
- Factory default parameter settings pre-programmed for European, Asian, and North American requirements.
- Output frequency (and hence motor speed) can be controlled by:
  1. frequency setpoint using the keypad
  2. High resolution analogue setpoint (voltage or current input)
  3. External potentiometer to control motor speed
  4. 8 fixed frequencies via binary inputs
  5. Motorised potentiometer function (raise and lower speed pushbuttons)
  6. Serial RS485 interface
- Acceleration/deceleration times.
- Two fully-programmable relay outputs (13 functions).
- Fully-programmable analogue outputs (1 for MICROMASTER Eco, 2 for MIDIMASTER Eco).
- External options connector for optional multi-language Clear Text Display (OPe).
- Dual Motor-parameter sets available if Clear Text Display option (OPe) is fitted.
- Integral software controlled cooling fan.
- Side by side mounting without additional clearance. (IP20/21 models).
- Optional protection to IP56 (NEMA 4/2) for MIDIMASTER Eco inverters.
- Standard open loop quadratic V/F Control, ideal for simple applications such as pumps and fans.
- Range of drives benefits from the standard inclusion of a PID controller for closed loop system regulation.
- All products make use of the same, simple to use, standard user interface consisting of push buttons and LED display.
- User-friendly screwless terminals used for control connections. (MICROMASTER Eco only)
- RS485 serial interface is standard, allowing up to 31 drives to be networked to a PLC or Building Management System (BMS).
- Drive can be enabled via keypad, via digital inputs or via standard RS485 serial interface.
- Motor speed set-point can be selected, using a digital set-point, motorised potentiometer, fixed frequency, analogue input or via the RS485 serial link.
- Mixed mode control is also available, allowing drive control and setpoint input to be from different sources.
- Drives can be configured to start automatically following a mains break or after a fault.
- Parameter sets are fully compatible between different product types, reducing learning time.
- All drives are certified in accordance with VDE, UL and Canadian UL, and are manufactured to ISO9001.
- All drives conform to the requirements of the EC low voltage directive 73/23/EEC and have been awarded the CE mark.

TECHNICAL FEATURES

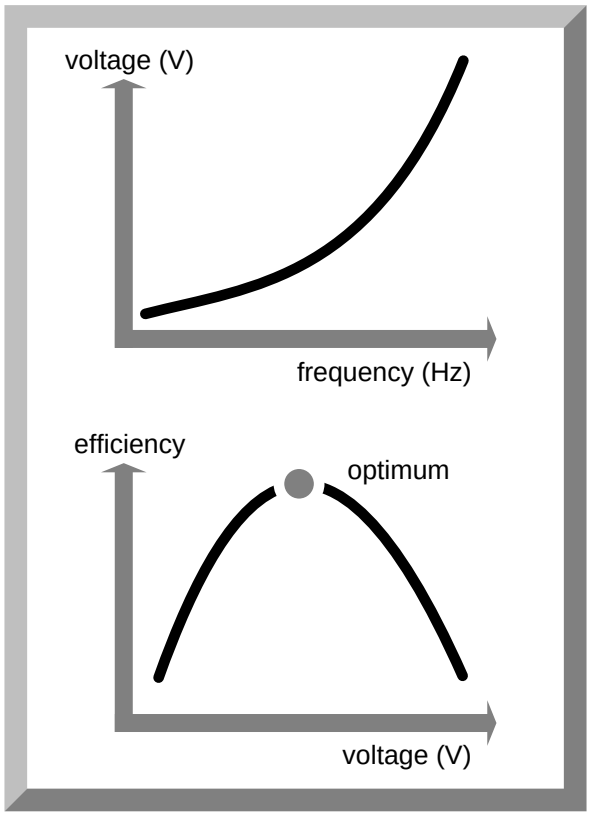
Inverter	MICROMASTER Eco	MIDIMASTER Eco
Input Vol tage	3 AC 208 - 240V±10% 3 AC 380 - 500V±10%	3 AC 208 - 240V±10% 3 AC 380V - 500V±10% 3 AC 525V - 575V±15%
Power Ranges 3 AC 208-240V 3 AC 380-500V 3 AC 525-575V	 1.1kW - 4.0kW 1.1kW - 7.5kW -	 5.5kW - 45kW (1.1kW - 45kW) IP56 11kW - 90kW (3kW - 90kW) IP56 4kW - 45kW (4kW - 45kW) IP56
Protection Level	IP20/NEMA1	IP21/NEMA1 or IP56 / NEMA 4/12 or IP20 /NEMA1 with integrated Class A EMC filter
EMC conformance EN55011 Class A 3 AC 208-240V 3 AC 380-460V 3 AC 525-575V	 Footprint Filter Footprint Filter not available	 Integrated or external Filter Integrated or external Filter not available
EMC conformance EN55011 Class B 3 AC 208-240V 3 AC 380-460V 3 AC 525-575V	 Footprint Filter Footprint Filter not available	 External Filter External Filter not available
Temperature Range	0 - 50^{0}C	0 - 40^{0}C See Section 14 for derating at higher temperatures
Control Method	Energy Control Optimisation (Eco) Mode or Multi-motor Mode.	
Protection Features	Undervoltage, Overvoltage, Overload, Short-Circuit, Earth Fault, Motor Pull-out, Motor Overtemperature, Drive Overtemperature	
Maximum Motor Cable Length	See section 14	See Section 14
Overload Capability	150% for 60 sec	110% for 60 sec
Digital Inputs	6 configurable	6 configurable
Fixed Frequencies	8	8
Relay Outputs	2 configurable (230V AC/1.0A)	2 configurable (230V AC/1.0A)
Analogue Inputs	2	2
Analogue Outputs	1 configurable	2 configurable
Serial Interface	RS485	
Dynamic Braking	Compound Braking DC Injection Braking	Compound Braking /DC Injection Braking
Process Control	PID	PID

6. ENERGY SAVING PROGRAM

ENERGY CONTROL OPTIMIZATION (P077)

This feature provides :

- “Energy Control Optimization” (Eco)
- Automatically increases and decreases motor voltage in order to search for the minimum power consumption
- Operates when the setpoint speed is reached
- Factory default setting



The Eco starts to analyse the power consumption of the motor as soon as the motor has reached setpoint speed (i.e. when acceleration is complete).

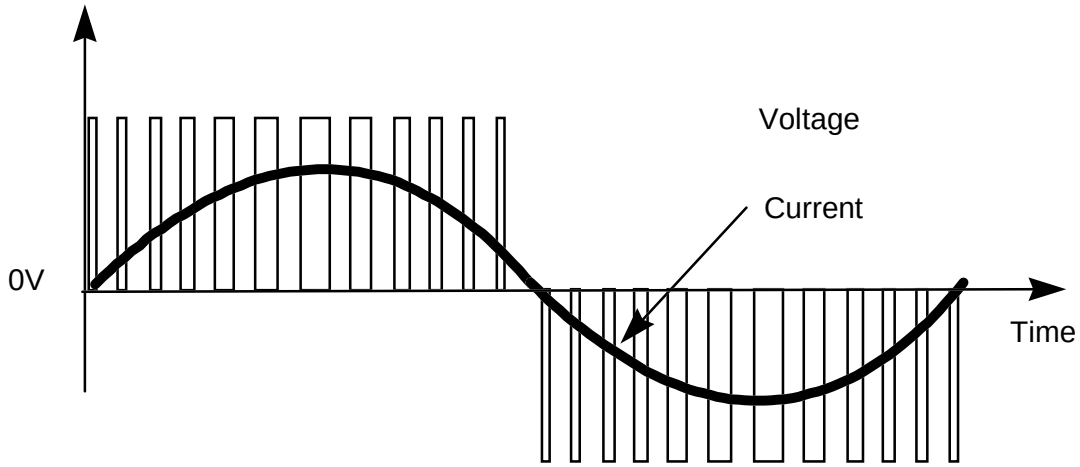
It then begins to search for the optimum efficiency (lowest power consumption) by slightly lowering or raising the output voltage to the motor.

For example, if the Eco detects that the power consumption is increasing as it is increasing the voltage to the motor, then the control strategy will begin to decrease the output motor voltage in search of the lowest power consumption level. The converse of this will also apply, again to automatically determine the lowest power consumption level.

The Control Mode (P077=4) is set to Energy Control Optimisation as the factory default.

The amount of additional energy saved using this optimisation technique can vary considerably and is dependent on motor loading, motor type and duty cycle. Typical additional savings can be between 2% and 5%.

7. PULSE WIDTH MODULATION (PWD) OUTPUT METHOD



Pulse Width Modulation

SWITCHING FREQUENCY FOR LOW MOTOR NOISE

- PWM (pulse width modulation) switching frequency adjustable from 2kHz to 16kHz
- 16kHz above audible frequency
- The pulse width modulation (PWM) switching frequency used is proportional to the heating and energy losses within the inverter. The higher the switching frequency the greater is the amount of heat produced by the inverter output devices (IGBTs). An overtemperature trip can result if the inverter is operating close to its maximum rated temperature and is fully loaded.
- The Eco unit automatically optimizes switching frequency whenever possible for motor noise reduction
- Lowers switching frequency if heat sink temperature exceeds limits
- Once heat sink temperature returns to normal, switching frequency returns to setting

Larger MIDIMASTER Eco units may be restricted from operating above 4kHz. Refer to parameter P076 which shows output current restrictions associated with switching frequency.

8. Eco SELECTION CRITERIA - SIZE, TYPE ETC.

Generally, drive selection is straightforward, as the motor rating is already known and the speed range requirements are either pre-determined, or easily identified and accomplished. However, when a drive system is selected from first principles, careful consideration may avoid problems in installation and operation, and may also generate significant cost savings.

OVERALL CONSIDERATIONS

- Make sure that the Current rating of the inverter is compatible with the name plate current rating of motor - power rating can be used as a rough guide.
- Check that you have selected the correct operating voltage and that the motor terminals are configured correctly.
- Make sure that the speed range you require is attainable. Operation above normal supply frequency (50 or 60Hz) is usually only possible at reduced power. Operation at low frequency and high torque (not normally a characteristic of fans and pumps) can cause the motor to overheat unless provision is made for additional cooling.
- Do you need to operate with cables longer than 100m, or screened or armoured cables longer than 50m ?. If so, it may be necessary to de-rate the inverter, or fit a choke to compensate for the cable capacitance. See section 14 for motor cable length details.
- The Eco is only intended for use with centrifugal pumps and fans see p 8-8 for further information.

SUPPLY SIDE REQUIREMENTS

To achieve maximum reliability and optimum performance, the main power supply to the inverter system must be suited to the inverter. The following points should be considered:

SUPPLY TOLERANCE

The inverters are designed to operate on a wide range of supply voltages as follows:

208 - 240 V +/- 10% i.e. 187-264V
380 - 500 V +/- 10% i.e. 342-550V
525 - 575 V +/- 15% i.e. 472-633V

Inverters will operate over a supply frequency of 47 - 63 Hz

Many supplies vary outside these levels. For example:

- Supply voltages at the end of long power lines in remote areas can rise excessively in the evening and weekends when large loads are no longer present.
- Industries with locally controlled and generated supplies can have poor voltage regulation and control.
- Power systems in certain parts of the world may not meet the inverter input voltage tolerances.

In all installations, check that the supply will remain within the voltage tolerances stated above. Operation outside of the stated supply levels may cause damage and give unreliable operation.

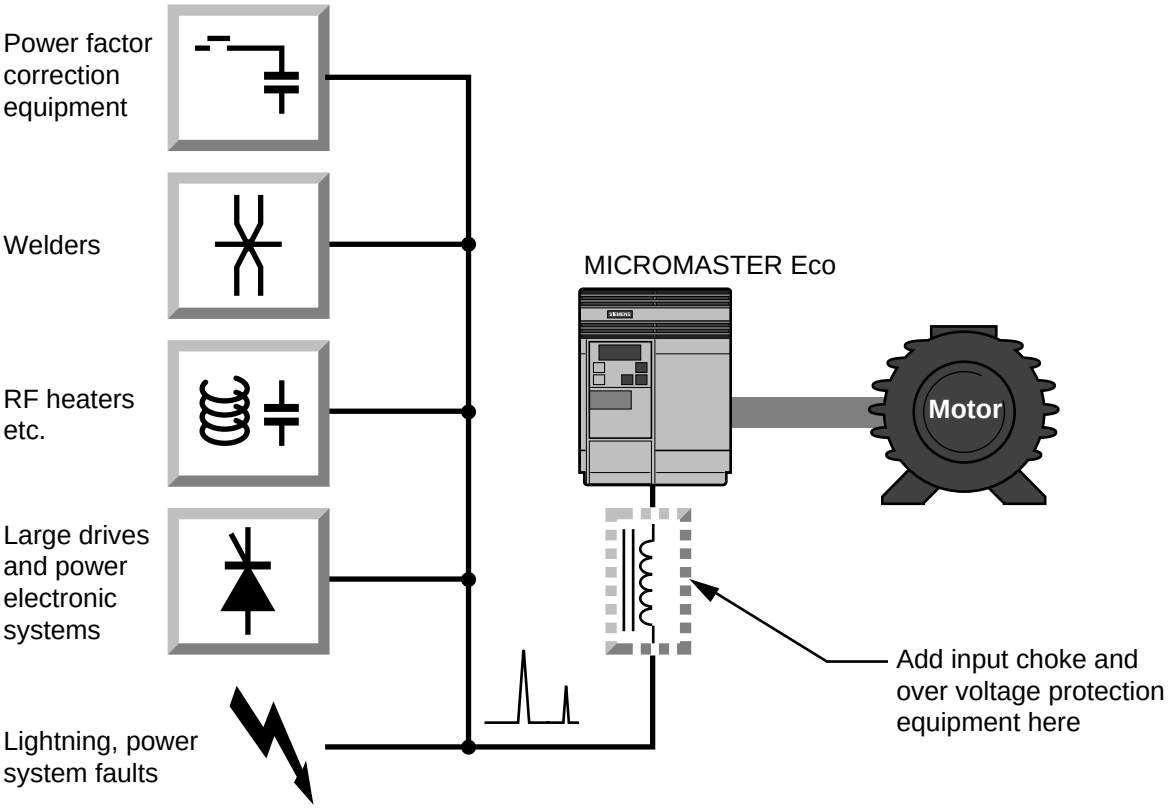
SUPPLY DISTURBANCE

Many supplies are well controlled and remain in tolerance, but are affected by local disturbances. These can cause faulty operation and damage to inverters. In particular, check for:

- Power Factor Correction equipment. Unsuppressed switching of capacitor banks can produce very large voltage transients and is a common cause of inverter damage.
- High power welding equipment, especially resistance and RF welders.
- Other drives, semiconductor heater controllers etc.

The inverter is designed to absorb a high level of supply disturbance - for instance, voltage spikes up to 2kV. However, the above equipment can cause power supply disturbances in excess of this. It will be necessary to suppress this interference - preferably at source - or at least by the installation of an input choke in the inverter supply. EMC filters do not suppress disturbances with this level of energy. Over-voltage protection products such as metal oxide varistors should also be considered in extreme cases.

Damage can also be caused by local supply faults and the effects of electrical storms. In areas where these are expected, similar precautions are recommended.



UNGROUNDED SUPPLIES

Certain installations need to operate with supplies that are isolated from the protective earth (IT supply). This permits equipment to continue to run following a line to earth fault. However, MICROMASTER Eco and MIDIMASTER Eco are designed to normally operate on grounded supplies and are fitted with interference suppression capacitors between the supply and ground. Hence operation on ungrounded supplies should be restricted. Please consult Siemens for clarification.

LOW FREQUENCY HARMONICS

The inverter converts the AC supply to DC using an uncontrolled diode rectifier bridge. The DC link voltage is close to the peak AC supply voltage, so the diodes only conduct for a short time at the peak of the AC waveform.

The current waveform therefore has a relatively high RMS value as a high current flows from the supply for a short time.

For typical harmonic details, refer to Section 15.

MICROMASTER Eco

MICROMASTER can be used on unearthed supplies if connected through an isolating transformer.

Alternatively they may also be connected directly to the unearthed supply, but the inverter may then shut down (F002) if an output earth fault develops.

MIDIMASTER Eco

The 380/500V models are suitable for use on unearthed supplies at a maximum switching frequency of 2kHz (P076 = 6 or 7). This is to prevent the input Y capacitors from overheating in the event of an earth fault on the Eco output.

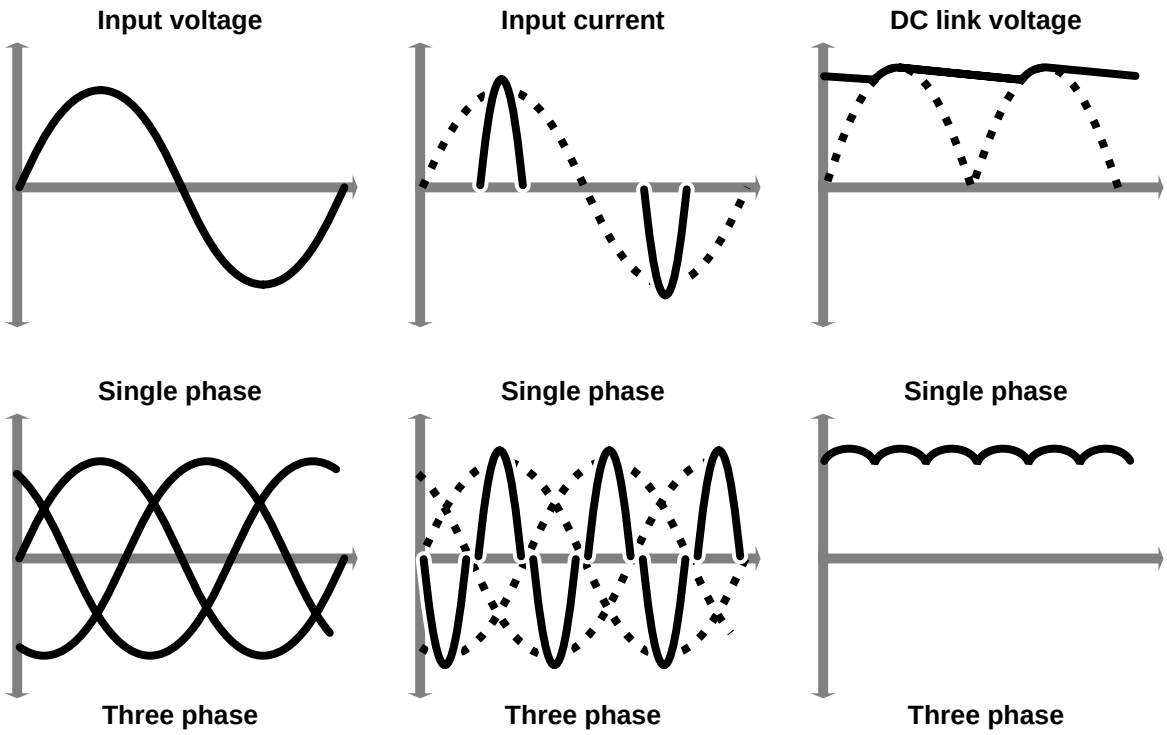
The MIDIMASTER Eco will continue to operate normally under earth fault conditions at the MIDIMASTER Eco input.

Earth fault monitoring on the input supply, capable of detecting an earth fault on the motor output, is recommended.

EMC FILTER RESTRICTIONS FOR ALL PRODUCTS

The input RFI suppression filters **cannot** be used since they are designed for earthed supplies. Many unearthed supplies are only intended for industrial users (particularly 500V ones), and EN61800-3 does not impose any emissions limits in such applications. Therefore a filter may not be required in any case.

The EMC tests have been carried out according to EN61800-3 on earthed supplies. The test results will not be valid for unearthed supplies.


Input voltage
Input current
DC link voltage
Single phase
Single phase
Single phase
Three phase
Three phase
Three phase

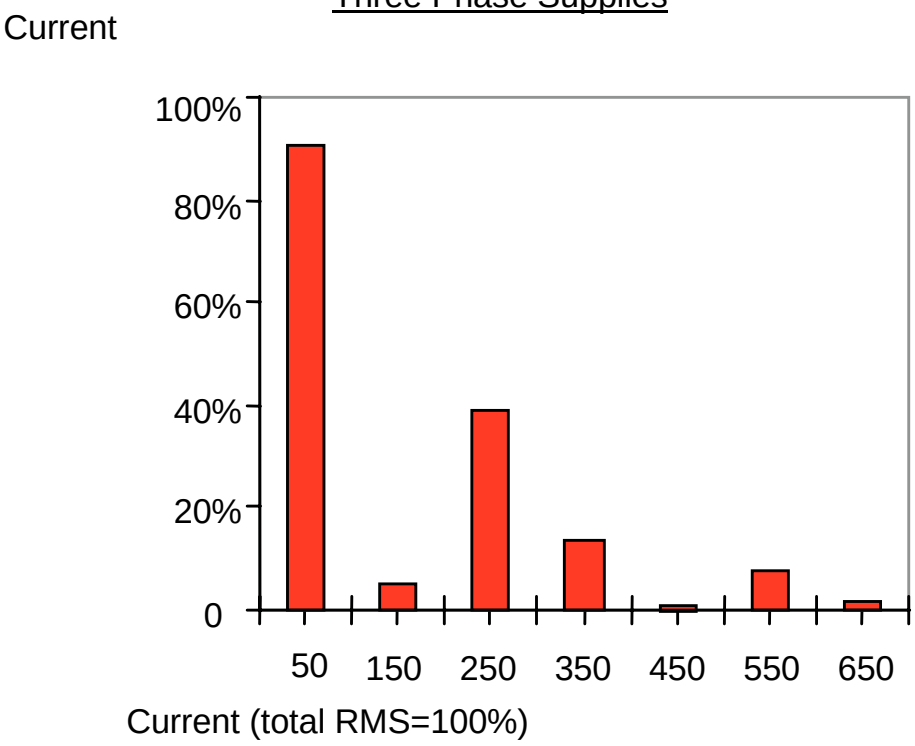
This means that the input current waveform consists of a series of low frequency harmonics, and this may in turn cause voltage harmonic distortion, depending on the supply impedance.

Sometimes these harmonics need to be assessed in order to ensure that certain levels are not exceeded. Excessive harmonic levels can cause high losses in transformers, and may interfere with other equipment. In any case, the rating and selection of cabling and protection equipment must take into account these high RMS levels. Some typical measured harmonic levels are shown below.

In order to calculate the harmonics in a particular supply system it is essential that the supply impedance is known. This is usually stated in terms of fault current levels, transformer size, and installed impedance such as line inductors etc. The addition of input line chokes reduces the level of harmonic currents and also reduces the overall RMS current as well as improving the overall power factor.

Where supplies have very low impedance (such as below 1%) an input inductor is recommended in any case to limit peak currents in the drive.

Three Phase Supplies



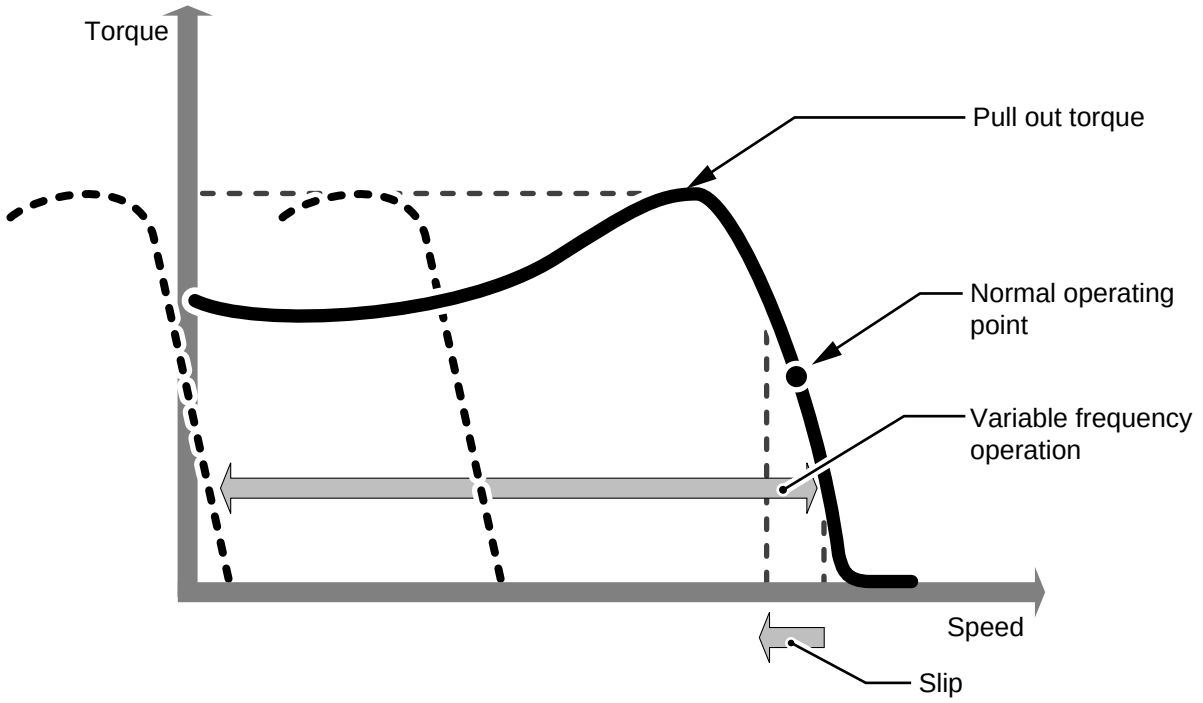
Typical Harmonic content - Measured Results (50Hz supply)

MOTOR LIMITATIONS

The motor speed is determined mainly by the applied frequency. The motor slows down a little as the load increases and the slip increases. If the load is too great the motor will exceed the maximum torque and stall or 'pull out'.

The standard induction motor is cooled by a built in fan connected directly to the shaft that runs at motor speed. This is designed to cool the motor at full load and name plate rated speed. If a motor runs at a lower frequency and at full torque - that is high current not normally an operating condition of pumps and fans - motor cooling may be inadequate. Motor manufacturers generally give the necessary de-rating information, but a typical de-rating curve would limit output torque at zero frequency rising to full output torque capability at 50% of nameplate rated speed (see diagram). Ensure that these limitations are not exceeded for long term operation.

Use the I^2t function to help protect the motor (See P074 in parameter descriptions) or consider using a motor with built in thermal protection such as a thermistor (PTC).

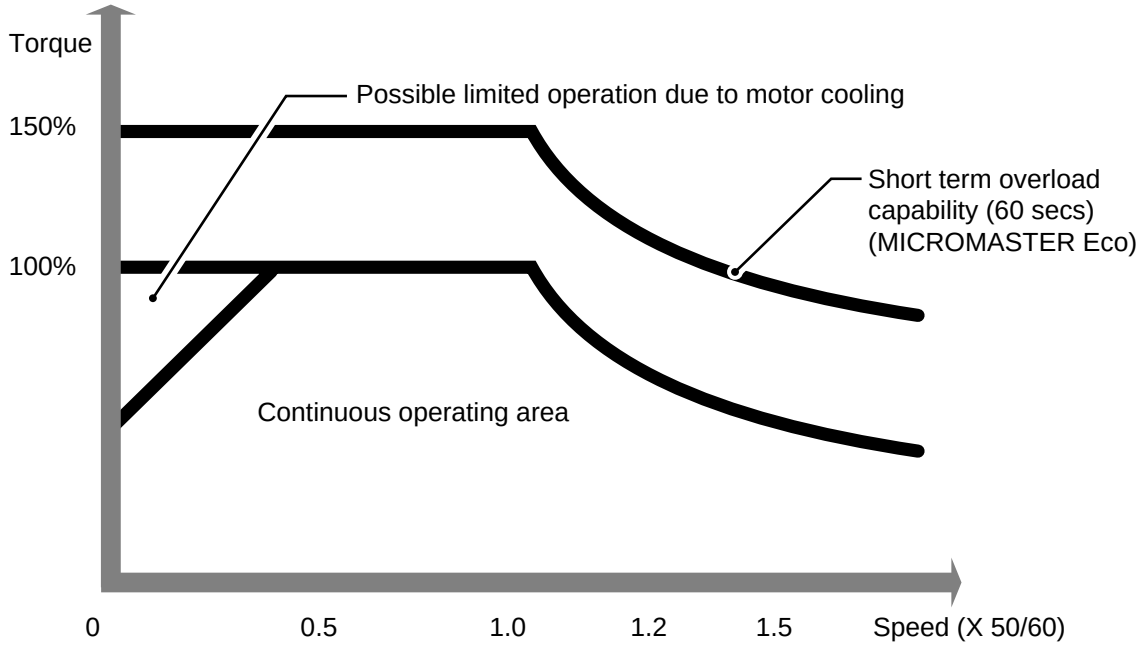


High speed operation of standard motors is usually limited to twice the normal operating speed (i.e. up to 6000 or 7200 rpm) of a two pole motor because of bearing limitations. However, because the motor magnetic flux level will reduce above base speed (because the output voltage is limited to approximately the input voltage) the maximum torque will also fall in inverse proportion to the speed above base speed.

It is not usually possible to operate a fan or pump motor over its base speed since the torque (current) requirement will increase proportionally to the square of the speed.

However, if a motor is connected as a low voltage motor (delta connected motor windings) and operated on a higher voltage inverter, full torque may be obtained up to 1.7 times base frequency if the inverter is correctly set up. Obtain the correct voltage/frequency curve by setting the motor parameters as follows:

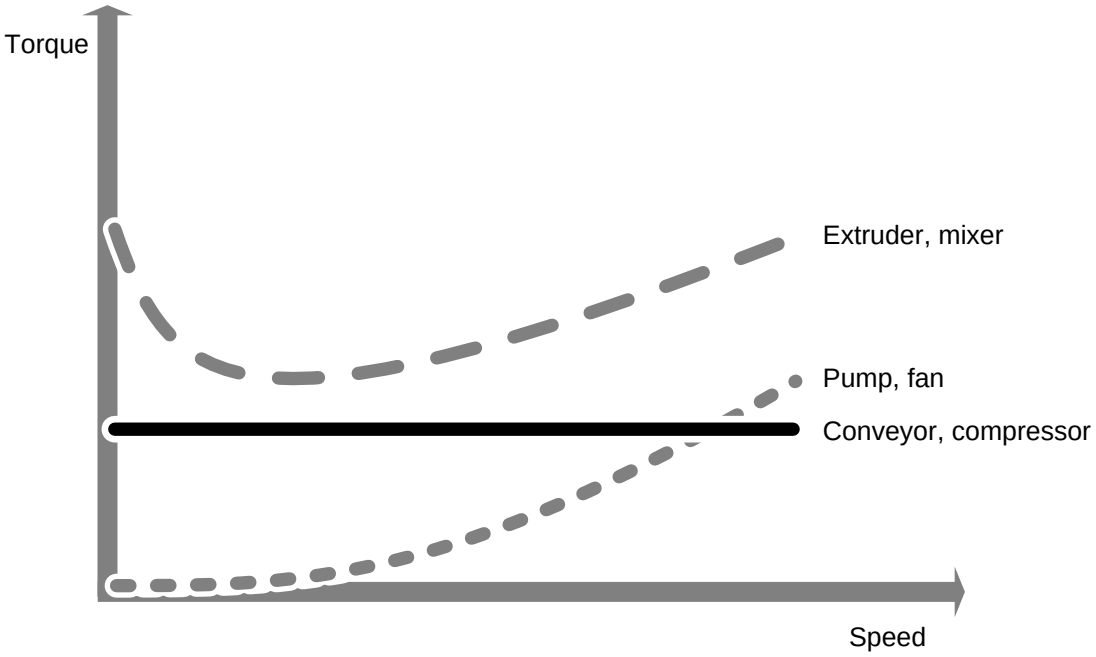
P081= 87
P084= 400 Hz (or to suit supply)



LOAD CONSIDERATIONS

The inverter and motor requirements are determined by the speed range and torque requirements of the load. The relationship between Speed and Torque is different for different loads. Many loads can be considered to be Constant Torque loads. That is, the torque remains the same over the operating speed range. Typical constant torque loads are compressors, positive displacement pumps and conveyors.

These constant torque loads are generally not suited to the MICROMASTER Eco since it is rated only for variable torque loads such as pumps and fans.



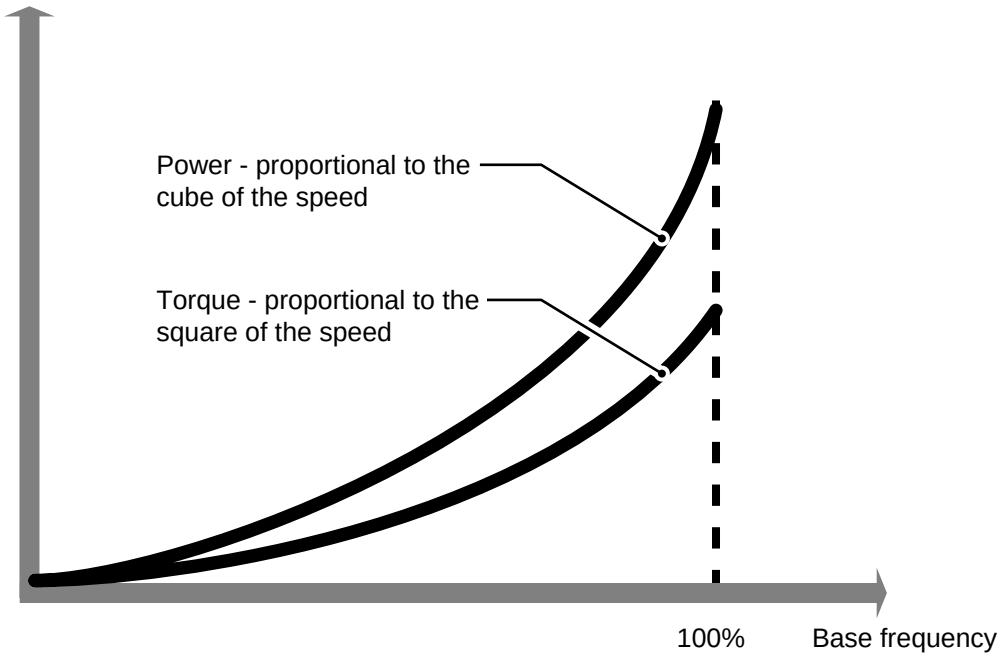
VARIABLE TORQUE APPLICATIONS

Some loads have a Variable Torque characteristic, that is, the torque increases with the speed. Typical variable torque loads are centrifugal pumps and fans. In these applications the load is proportional to the square of the speed, and therefore the power is proportional to the cube of the speed. This means that at reduced speeds there is a great reduction in power and therefore energy saving - a major advantage of variable speed drives applied to pumps and fans. For example, a 10% reduction in speed will give a theoretical 35% reduction on power!

Because the power is greatly reduced, the voltage applied to the motor can also be reduced and additional energy saving achieved. A 'quadratic' or 'pump and fan' voltage to frequency relationship is a factory default within the MICROMASTER Eco and MIDIMASTER Eco.

It is not generally useful to run pumps or fans above base speed as the power will rise excessively and the fan or pump may become inefficient or damaged.

MIDIMASTER Eco are therefore variable torque rated for pump and fan operation can give an additional capital cost saving in these applications.



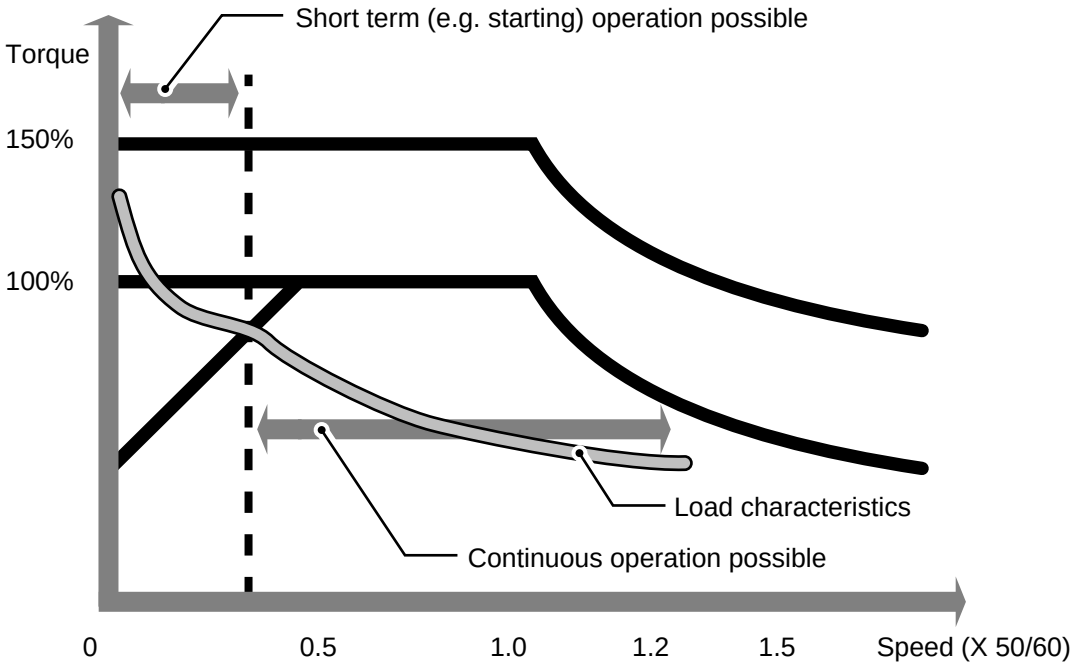
OTHER LOADS

Many other loads have non linear or varying torque relationships. The torque requirement of the load should be understood before the inverter and motor is selected.

By comparing the load/speed requirement with the motor capability, the correct motor can be selected. Remember a different pole pair arrangement (nameplate rated speed) may give a better match to the load needs.

Starting torque may need special consideration. If a high starting torque is required this must be considered during rating.

This type of starting duty is generally not characteristic of fan and pump applications.



ENVIRONMENTAL CONSIDERATIONS

The inverter is designed for operation in an HVAC environment. However there are certain limitations which must be considered; the following check list should help:

- Check that the airflow through the inverter will not be blocked by wiring etc. Ensure adequate clearance between cable trunking and the top and bottom ventilation ducts of the inverter.
- Make sure the temperature of the air does not exceed 50°C MICROMASTER Eco or 40°C MIDIMASTER Eco. Remember to allow for any temperature rise inside the enclosure or cubicle.
- The inverters are available with protection levels of IP20 (MICROMASTER Eco), IP21 or IP56 (MIDIMASTER Eco).
  IP20 and IP21 units need additional protection against dust , dirt, and water.
- The inverter is designed for fixed installation and is not designed to withstand excessive shock and vibration.
- The inverter will be damaged by corrosive atmospheres.
- Protect the unit from dust; dust can build up inside the unit, damage the fans, and prevent proper cooling. Conductive dust, such as metal dust, will damage the unit.
- Give due consideration to Electromagnetic Compatibility (EMC), such as:

  1. The inverter should be protected from the effects of equipment such as Power Factor Correction equipment, Resistance Welding Equipment etc.
  2. The inverter should be well grounded.
  3. How will the inverter and any control equipment (contactors, PLCs, relays sensors etc.) interact? Contactor coils should be suppressed using an R-C module. BMS units actuators and sensors should be well earthed.

IP Protection

The IP number defines the level of Ingress Protection (IP) for the particular inverter.

MICROMASTER Eco models have an IP rating of IP20 (US equivalent NEMA 1).

MIDIMASTER Eco models have an IP rating of IP21 (US equivalent NEMA 1) or IP56 (US equivalent NEMA 4/12).

Table 4 explains what the numbers in the IP rating mean in terms of ingress protection:

First Number IP**X**XX	Second Number IPX**X**X	Third Number (not quoted) IPXX**X**
0 No protection	**0** No protection	**0** No protection
1 Protected against solid objects of 50mm or bigger	**1** Protected against water falling vertically	**1** Protected against 0.225J impact
2 Protected against solid objects of 12mm or bigger	**2** Protected against direct sprays up to 15 deg. From vertical	**2** Protected against 0.375J impact
3 Protected against solid objects of 2.5mm or bigger	**3** Protected against direct sprays up to 60 deg. From vertical	**3** Protected against 0.5J impact
4 Protected against solid objects of 1mm or bigger	**4** Protected against sprays from all directions	**5** Protected against 2.0J impact
5 Protected against dust (limited ingress)	**5** Protected against low pressure jets from all directions	**7** Protected against 6.0J impact
6 Protected against dust (totally)	**6** Protected against high pressure jets from all directions	**9** Protected against 20.0J impact
	7 Protected against immersion between 15cm and 1m	
	8 Protected against immersion under pressure	

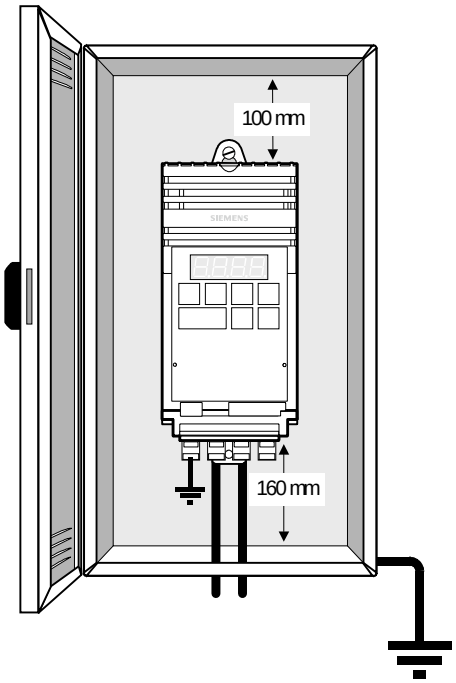
9. MECHANICAL INSTALLATION

MICROMASTER Eco and MIDIMASTER Eco inverters are available in the following models, with corresponding frame sizes and power rating as indicated; Frame sizes A, B & C refer to the dimensions of the MICROMASTER Eco units and frame sizes 4, 5, 6, &, 7 refer to the dimensions of the MIDIMASTER Eco units.

HVAC Inverter Model / type	Voltage rating	Frame Size	Motor ratings	
			P(kW)	P(Hp)
ECO1-110/2	208-240V +/-10V	B	1.1	1.5
ECO1-150/2		B	1.5	2
ECO1-220/2		C	2.2	3
ECO1-300/2		C	3	4
ECO1-400/2		C	4	5
ECO1-550/2		4	5.5	7.5
ECO1-750/2		4	7.5	10
ECO1-1100/2		5	11	15
ECO1-1500/2		6	15	20
ECO1-1850/2		6	18.5	25
ECO1-2200/2		6	22	30
ECO1-3000/2		7	30	40
ECO1-3700/2		7	37	50
ECO1-4500/2		7	45	60
ECO1-110/3	380-500V +/-10V	A	1.1	1.5
ECO1-150/3		A	1.5	2
ECO1-220/3		B	2.2	3
ECO1-300/3		B	3	4
ECO1-400/3		C	4	5
ECO1-550/3		C	5.5	7.5
ECO1-750/3		C	7.5	10
ECO1-1100/3		4	11	15
ECO1-1500/3		4	15	20
ECO1-1850/3		5	18.5	25
ECO1-2200/3		5	22	30
ECO1-3000/3		6	30	40
ECO1-3700/3		6	37	50
ECO1-4500/3		6	45	60
ECO1-5500/3		7	55	75
ECO1-7500/3		7	75	100
ECO1-9000/3		7	90	125
ECO1-400/4	525-575V +/-15V	4	4	5
ECO1-550/4		4	5.5	7.5
ECO1-750/4		4	7.5	10
ECO1-1100/4		4	11	15
ECO1-1500/4		4	15	20
ECO1-1850/4		5	18.5	25
ECO1-2200/4		5	22	30
ECO1-3000/4		6	30	40
ECO1-3700/4		6	37	50
ECO1-4500/4		6	45	60

The unit must be secured to a suitable, non-combustible, vertical surface (a load bearing wall for the heavier MIDIMASTER Eco range). Depending on frame size, use nuts, bolts and washers as shown in the following table:

Frame size	A	B	C	4	5	6	7
Bolt size	M4	M4	M5	M8	M8	M8	M8
Quantity	2	4	4	4	4	4	6
Torque (Nm)	2.5	2.5	3.0	-	-	-	-



Frame size A units can be DIN rail Mounted.

Frame size 7 units should be lifted using lifting lugs provided.

SAFETY INFORMATION AND ENVIRONMENTAL REQUIREMENTS

- This equipment must be earthed
- Do not energise the equipment with the cover removed
- The equipment must be installed and commissioned only by qualified personnel
- Obey all general and regional installation and safety regulations relating to work on high voltage installations, as well as regulations covering correct use of tools and personal protective equipment
- Make sure that the clearance for cooling inlets and outlets, above and below the inverter, is at least 150mm. If the unit is installed in a cabinet, it may be necessary to install cabinet cooling fans.

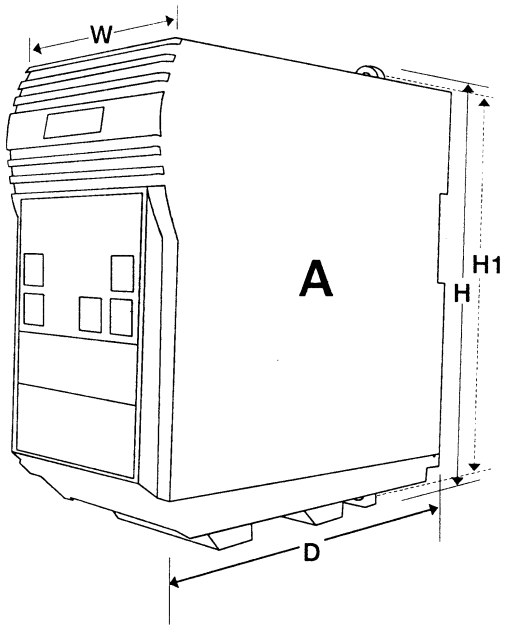
Use the formula below to calculate the air-flow required:
Air-flow (m^3 / hr) = (Dissipated Watts / ΔT) x 3.1

Typical dissipation (Watts) = 3% of inverter rating.
ΔT = Allowable temperature rise within cabinet in °C.
3.1 = Specific heat of air at sea level.

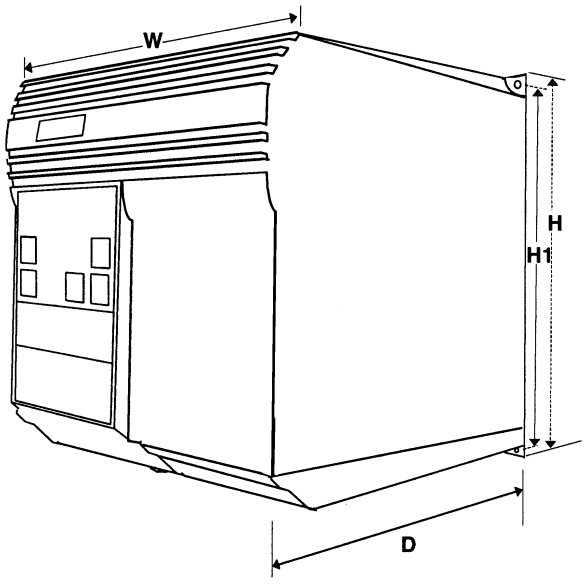
- Use insulated hand tools on mains input and motor terminals. Dangerous voltages can be present even when the inverter is not operating
- Do not exceed operating temperature range 0°C to 50°C for the MICROMASTER Eco, or 0°C to 40°C for the MIDIMASTER Eco range
- De-rate the inverter if operating at altitude above 1000m
- Do not install the inverter where it will be subject to shock, vibration, electro-magnetic radiation, water hazards, or atmospheric pollutants such as dust or corrosive gasses

CLEARANCES AND DIMENSIONS - MICROMASTER Eco

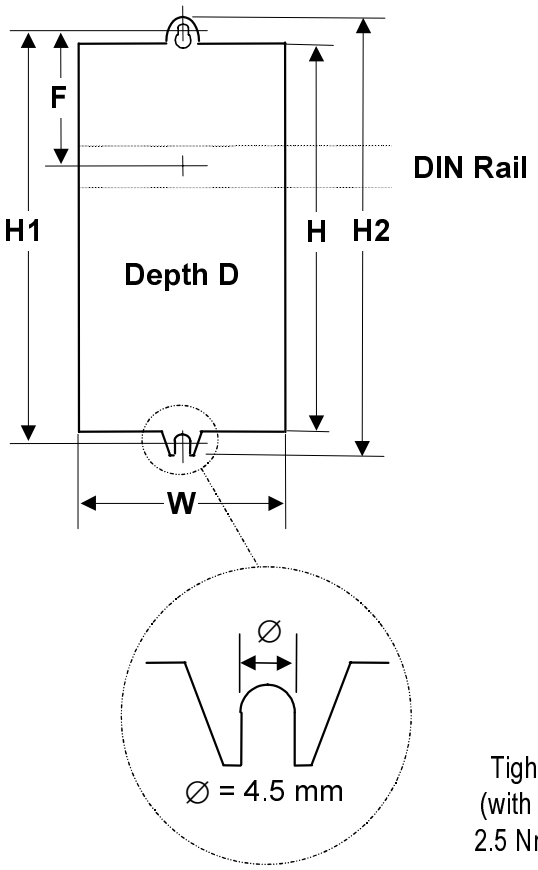
	H	W	D	H1	H2	W1	F
A	147	73	141	160	175	-	55
B	184	149	172	174	184	138	-
C	215	185	195	204	232	174	-



MICROMASTER Eco Frame Size A



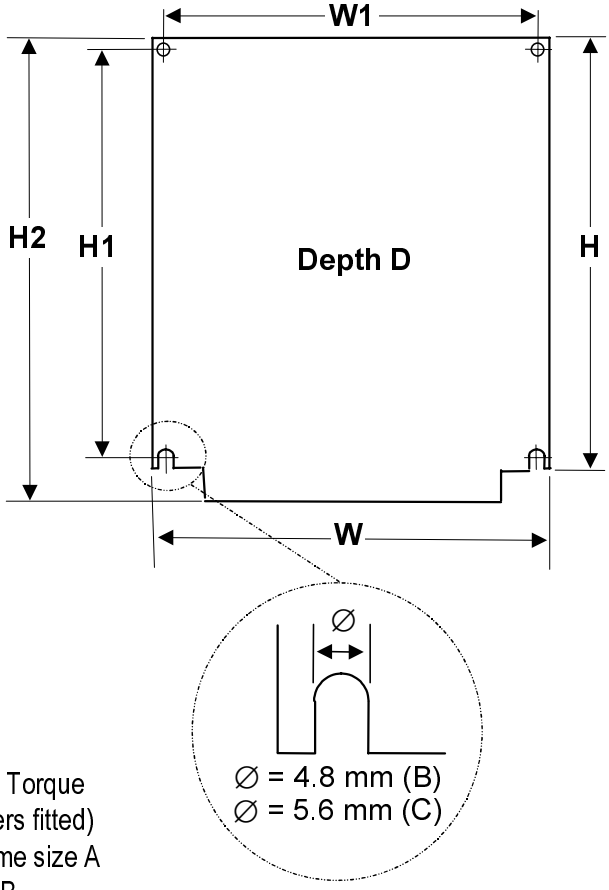
MICROMASTER Eco Frame Size B and C



2 bolts M4
2 nuts M4
2 washers M4

Frame Size A

Tightening Torque
(with washers fitted)
2.5 Nm Frame size A
and B
3.0 Nm Frame size C



Frame size B:
4 bolts M4
4 nuts M4
4 washers M4

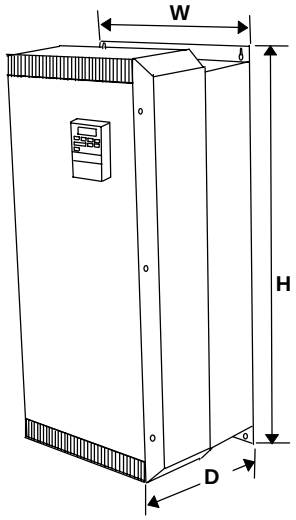
Frame size C:
4 bolts M5
4 nuts M5
4 washers M5

Frame Sizes B and C

CLEARANCES AND DIMENSIONS - MIDIMASTER Eco

IP21 / NEMA 1						
Frame Size	**W**	**H**	**D**	**W1**	**H1**	**Weight Kg**
4 =	275 x 450 x 210			255	430	11
5 =	275 x 550 x 210			255	530	15
6 =	275 x 650 x 285			255	630	27
7 =	420 x 850 x 310			400	830	56
	Dimensions D includes the front control panel. If a Clear Text Display (OPe is to be included, an additional 30mm will be required.					

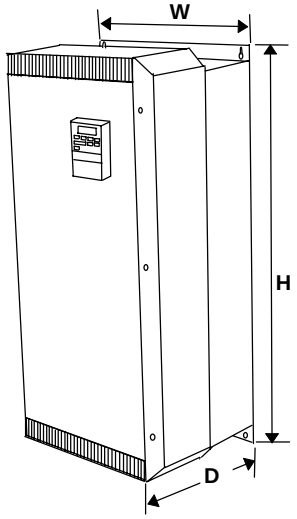
IP56 / NEMA 4/12						
Frame Size	**W**	**H**	**D**	**W1**	**H1**	**Weight Kg**
4 =	360 x 675 x 351			313	655	30
5 =	360 x 775 x 422			313	755	40
6 =	360 x 875 x 483			313	855	54
7 =	500 x 1150 x 450			533	1130	100
	Dimension D includes the front panel access door.					



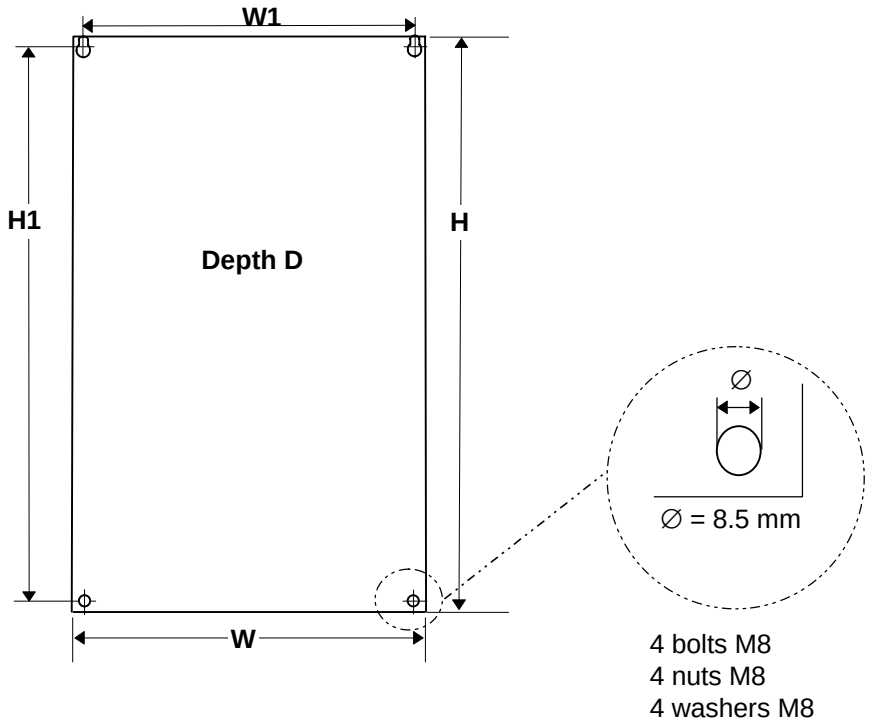
MIDIMASTER Eco (Typical)

CLEARANCES AND DIMENSIONS - MIDIMASTER Eco

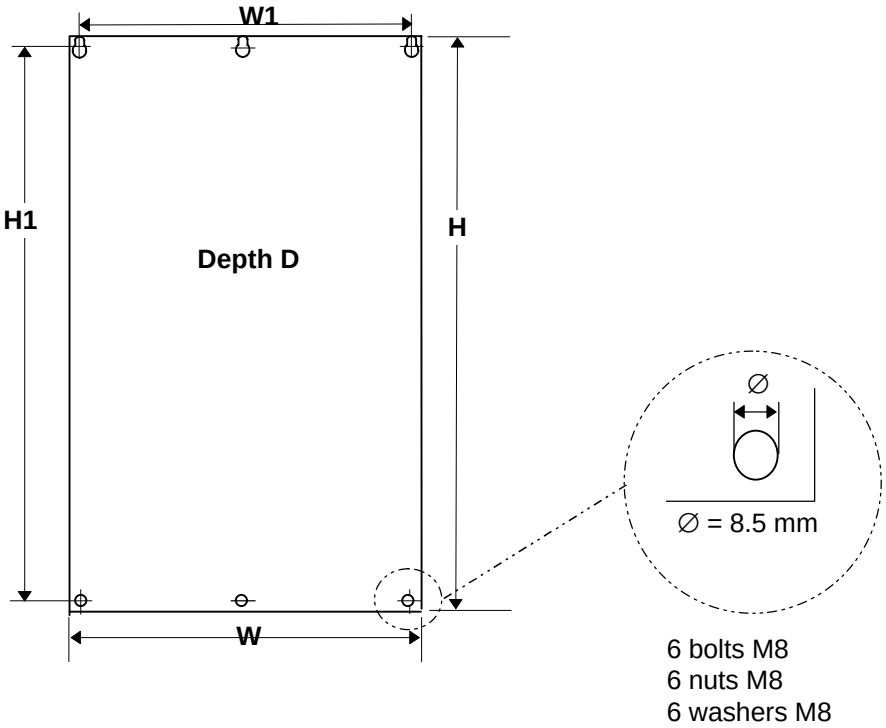
Frame Size	W	H	D	W1	H1	Weight Kg
4 =	275 x 700 x 210			255	680	19
5 =	275 x 800 x 210			255	780	24
6 =	275 x 920 x 285			255	900	39
7 =	420 x 1150 x 310			400	1130	90
	Dimensions D includes the front control panel. If a Clear Text Display (OPe is to be included, an additional 30mm will be required.					



MIDIMASTER Eco (Typical)



Frame Sizes 4, 5 and 6



Frame Size 7

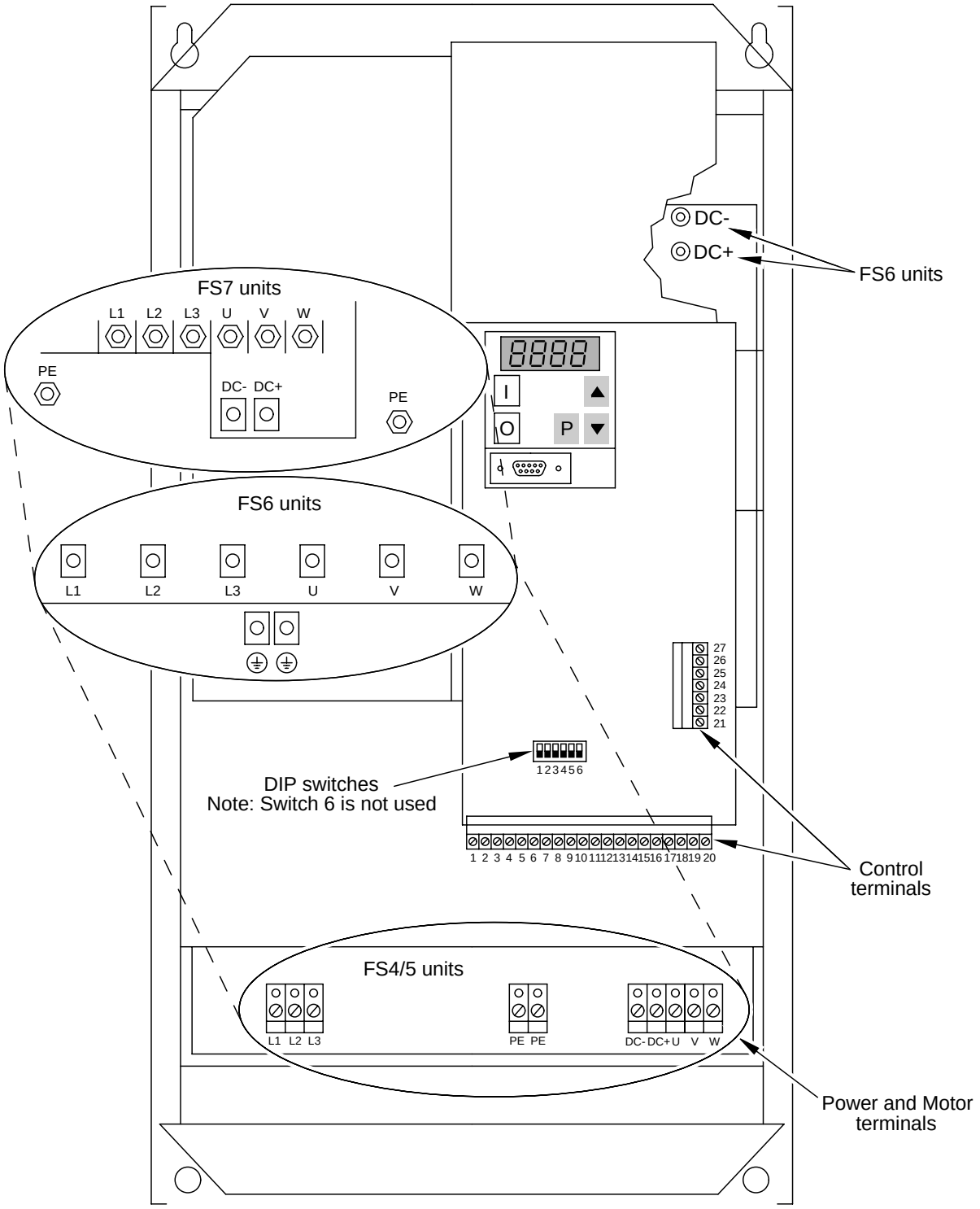
10. ELECTRICAL INSTALLATION

SAFETY INFORMATION AND GENERAL GUIDELINES

- Make sure that the motor terminals are configured for the correct supply voltage
- Make sure that the input power supply is isolated before making or changing any connections
- The control power supply and motor leads must be laid separately. They must not be fed through the same cable conduit/trunking and should cross at 90° wherever this is unavoidable
- High voltage insulation test equipment must not be used on any cables connected to the inverter

Motors can be connected to inverters either individually or in parallel. For parallel motor operation each motor should have an overload protection relay fitted. Set parameter P077 to 0 for multi-motor operation mode.

For wiring guidelines to minimise the effect of electro-magnetic interference (EMI), refer to the relevant section of this manual.



Location of power and control terminals

POWER AND MOTOR CONNECTIONS - MIDIMASTER Eco RANGE

1. Gain access to power and motor terminals by removing the front cover from the inverter (lower-front cover only, for frame size 7).
2. Make sure that the power source supplies the correct voltage and has the necessary current supply capacity. Make sure that the appropriate circuit-breaker (or fuses) with the specified current rating are connected between the power supply and inverter (Refer to Table of recommended fuses and ratings on page 10-5).
3. Feed the cables through the correct glands in the base of the inverter. Secure the cable glands to the inverter and connect the leads to the power and motor terminals.
4. Connect the power input leads to the power terminals L1, L2, L3 (3 phase) and earth (PE) using a 4-core cable and lugs to suit the cable size.
5. Use a 4-core cable and suitable lugs to connect the motor leads to the motor terminals U, V, W and earth (PE) .
6. Tighten all the power and motor terminals:

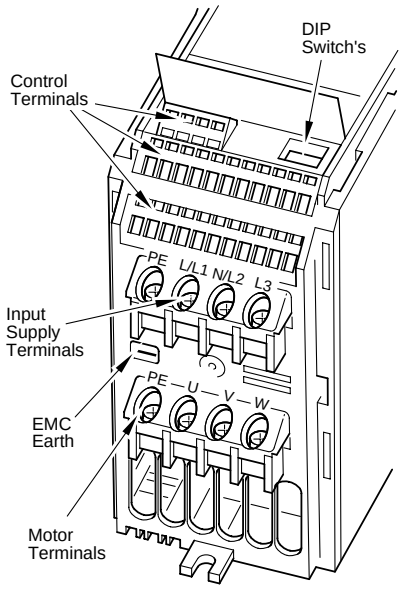
   Frame size 4 and 5: Tighten up each of the power and motor terminal screws to 1.1 Nm.
   Frame size 6: tighten up each of the power and motor terminal Allen-screws to 3.0 Nm.
   Frame size 7: Tighten up each of the M12 power and motor terminal nuts to 30 Nm.

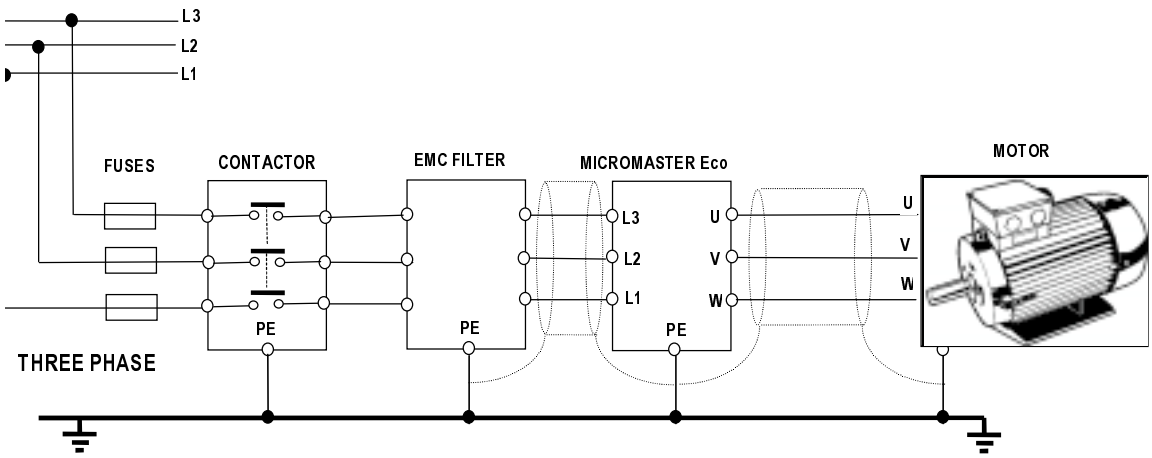
Make sure that all the leads are connected correctly and the equipment is properly earthed.

The total length of the motor cable(s) should generally not exceed 100m. If a screened motor cable is used or if the cable channel is well grounded, the maximum length should generally not exceed 50m. Cable lengths above 200m are possible by derating the invertor's output current or by using additional output chokes. Refer to table of maximum recommended motor cable lengths. Section 14.

8. Secure the front cover to the inverter when all connections are complete and before energising.

POWER AND MOTOR CONNECTIONS - MICROMASTER Eco RANGE





Gain access to terminals Frame size A.

The power and motor terminals are directly accessible beneath the inverter.

Gain access to terminals Frame size B.

Insert the blade of a small screwdriver into the slot in the front of the inverter and press in the direction of the arrow. At the same time, press down on the tab at the side of the access panel. This will release the access panel, which will then swing down on its rear-mounted hinges.

The access panel can be removed from the inverter when at an angle of approximately 30° to the horizontal. If allowed to swing lower, the panel will remain attached to the inverter.

Remove the earthing screw from the gland plate.

Press both release catches to release the gland plate and then remove the metal gland plate from the inverter.

Gain Access to Terminals Frame Size C

While supporting the fan housing with one hand, insert the blade of a screwdriver into the slot on the underside of the inverter and press upwards to release the securing tab. Lower the fan housing, allowing it to swing out to the right on its side-mounted hinges.

Applying pressure to the gland plate, release 2 clips in the direction of the arrows. Swing the plate out to the left on its side-mounted hinges.

1. Make sure that the power source supplies the correct voltage and has the necessary supply current capacity. Make sure that the appropriate circuit-breaker or fuses with the specified current rating are connected between the power supply and inverter (Refer to the fuse recommendations on page 10-5).

Frame Size B + C

2. Feed the cables through the correct glands in the base of the inverter. Secure the cable glands to the inverter and connect the leads to the power and motor terminals.
3. For the power input, use a 4-core cable for three phase units.
4. Connect the power input leads to the power terminals L/L1, N/L2, L3 (3 phase), and earth (PE).
5. Use a 4-core cable and suitable lugs to connect the motor leads to the motor terminals U, V, W and the earth (PE).
6. Tighten all the power and motor terminals

Frame Size A

These connections have to be made with the inverter removed from the mounting surface. Care must be taken routing the leads through the moulded clips to prevent trapping and chafing when the unit is mounted and secured to the selected surface.

Make sure that the leads are connected correctly and the equipment is properly earthed.

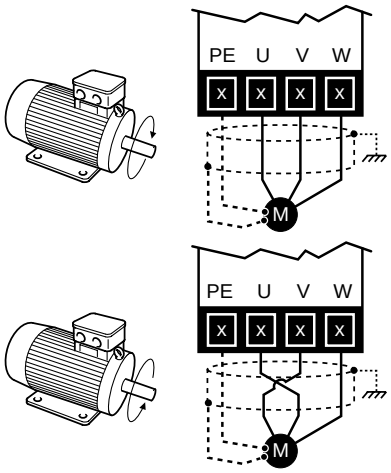
The total length of the motor cable should not generally exceed 150 m. If a screened motor cable is used or if the cable channel is well grounded, the maximum length should be 100 m. Cable lengths up to 200 m are possible by using additional output chokes or de-rating the inverter's output current.

RECOMMENDED FUSES AND RATINGS

HVAC Inverter Model / type	Recommended Fuse Rating	Recommended Fuse (Duty Class gL) Order Code
ECO1-110/2	16A	3NA3805
ECO1-150/2	20A	3NA3807
ECO1-220/2	25A	3NA3810
ECO1-300/2	35A	3NA3814
ECO1-400/2	25A	3NA3810
ECO1-550/2	50A	3NA3820
ECO1-750/2	63A	3NA3822
ECO1-1100/2	63A	3NA3822
ECO1-1500/2	63A	3NA3822
ECO1-1850/2	80A	3NA3824
ECO1-2200/2	100A	3NA3830
ECO1-3000/2	100A	3NA3830
ECO1-3700/2	160A	3NA3036
ECO1-4500/2	200A	3NA3140
ECO1-110/3	10A	3NA3803
ECO1-150/3	10A	3NA3803
ECO1-220/3	16A	3NA3805
ECO1-300/3	16A	3NA3805
ECO1-400/3	20A	3NA3807
ECO1-550/3	20A	3NA3807
ECO1-750/3	20A	3NA3807
ECO1-1100/3	35A	3NA3814
ECO1-1500/3	35A	3NA3814
ECO1-1850/3	50A	3NA3820
ECO1-2200/3	50A	3NA3820
ECO1-3000/3	80A	3NA3824
ECO1-3700/3	80A	3NA3824
ECO1-4500/3	100A	3NA3830
ECO1-5500/3	125A	3NA3032
ECO1-7500/3	160A	3NA3036
ECO1-9000/3	200A	3NA3140
ECO1-400/4	10A	3NA3803-6
ECO1-550/4	10A	3NA3803-6
ECO1-750/4	16A	3NA3805-6
ECO1-1100/4	25A	3NA3810-6
ECO1-1500/4	35A	3NA3814-6
ECO1-1850/4	35A	3NA3814-6
ECO1-2200/4	50A	3NA3820-6
ECO1-3000/4	50A	3NA3820-6
ECO1-3700/4	63A	3NA3822-6
ECO1-4500/4	80A	3NA3824-6

DIRECTION OF ROTATION

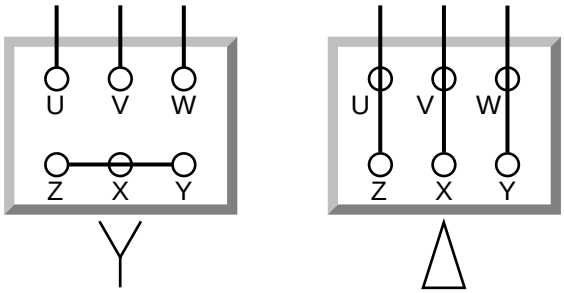
The direction of rotation of the motor can be reversed during commissioning by changing over two of the output connections on the Eco.



STAR OR DELTA MOTOR CONNECTION

The MICROMASTER Eco & MIDIMASTER Eco range can be used to control all types of three-phase asynchronous standard motors.

The voltage and connection method should be taken from the motor nameplate, but as a general rule, larger motors (380/660 volt) are delta-connected and smaller motors (220/380 volt) are star-connected.



MULTI-MOTOR CONNECTION

The MICROMASTER Eco & MIDIMASTER Eco range can be used to control several motors connected in parallel.

If the motors to be controlled are to run at different speeds from one another, then motors with different rated speeds must be used. Because motor speeds will change simultaneously, the ratio between the rated motor speeds will be consistent over the full range.

If motor sizes vary to any great extent, this could cause problems at start-up and at low rpm. This is because smaller motors need a higher voltage during start-up, as they have a higher resistance value in the stator.

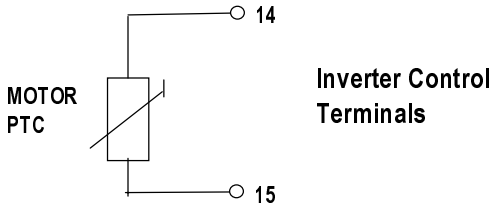
Additional motor protection (e.g. thermistors in every motor or individual thermal overload relays) is essential in systems with parallel motor operation. This is because the inverter's internal thermal protection cannot be used, as output current must be programmed to match the overall motor current.

Total motor current consumption must not exceed maximum rated output current.

Parameter P077 should be set to multi motor mode.

MOTOR OVERLOAD PROTECTION

When operated below rated speed, the cooling effect of fans fitted to the motor shaft is reduced, so that most motors require de-rating for continuous operation at low frequencies. However, variable torque loads such as pumps and fans are generally not heavily loaded at low speeds. To provide motors with additional protection against overheating, a PTC (thermistor) temperature sensor may be fitted to the motor and connected to the inverter control terminals. Note: to enable the motor overload protection trip function, see parameter P087=1.



CONTROL CONNECTIONS (ALL MODELS)

GENERAL INFORMATION

Use screened cable for the control cable, Class 1 60/75 °C copper wire only (for UL compliance). Tightening torque for the field wiring terminals is 1.1 Nm.

Do not use the internal RS485 connections (terminals 24 and 25) if you intend using the external RS485 D-type connection on the front panel (e.g. to connect a Clear Text Display/option (OPe).

DIP switches select between voltage (V) and current (I) analogue speed setting inputs. They also select between either a voltage or current PID feedback signal. These switches can only be accessed when:

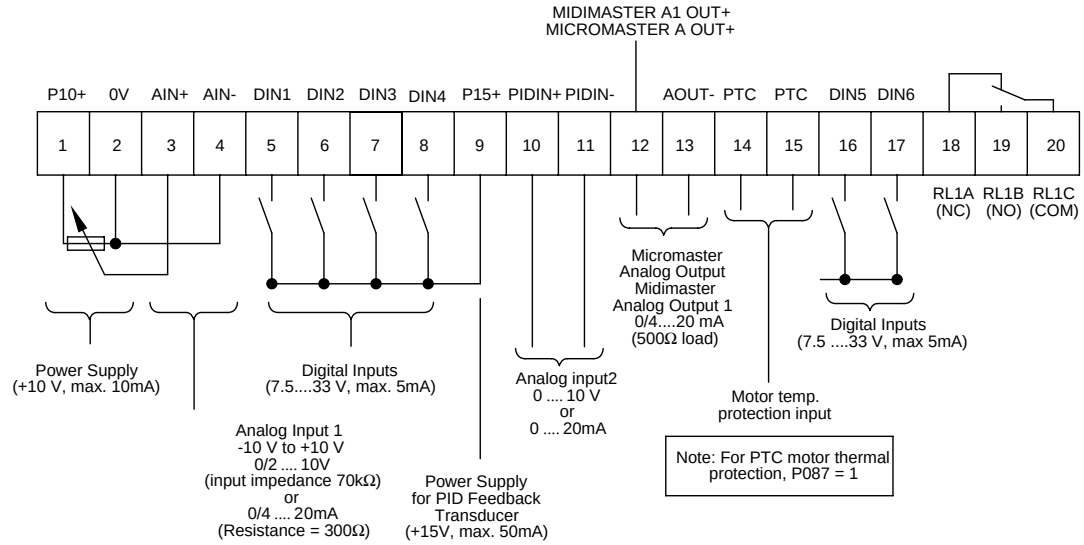
- for Frame sizes 4, 5 and 6, the front cover is removed.
- for Frame size 7, the lower front cover is removed.
- for Frame sizes A, B, C, the flap on the front cover is open.

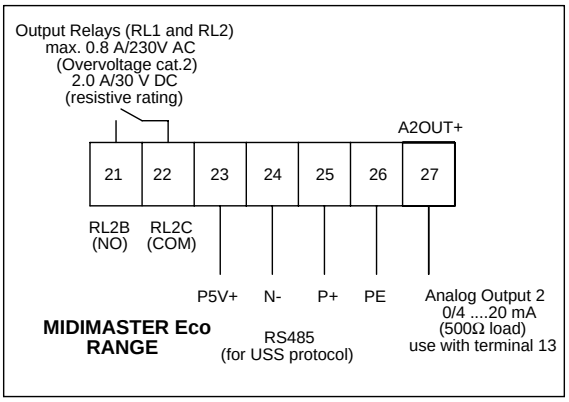
MICROMASTER Eco

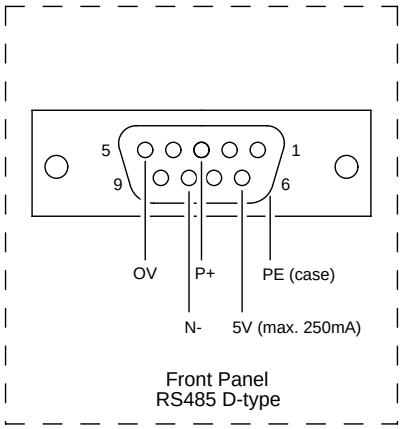
Insert a small screwdriver in the slot above the terminal, whilst inserting control wire from below. Withdraw the screwdriver to secure the wire.

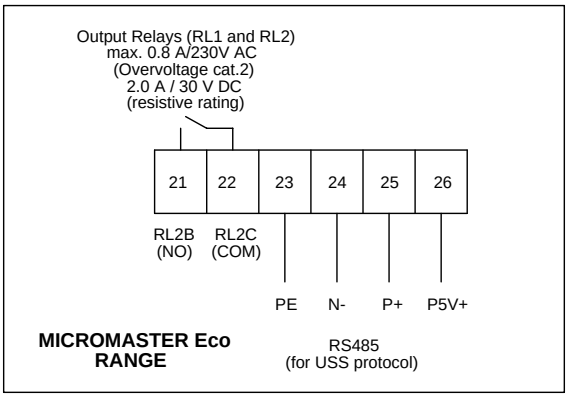
MIDIMASTER Eco

Control connections to the MIDIMASTER Eco are made via two terminal blocks located on the control panel. The terminal blocks are of a two-part design. The part containing the screw terminals can be unplugged from its housing before wires are connected. When all connections to the terminals have been secured, the terminal block must be plugged firmly back into its housing.









Control Connections

11. APPLICATION EXAMPLES

The following examples are based on actual applications where Siemens Drives have been successfully applied:

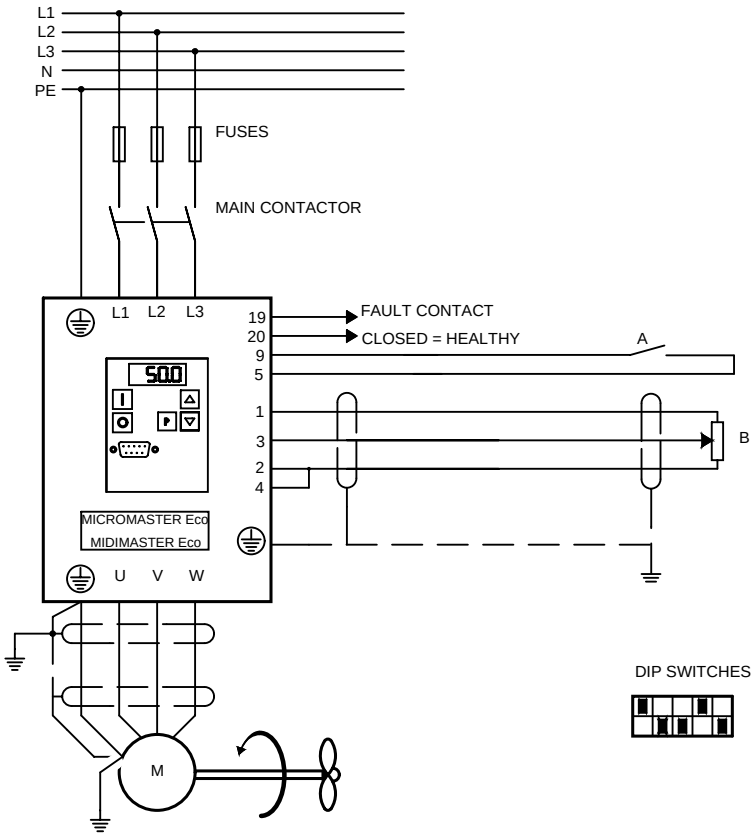
EXAMPLE 1

POTENTIOMETER SETPOINT AND RUN/STOP VIA TERMINALS

A fan is to be speed controlled using a potentiometer to provide the control signal

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG/POTENTIOMETER SET POINT
P007 = 0	SELECT RUN/STOP FROM TERMINALS



ITEM	DESCRIPTION
A	RUN/STOP SWITCH
B	SPEED SETTING POTENTIOMETER, 1KΩ

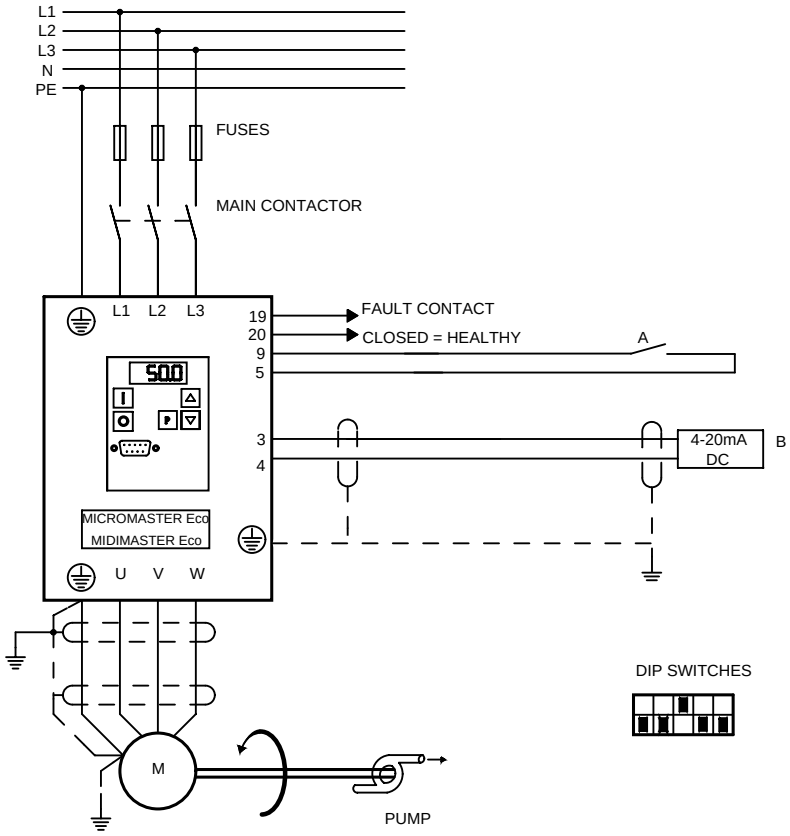
EXAMPLE 2.

ANALOG CURRENT SETPOINT AND RUN/STOP VIA TERMINALS

A pump is to be speed controlled using an external 4 - 20 mA current signal

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG SET POINT
P007 = 0	SELECT RUN/STOP FROM TERMINALS
P023 = 1	SELECT 4 - 20 mA RANGE



ITEM	DESCRIPTION
A	RUN/STOP SWITCH
B	4 - 20 mA SPEED SETTING SIGNAL

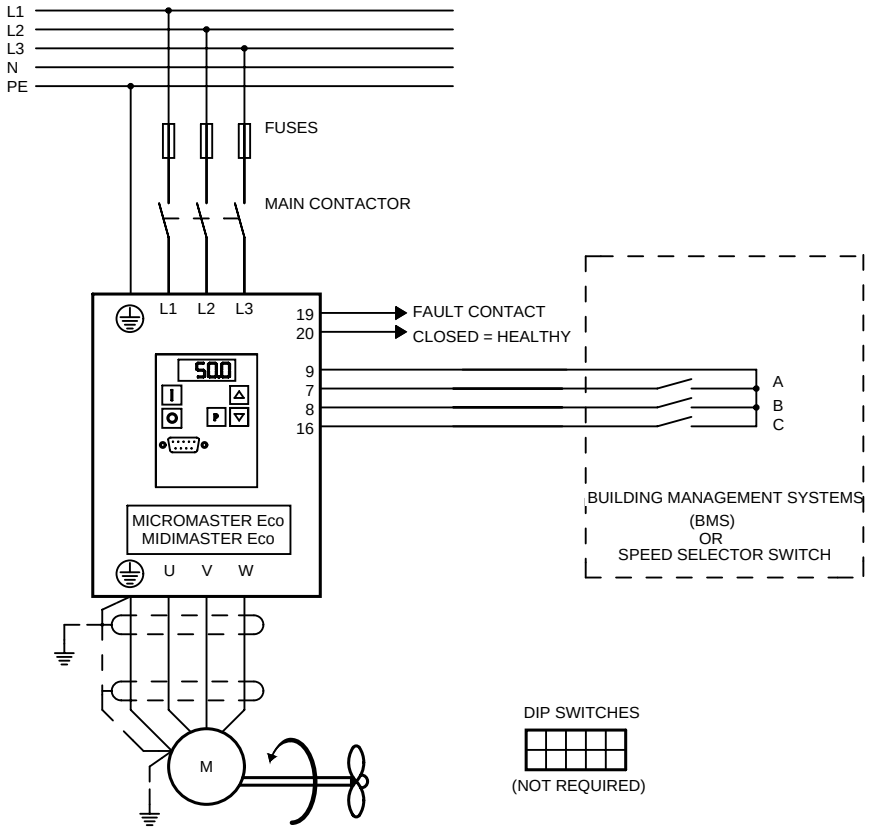
EXAMPLE 3.

FIXED SPEEDS VIA TERMINAL RAIL

A fan is to be run at 3 fixed speeds using digital inputs to control the speed setting

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 2	SELECT FIXED FREQUENCIES FROM TERMINALS
P007 = 0	SELECT RUN/STOP FROM TERMINALS
P053 = 18	FIXED FREQUENCY 3 (P043) TERMINAL 7
P054 = 18	FIXED FREQUENCY 2 (P042) TERMINAL 8
P055 = 18	FIXED FREQUENCY 1 (P041) TERMINAL 16
P041 = 50	FIXED FREQUENCY 1 = 50 Hz
P042 = 40	FIXED FREQUENCY 2 = 40 Hz
P043 = 20	FIXED FREQUENCY 3 = 20 Hz



ITEM	DESCRIPTION
A	SWITCH - RUN AT 20Hz
B	SWITCH - RUN AT 40Hz
C	SWITCH - RUN AT 50Hz

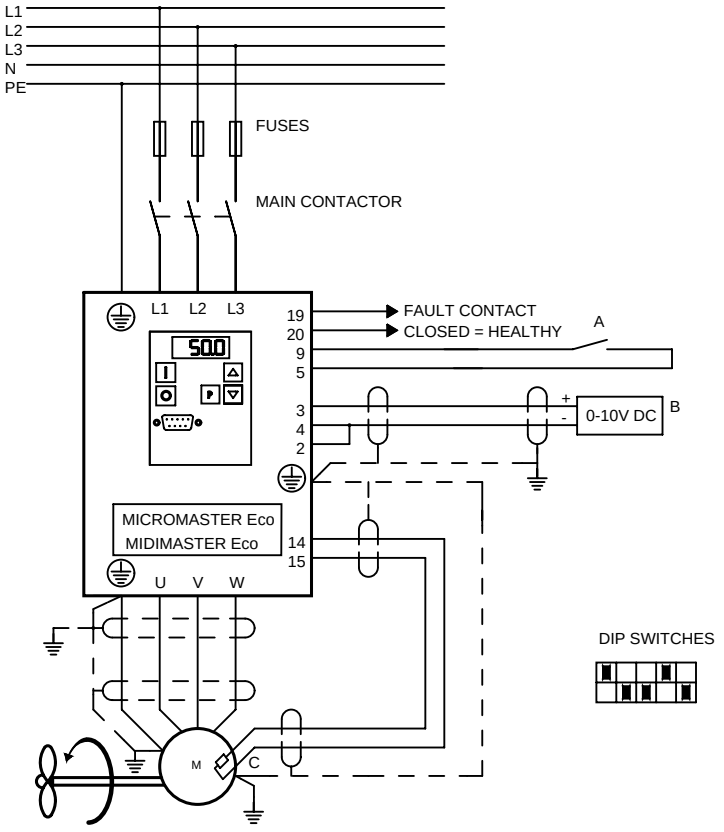
EXAMPLE 4

MOTOR THERMISTOR PROTECTION AND SPEED SETTING BY DC SIGNAL

A fan is to be speed controlled using a potentiometer to provide the control signal. A thermistor is installed in the fan motor to obtain optimum motor protection

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG SETPOINT
P007 = 0	P007 = SELECT RUN/STOP FROM TERMINALS
P087 = 1	SELECT MOTOR THERMISTOR PROTECTION



ITEM	DESCRIPTION
A	RUN/STOP SWITCH
B	0 - 10V DC SPEED SETTING SIGNAL
C	MOTOR THERMISTOR

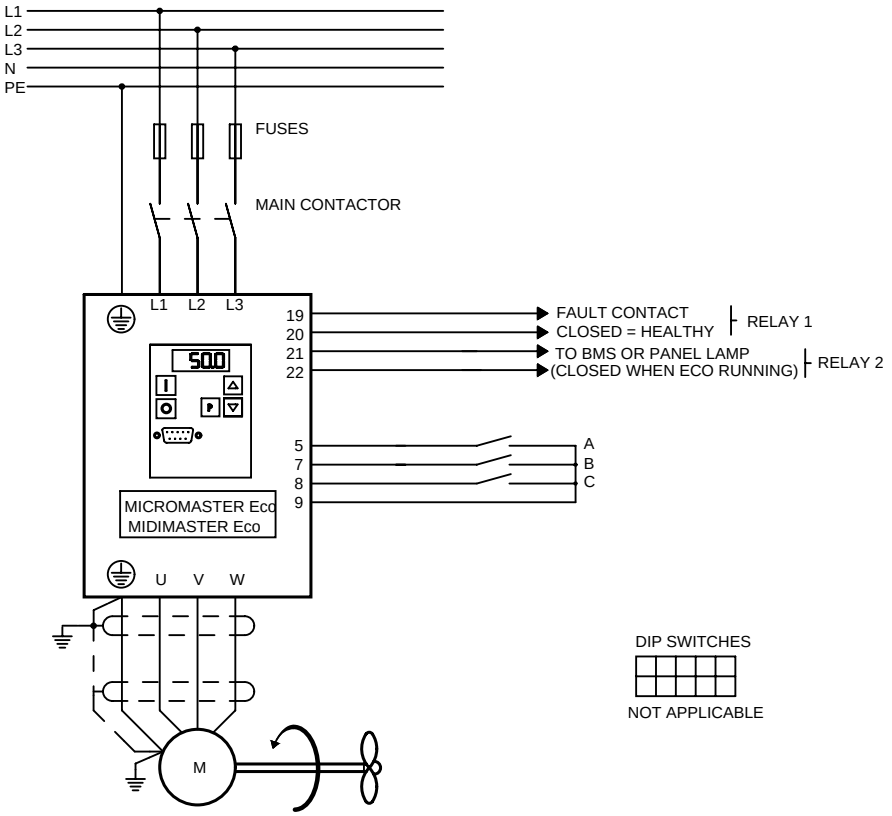
EXAMPLE 5

MOTORISED POTENTIOMETER. OUTPUT RELAY CLOSING WHEN RUNNING

A fan is to be speed controlled by push buttons or contacts which when operated will raise and lower the speed setpoint (The inverter energises a relay output to indicate it is running).

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P007= 0	SELECT RUN/STOP AND SPEED UP/DOWN CONTROL FROM DIGITAL INPUT TERMINALS
P053 = 11	INCREASE SPEED (DIGITAL INPUT 3) TERMINAL 7
P054 = 12	DECREASE SPEED (DIGITAL INPUT 4) TERMINAL 8
P062 = 11	INVERTER IS RUNNING (RELAY 2)



ITEM	DESCRIPTION
A	RUN/STOP SWITCH
B	INCREASE SPEED (PUSH BUTTON OR BMS)
C	DECREASE SPEED (PUSH BUTTON OR BMS)

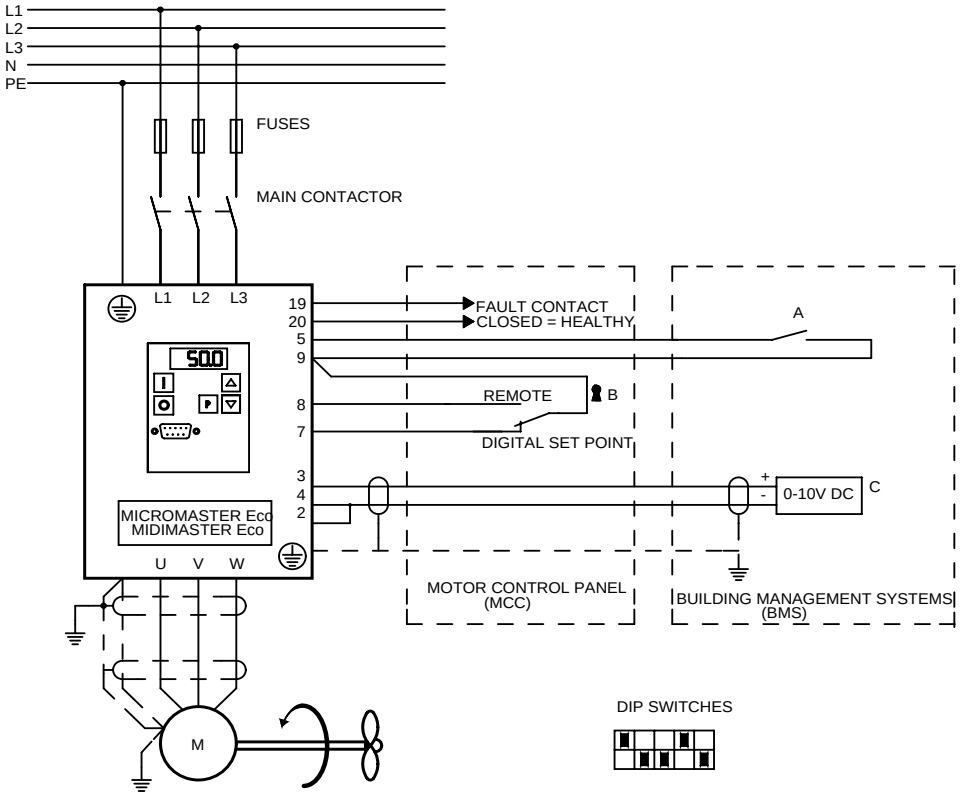
EXAMPLE 6

LOCAL (KEYPAD)/REMOTE (BMS) SELECTION

A fan is to be speed controlled using a potentiometer to provide the control signal. The potentiometer value being set either locally or remotely via keyswitch selection on the motor control panel.

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P053 = 13	SWITCH BETWEEN ANALOG SPEED SETTING AND Eco KEYPAD SPEED SETTING
P054 =9	SWITCH BETWEEN LOCAL KEYPAD DISPLAY RUN/STOP AND REMOTE DIGITAL INPUT TERMINAL RUN/STOP



ITEM	DESCRIPTION
A	RUN/STOP COMMAND FROM BMS
B	KEY SWITCH ON MCC PANEL FOR LOCAL/REMOTE SELECTION (SHOWN IN LOCAL KEYPAD MODE)
C	0 - 10V DC SPEED SETPOINT FROM BMS

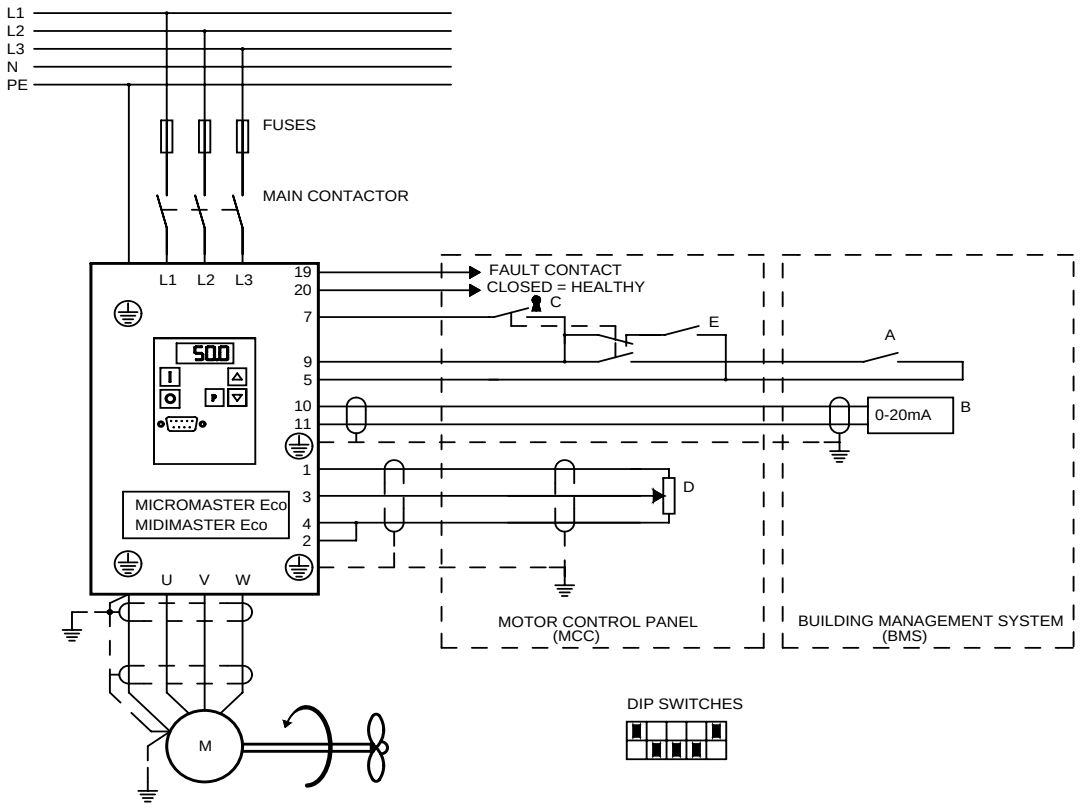
EXAMPLE 7

LOCAL POTENTIOMETER/REMOTE BMS SELECTION FROM FRONT OF MCC PANEL

A fan is to be speed controlled locally, using a potentiometer on the motor control panel to provide the control signal, or, remotely using an external 4 - 20 mA current signal. The local or remote control is set via a keyswitch on the motor control panel. An additional run/stop contact is provided within the motor control panel.

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG SET POINTS
P007 = 0	SELECT RUN/STOP VIA DIGITAL INPUT TERMINALS
P053 = 24	SWITCH BETWEEN ANALOG SPEED SETPOINT (LOCAL POTENTIOMETER) AND SETPOINT 2 (REMOTE BMS)



ITEM	DESCRIPTION
A	REMOTE RUN/STOP COMMAND FROM BMS
B	REMOTE 0 - 20 mA SPEED SETTING SIGNAL FROM BMS
C	KEYSWITCH ON MCC PANEL TO SELECT BETWEEN LOCAL AND REMOTE (SHOWN IN LOCAL)
D	LOCAL SPEED SETTING POTENTIOMETER ON MCC PANEL
E	LOCAL RUN/STOP CONTACTS WITHIN MCC PANEL

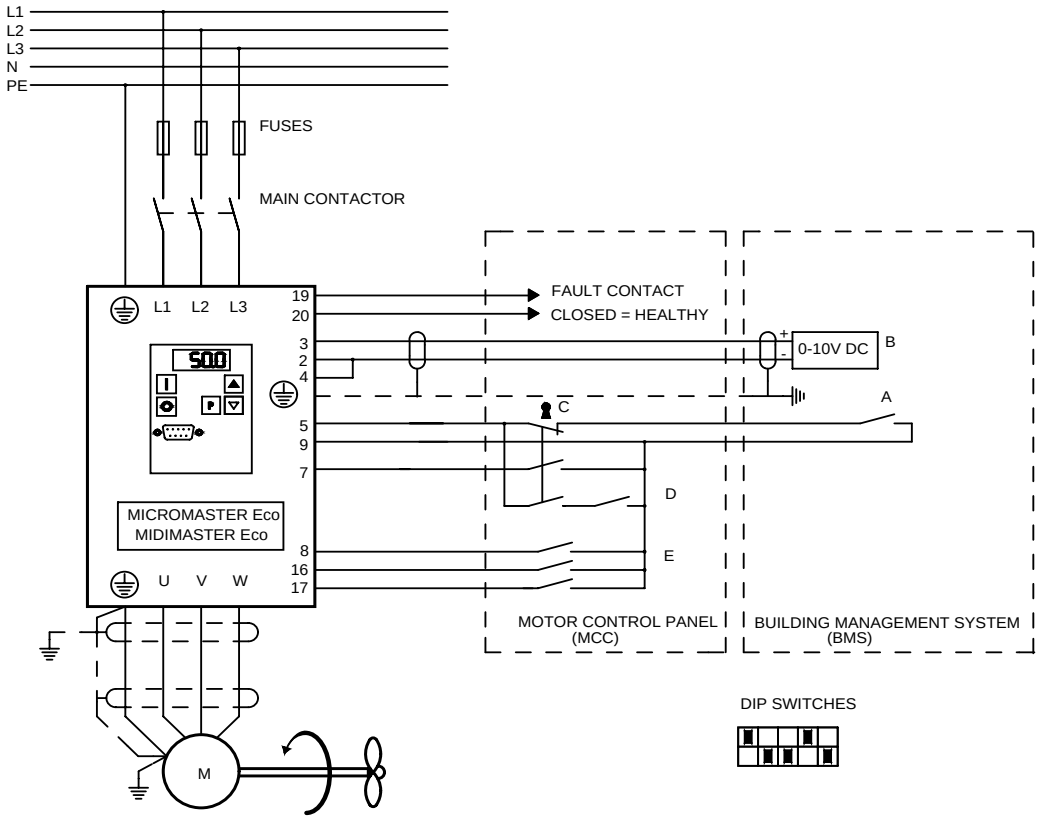
EXAMPLE 8

MCC PANEL FIXED FREQUENCIES/REMOTE (BMS) SELECTION

A fan is to be speed controlled locally, using a fixed speed selector switch on the motor control panel to provide 3 fixed frequency output signals, or, remotely using an external 0 - 10V DC speed setting signal. The local or remote control is set via a keyswitch on the motor control panel. An additional run/stop contact is provided within the motor control panel.

All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P005 = 0	TUNE INTERNAL SETPOINT TO 0Hz
P006 = 2	SELECT FIXED FREQUENCIES
P007 = 0	SELECT RUN/STOP VIA DIGITAL INPUT TERMINALS
P041 = 10	FIXED FREQUENCY 1 = 10Hz
P042 = 30	FIXED FREQUENCY 2 = 30Hz
P047 = 50	FIXED FREQUENCY 6 = 50Hz
P053 = 13	SELECT BETWEEN ANALOG AND DIGITAL INPUTS
P054 = 6	FIXED FREQUENCY 2 (P042) TERMINAL 8
P055 = 6	FIXED FREQUENCY 1 (P041) TERMINAL 16
P356 = 6	FIXED FREQUENCY 6 (P047) TERMINAL 17



ITEM	DESCRIPTION
A	RUN/STOP COMMAND FROM BMS
B	0 -10V DC SPEED SETTING SIGNAL FROM BMS
C	KEYSWITCH LOCAL/BMS SELECTION
D	LOCAL RUN/STOP CONTACTS WITHIN MCC
E	LOCAL FIXED SPEED SELECTOR SWITCHES

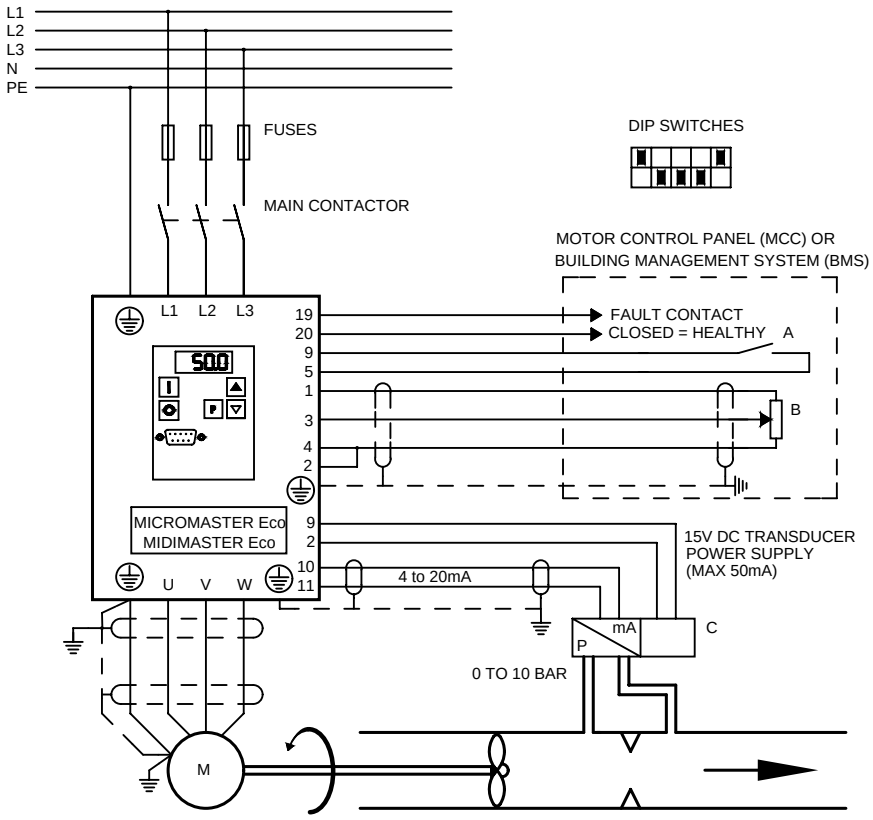
EXAMPLE 9

PID CONTROL - PRESSURE SETPOINT

In a ventilation system, the duct pressure differential is to be adjustable by means of a 0 - 10V potentiometer. Output signals from the pressure transducer are supplied to the Eco, the selected pressure differential must be kept constant , and the internal PID regulator is used to achieve this.

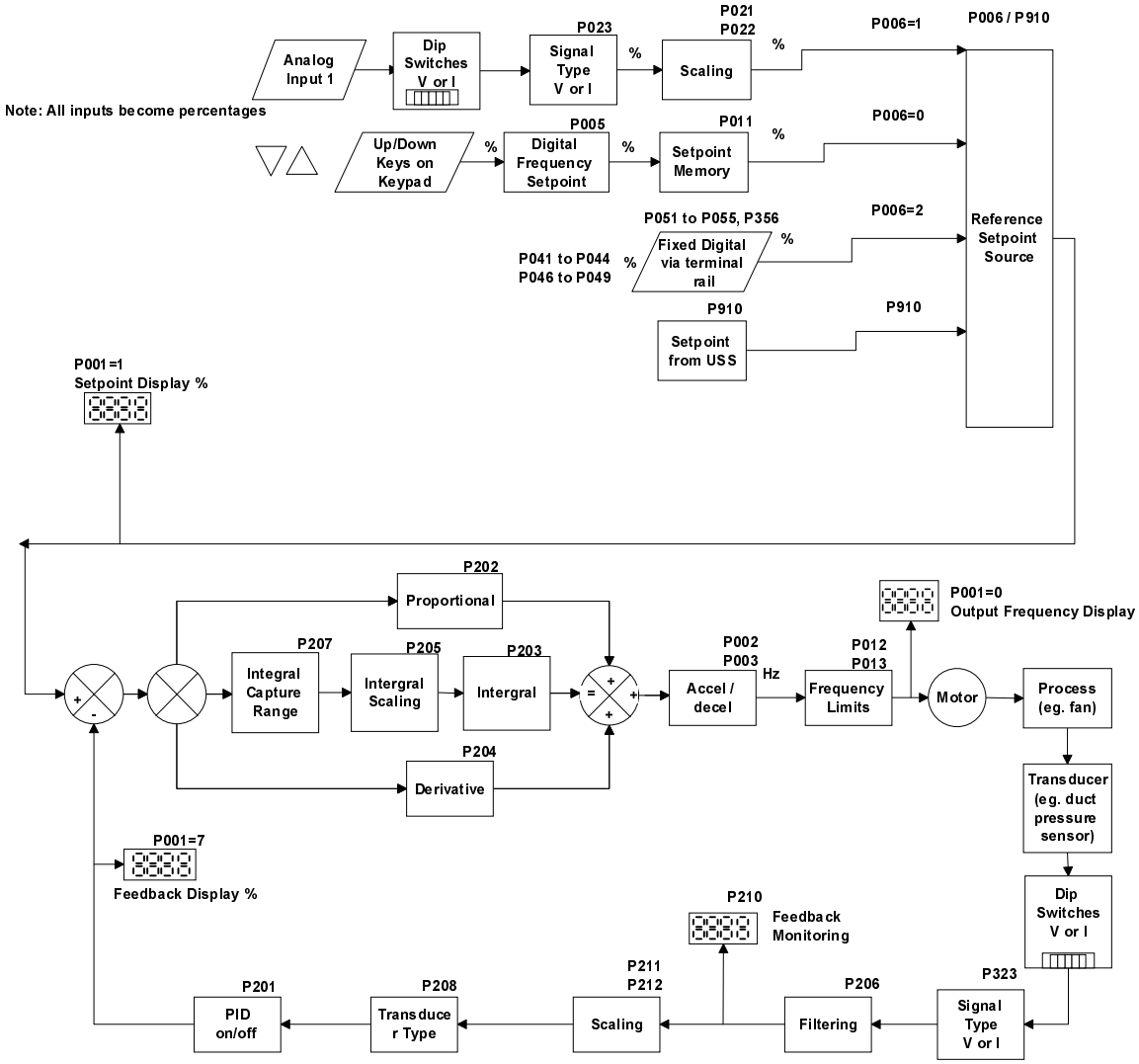
All settings based on factory settings with the following exceptions :

PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG SETPOINT
P007 = 0	SELECT RUN/STOP VIA TERMINALS
P012 = 10	MINIMUM SPEED = 10Hz
P201 = 1	PID ENABLED
P202 = 1	PID PROPORTIONAL GAIN (MAY NEED TUNING)
P203 = 0 P205 = 10	PID INTEGRAL GAIN (MAY NEED TUNING)
P220 = 1	SWITCH OFF AT MINIMUM SPEED
P211 = 20 P212 = 100	SELECT ANALOG (PID) INPUT FOR 4 - 20mA



ITEM	DESCRIPTION
A	RUN/STOP COMMAND
B	PRESSURE SETPOINT POTENTIOMETER OR 0 - 10V DC SIGNAL
C	DIFFERENTIAL PRESSURE TRANSDUCER Note: Link terminals 2 and 10 if a 2 wire transducer is used.

PID FLOW CHART



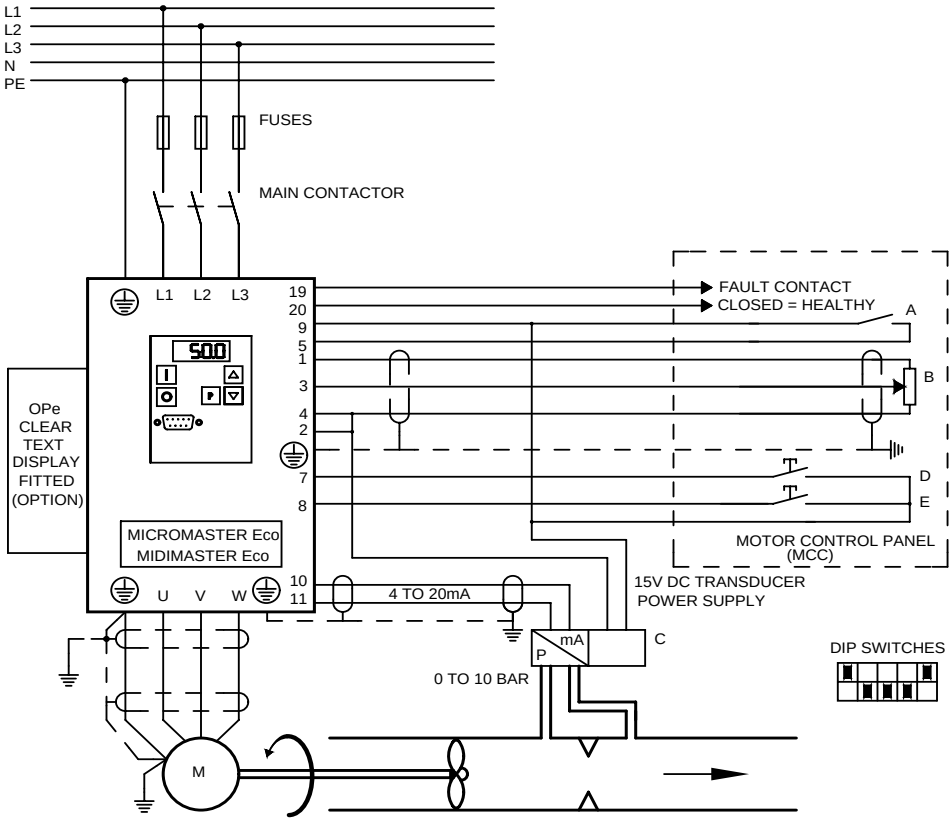
EXAMPLE 10

SELECT BETWEEN POTENTIOMETER CONTROL AND PID REGULATION

In a ventilation system, the duct pressure differential is to be adjustable by means of a potentiometer. Output signals from the pressure transducer are supplied to the Eco, the selected pressure differential must be kept constant , and the internal PID regulator is used to achieve this. Alternatively, selection can be made at the motor control panel for closed loop PID regulation.

All settings based on factory settings with the following exceptions :

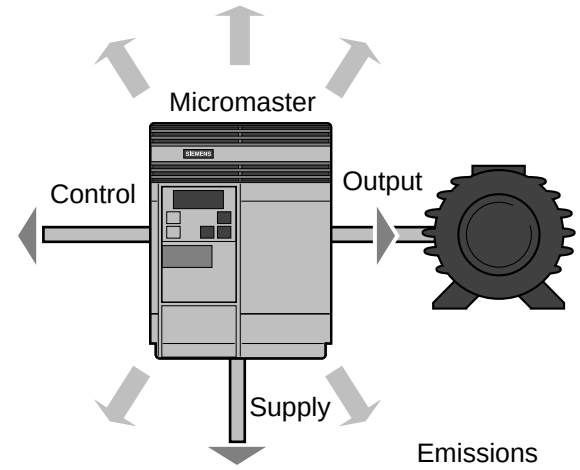
PARAMETER CHANGES FROM FACTORY DEFAULTS	
SETTING	**DESCRIPTION**
P006 = 1	SELECT ANALOG SETPOINT
P007 = 0	SELECT RUN/STOP VIA TERMINALS
P012 = 10	MINIMUM SPEED = 10Hz
P053 = 22	DOWNLOAD OPe PARAMETER SET 0
P054 = 23	DOWNLOAD OPe PARAMETER SET 1
P201 = 1	PID ENABLED (SEE ABOVE OPe SETTINGS)
P202 = 1	PID PROPORTIONAL GAIN (MAY NEED TUNING)
P203 = 0.1 P205 = 10	PID INTEGRAL GAIN (MAY NEED TUNING)
P220 = 1	SWITCH OFF AT MINIMUM SPEED
P211 = 20 P212 = 100	SET ANALOG (PID) INPUT FOR 4 - 20 mA

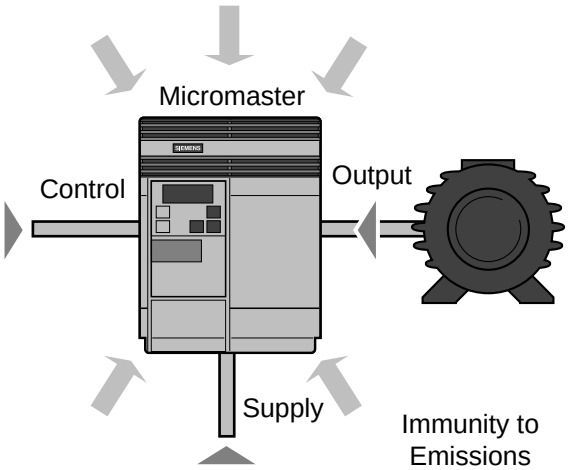


ITEM	DESCRIPTION
A	RUN/STOP COMMAND FROM MCC PANEL
B	SETPOINT POTENTIOMETER
C	DIFFERENTIAL PRESSURE TRANSDUCER
D	SELECT LOCAL POTENTIOMETER PUSHBUTTON
E	SELECT PID CONTROL PUSHBUTTON

12. EMC GUIDELINES

All electronic and electrical equipment generate unwanted signals. These signals can be emitted from the product either via cables that are connected to the product (Input, output, control signals etc.) or via electromagnetic radiation 'radio transmission'. These signals can be received by other products (via the same routes) and can interfere with the correct operation of the product.





Any particular product gives out a certain level of emissions, and has a certain level of immunity to incoming signals from other products. If the immunity of all products is higher than their emissions, there is no problem. If the immunity is lower, severe problems can occur, causing quality problems, damage, or in extreme cases injury.

Electro-magnetic Compatibility (EMC) concerns how equipment works together; Electro-magnetic Interference (EMI) refers to the unwanted signals themselves.

EMI has become a more serious problem recently as more electronic systems (which may prove to have low immunity) are used in industrial applications, and as power electronic products such as drives, generate high frequency signals which can produce high levels of interference.

ELECTRO-MAGNETIC COMPATIBILITY (EMC)

All manufacturers/assemblers of electrical apparatus which performs a complete intrinsic function which is placed on the European market as a single unit intended for the end user must comply with the EMC directive EEC/89/336 after January 1996. There are three ways by which the manufacturer/assembler can demonstrate compliance:

- **Self-Certification**
  This is a manufacturer's declaration that the European standards applicable to the electrical environment for which the apparatus is intended have been met. Only standards which have been officially published in the Official Journal of the European Community can be cited in the manufacturer's declaration.
- **Technical Construction File**
  A technical construction file can be prepared for the apparatus describing its EMC characteristics. This file must be approved by a 'Competent Body' appointed by the appropriate European government organisation. This approach allows the use of standards which are still in preparation.
- **EC Type-Examination Certificate**
  This approach is only applicable to radio communication transmitting apparatus.

The MICROMASTER Eco and MIDIMASTER Eco units do not have an intrinsic function until connected with other components (e.g. a motor). Therefore, the basic units are not allowed to be CE marked for compliance with the EMC directive. However, full details are provided of the EMC performance characteristics of the products when they are installed in accordance with the wiring recommendations in the Wiring Guidelines at the end of this section.

Compliance Table (MICROMASTER Eco):

Model No.	EMC Class
ECO1-110/2 - ECO1-400/2	Class 1
ECO1-110/2 - ECO1-400/2 with external filter (see table)	Class 2*
ECO1-110/3 - ECO1-750/3	Class 1
ECO1-110/3 - ECO1-750/3 with external class A filter (see table)	Class 2*
ECO1-110/3 - ECO1-750/3 with external class B filter (see table)	Class 3*

Compliance Table (MIDIMASTER Eco):

Model No.	EMC Class
ECO1-550/2 - ECO1-4500/2	Class 1
ECO1-550/2 - ECO1-4500/2 with class A external filter (see table)	Class 2*
ECO1-550/2 - ECO1-2200/2 with class B external filter (see table)	Class 3*
ECO1-1100/3 - ECO1-7500/3	Class 1
ECO1-1100/3 - ECO1-7500/3 with class A external filter (see table)	Class 2*
ECO1-1100/3 - ECO1-4500/3 with class B external filter (see table)	Class 3*
ECO1-400/4 - ECO1-4500/4	Class 1

Filter Part Numbers:

Inverter Model No.	Class A Filter Part No.	Class B Filter Part No.	Standard
ECO1-110/2 - ECO1-150/2 (IP20 only)	6SE3290-0DB87- 0FA3	6SE3290-0DB87-0FB3	EN 55011 / EN 55022
ECO1-220/2 - ECO1-400/2 (IP20 only)	6SE3290-0DC87- 0FA4	6SE3290-0DC87-0FB4	EN 55011 / EN 55022
ECO1-110/3 - ECO1-150/3	6SE3290-0DA87- 0FA1	6SE3290-0DA87-0FB1	EN 55011 / EN 55022
ECO1-220/3 - ECO1-300/3 (IP20 only)	6SE3290-0DB87- 0FA3	6SE3290-0DB87-0FB3	EN 55011 / EN 55022
ECO1-400/3 - ECO1-750/3 (IP20 only)	6SE3290-0DC87- 0FA4	6SE3290-0DC87-0FB4	EN 55011 / EN 55022
ECO1-110/2 - ECO1-400/2 (IP56 only)	6SE3290-0DG87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1-550/2	6SE3290-0DG87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1-750/2	6SE3290-0DH87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1-1100/2 - ECO1-2200/2	6SE3290-0DJ87- 0FA6	6SE2100-1FC21	EN 55011 / EN 55022
ECO1-3000/2 - ECO1-4500/2	6SE3290-0DK87- 0FA7		EN 55011 / EN 55022
ECO1-300/3 - ECO1-1500/3 (IP56 only)	6SE3290-0DG87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1- 1100/3 - ECO1-1500/3	6SE3290-0DG87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1-1850/3 - ECO1-2200/3	6SE3290-0DH87- 0FA5	6SE2100-1FC20	EN 55011 / EN 55022
ECO1-3000/3 - ECO1-4500/3	6SE3290-0DJ87- 0FA6	6SE2100-1FC21	EN 55011 / EN 55022
ECO1-5500/3 - ECO1-9000/3	6SE3290-0DK87- 0FA7		EN 55011 / EN 55022

Maximum mains supply voltage when filters are fitted is 460V.

Three classes of EMC performance are available.

These levels of performance are only achieved when using the default switching frequency (or less) and a maximum screened motor cable length of 25 m.

Compliance with the EMC Product Standard for Power Drive Systems EN 61800-3 for use in Second Environment (Industrial) and Restricted Distribution.

Class 1: General Industrial

EMC Phenomenon	Standard	Level
Emissions:		
Radiated Emissions	EN 55011	Level A1 *
Conducted Emissions	EN 61800-3	*
Immunity:		
Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
Burst Interference	EN 61000-4-4	2 kV power cables, 1 kV control
Radio Frequency Electromagnetic Field	IEC 1000-4-3	26-1000 MHz, 10 V/m

* Emission limits not applicable inside a plant where no other consumers are connected to the same electricity supply transformer

Class 2: Filtered Industrial

This level of performance will allow the manufacturer/assembler to self-certify their apparatus for compliance with the EMC directive for the industrial environment as regards the EMC performance characteristics of the power drive system. Performance limits are as specified in the Generic Industrial Emissions and Immunity standards EN 50081-2 and EN 50082-2.

EMC Phenomenon	Standard	Level
Emissions:		
Radiated Emissions	EN 55011	Level A1
Conducted Emissions	EN 55011	Level A1
Immunity:		
Supply Voltage Distortion	IEC 1000-2-4 (1993)	
Voltage Fluctuations, Dips, Unbalance, Frequency Variations	IEC 1000-2-1	
Magnetic Fields	EN 61000-4-8	50 Hz, 30 A/m
Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
Burst Interference	EN 61000-4-4	2 kV power cables, 2 kV control
Radio Frequency Electromagnetic Field, amplitude modulated	ENV 50 140	80-1000 MHz, 10 V/m, 80% AM, power and signal lines
Radio Frequency Electromagnetic Field, pulse modulated	ENV 50 204	900 MHz, 10 V/m 50% duty cycle, 200 Hz repetition rate

Class 3: Filtered - for residential, commercial and light industry

This level of performance will allow the manufacturer / assembler to self-certify compliance of their apparatus with the EMC directive for the residential, commercial and light industrial environment as regards the EMC performance characteristics of the power drive system. Performance limits are as specified in the generic emission and immunity standards EN 50081-1 and EN 50082-1.

EMC Phenomenon	Standard	Level
Emissions:		
Radiated Emissions	EN 55022	Level B1
Conducted Emissions	EN 55022	Level B1
Immunity:		
Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
Burst Interference	EN 61000-4-4	1 kV power cables, 0.5 kV control

The MICROMASTER Eco and MIDIMASTER Eco units are intended exclusively for professional applications. Therefore, they do not fall within the scope of the harmonics emissions specification EN 61000-3-2.

EMC Law: For Power Drive Systems EN61800-3

UNRESTRICTED DISTRIBUTION

When the product is available to the general public, an EC declaration of conformity and CE mark are required. (This is not applicable to the MICROMASTER Eco range which is always supplied via restricted distribution channels).

RESTRICTED DISTRIBUTION

When the product is not available to the general public (expert use only) EC declaration of conformity and CE mark are not required. However, components must be designed in such a way that they will not cause EMC disturbances when properly installed.

Limits specified in EN 61800-3

Characteristic	First Environment (Domestic)		Second Environment (Industrial)	
	Unrestricted	Restricted	Unrestricted	Restricted
Radiated Emissions	Class B (10m)	Class A (30m)	No limits specified - EMC warning required	No limits specified - information required
Conducted Emissions	Class B	Class A	Class A	based on today's unfiltered drives
Harmonics	1EC 1000-3-2(4)	1EC 1000-3-2(4)	"reasonable economic approach"	"reasonable economic approach"

ELECTRO-MAGNETIC INTERFERENCE (EMI)

The inverters are designed to operate in an environment where a high level of Electro-Magnetic Interference (EMI) can be expected. Usually, good installation practices will ensure safe and trouble-free operation. If there are any problems, the following guidelines may prove useful. In particular, grounding of the system at the inverter, as described below, may prove effective. The figures at the end of this section illustrate how filters should be installed and connected.

- Ensure that all equipment in the cubicle is well earthed using short, thick earthing cable connected to a common star point or busbar. It is particularly important that any control equipment (such as a BMS), that is connected to the inverter is also connected to the same earth or star point as the inverter via a short, thick link. Flat conductors (e.g. braids or metal brackets) are preferred as they have lower impedance at high frequencies.

  Connect the return earth from motors controlled by the inverter directly to the earth connection (PE) on the associated inverter.

- On the MIDIMASTER Eco, use saw-tooth washers when mounting the inverter and ensure that a good electrical connection is made between the heatsink and the back panel, removing paint if necessary to expose bare metal.

- Wherever possible, use screened leads for connections to the control circuitry. Terminate both the ends of the cable neatly, ensuring that unscreened wires are as short as possible. Use cable glands whenever possible and earth both ends of the screen on the control cable.

- Separate the control cables from the power connections as much as possible, using separate trunking, etc. If control and power cables need to cross, arrange the cables so that they cross at 90° if possible.

- Ensure that contactors in the cubicle are suppressed, either with R-C suppressors for AC contactors or 'flywheel' diodes for DC contactors, fitted to the coils. Varistor suppressors are also effective. This is particularly important if the contactors are controlled from the output relay on the inverter.

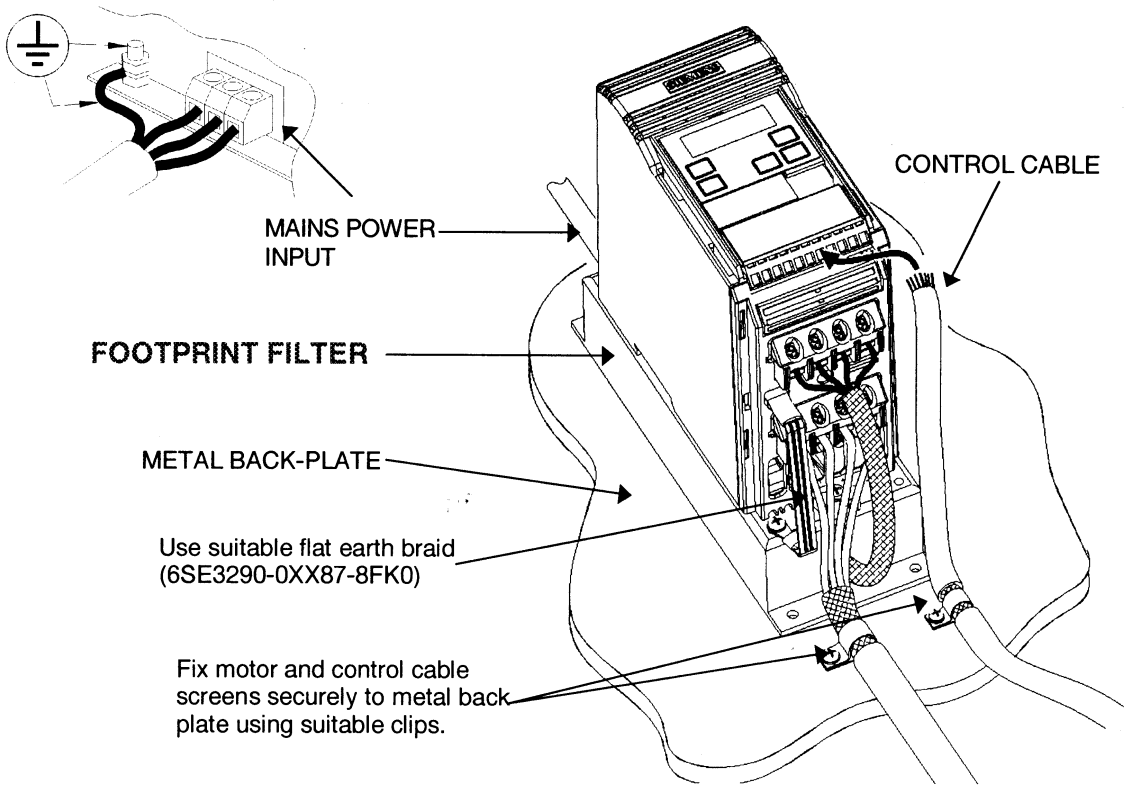
- Use screened or armoured cables for the motor connections and ground the screen at both ends via the cable glands.

- If the drive is to be operated in an Electro-magnetic noise-sensitive environment, the RFI filter should be used to reduce the conducted and radiated interference from the inverter. For optimum performance, there should be a good conductive bond between filter and metal mounting plate.

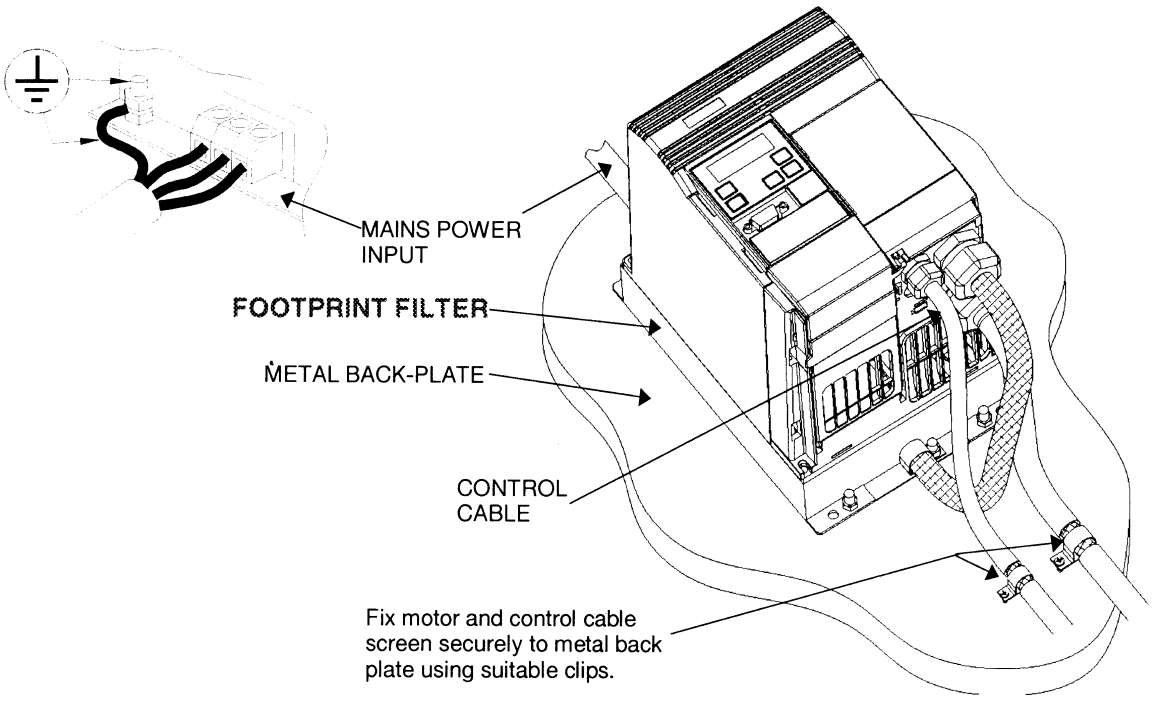
On no account must safety regulations be compromised when installing inverters!

WIRING GUIDELINES TO MINIMISE EFFECTS OF EMI

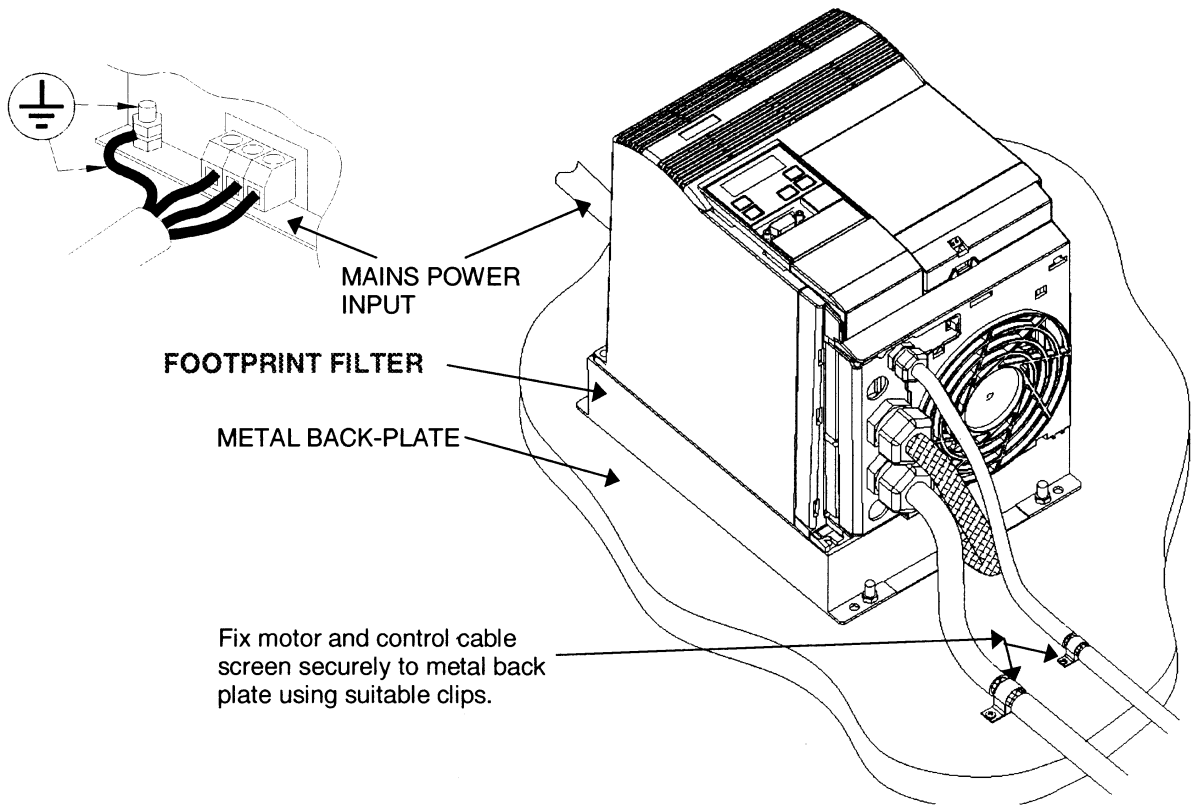
Frame Sizes A, B and C



Wiring guidelines to minimise effects of EMI MICROMASTER Eco (frame size A)



Wiring guidelines to minimise effects of EMI - MICROMASTER Eco (Frame Size B)

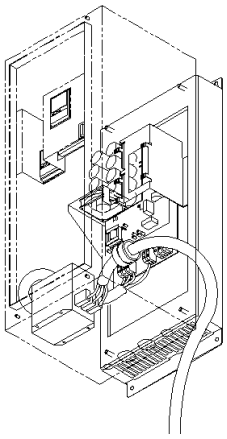


Wiring guidelines to mnimise effects of EMI - MICROMASTER Eco (Frame size C)

Frame Sizes 4 to 7 - IP56

Fitting of Accessory Filter (Frame Sizes 4,5 and 6, IP56)

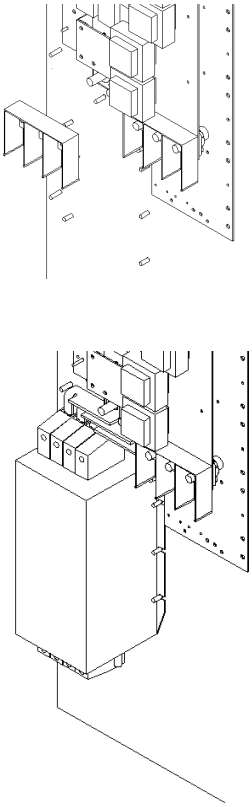
- The filter is mounted on the studs in the base of the enclosure
- Integral filter cables are connected to the inverter input terminals
- The input supply is brought through the gland position in the right hand face of the IP56 enclosure and connected to the filter input terminals.
- Motor and control connections are as standard.



Filter mounted within the IP56 MIDIMASTER Eco Frame size 4, 5 & 6

Fitting of Accessory Filter (Frame Sizes 7, IP56)

- Remove and discard the inverter input terminal connector plate.
- Remove the eight screws securing the input terminal divider to the printed circuit board.
- Remove and discard the input terminal divider.
- Refit the eight screws in the board.
- Fit the filter to the mounting studs.
- Connect the output of the filter to the input terminals of the inverter using the bus-bars supplied with the drive.



Filter mounted within the Frame Size 7 IP56 MIDIMASTER Eco

13. PROGRAMMING

The parameter settings required can be entered using the three parameterisation buttons, P, ▲ and ▼, on the front panel of the inverter. The parameter numbers and values are indicated on the four digit LED display.

KEYPAD

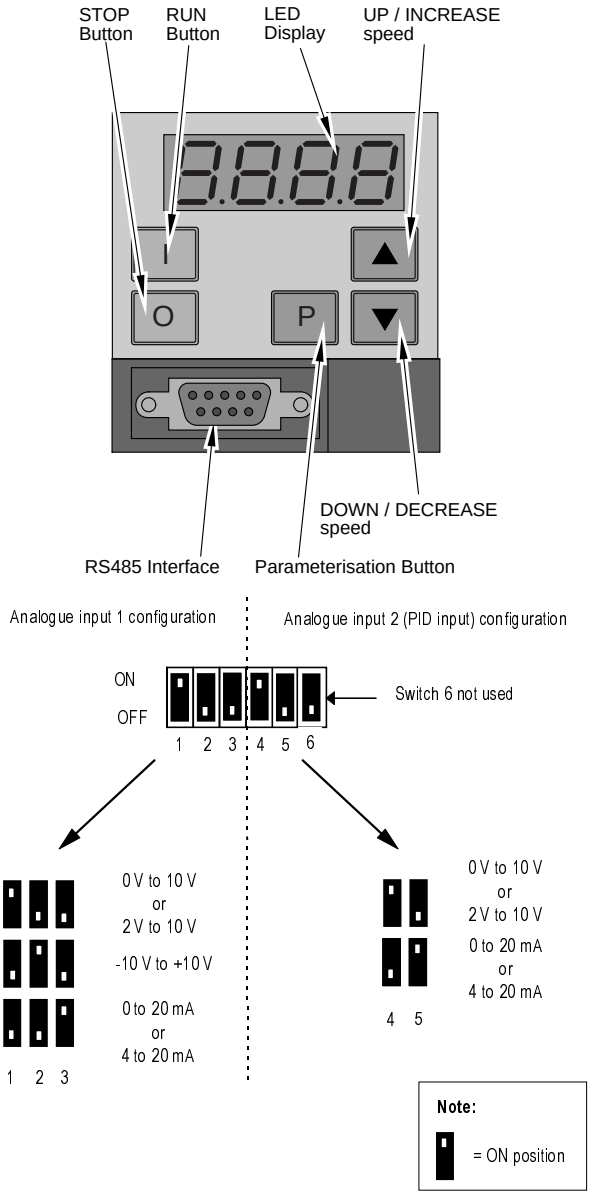
The keypad comprises membrane-type keys as well as an integral 4-digit 7-segment LED display. The keys are limited to [run], [stop], [up], [down] and [P]. All parameters can be accessed and changed using the keys.

DIP SELECTOR SWITCHES

DIP switches select between voltage (V) and current (I) analogue inputs. They also select either a voltage or current PID feedback signal. These switches can only be accessed when:

- the front cover is removed on the MICROMASTER Eco and MIDIMASTER Eco, Frame size 4, 5 and 6.
- the lower front cover is removed on the MIDIMASTER Eco, Frame size 7.

The five DIP selector switches have to be set in agreement with Parameters P023 or P323, according to the operation of the inverter. The figure opposite, shows the settings of the switches for the different modes of operation.



DIP Selector Switches

PARAMETER TYPES

There are three types of parameters:

- **True value parameters.**
  For example, setting parameter P003 ramp-down time to 10 seconds tells the Eco to take 10 seconds to slow the motor from its normal operating speed to stopped.
- **Limited range parameters**.
  The values themselves are not relevant and only represent the function required. For example:
  1. Parameter P199 can only be set to 0 or 1.
  2. setting the value to 0 tells the Eco to give access to the basic parameters only.
  3. setting the value to 1 gives access to the expert parameters.
- **'Read only' parameters.**
  The values of these parameters are factory set and provide the user with information. For instance, parameter P111 is a read only parameter and indicates the inverter's variable torque power rating in kW.

PARAMETER RANGES

The Eco has three ranges of parameters;

- Display mode
- Basic mode
- Expert mode.

One of the Basic mode parameters (P199) controls access to the Expert mode parameters.

ACCESSING PARAMETERS AND CHANGING VALUES

The ▲ and ▼ keys are used to change parameter values. The keys have two modes of operation:

- A single momentary press will change the value by a value of 1.
- Keeping the button pressed for longer initiates scrolling and allows values to be changed rapidly.

To access a parameter and change its value, follow the simple sequence described below:

Key	Action	Display
P	Press **P** to enter parameter mode	P000
▲ ▼	Use the [**up**] and [**down**] keys to select the required parameter number (eg ramp-up time)	P002
P	Press **P** to confirm that you wish to enter a value for that parameter. The current value is displayed	020.0
▲ ▼	Use the [**up**] and [**down**] keys to change the required value	025.0
P	Press **P** to confirm that you have changed the value as required. The parameter number is re-displayed.	P002
▲ ▼	Use the [**up**] and [**down**] keys to return the parameter number to the display default parameter.	P000
P	Press **P** to return to default display. The display will alternate between the setpoint frequency and actual output frequency, which will be 0 Hz.	

DISPLAY MODE PARAMETERS

Parameter	Function	Range	Default	Units
P000	Operating display	-	(output frequency)	Hz

Displays the output selected by P001 (an Expert mode parameter).

Display selection via P001:

0 = Output frequency (Hz)
1 = Frequency setpoint (i.e. speed at which inverter is set to run) (Hz)
2 = Motor current (A)
3 = DC-link voltage (V)
4 = Motor torque (% nominal)
5 = Motor speed (rpm)
6 = USS serial bus status
7 = PID Feedback signal (%)
8 = Output voltage (V)

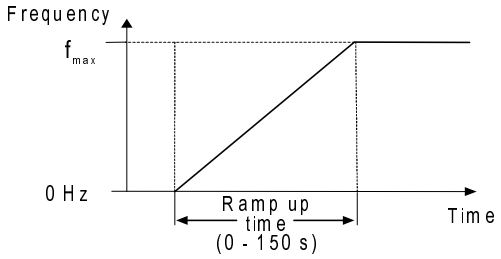
The default setting (0) displays the inverter output frequency. If the inverter is in stand-by mode, the flashing display will alternate between the setpoint frequency and actual output frequency, which will be 0 Hz when not being run.

In the event of a failure, the relevant fault code (Fnnn) is displayed.

BASIC MODE PARAMETERS

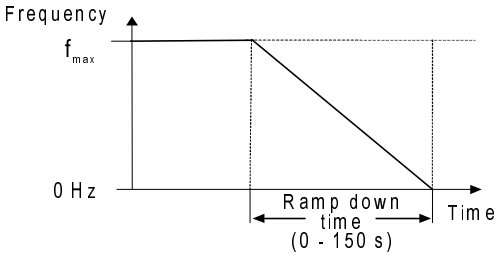
Parameter	Function	Range	Default	Units
P002	Ramp-up time	0 - 150.0	20	seconds

This is the time taken for the motor to accelerate from standstill to the maximum frequency. The maximum frequency is set by parameter P013. Setting the ramp-up time too short can cause the inverter to trip (Fault code F002 = overcurrent).



P003	Ramp-down time	0 - 150.0	20	seconds

This is the time taken for the motor to decelerate from maximum frequency to standstill. The maximum frequency is set by parameter P013. Setting the ramp-down time too short can cause the inverter to trip (Fault code F001 = DC link overvoltage). This is also the period for which injection braking is applied, if selected (refer to parameter P073 in Expert mode).



P006	Frequency setpoint source selection	0 - 2	0	-

The value of this parameter 0, 1, 2 or 3) selects the mode of control of the inverter's frequency setpoint.

0 = digital motorised potentiometer. the inverter runs at the frequency set in P005 (refer to Expert mode) and can be controlled with the [**up**] and [**down**] keys. If P007 (see below) is set to 0, the frequency can be increased or decreased by setting any two of the digital inputs (P051 to P055 or P356 - refer to Expert mode) to the values of 11 and 12.

1 = Analogue. the inverter output frequency is controlled by analogue input signals (0-10V, 0/4-20mA or potentiometer).

2 = Fixed frequency. Fixed frequency is only selected by setting the value of at least one of the digital inputs (P051 to P055 or P536 - refer to Expert mode) to the value of 6 or 18.

Parameter	Function	Range	Default	Units
P007	Keypad control	0 or 1	1	-

The value of this parameter (0 or 1) configures keypad control.

0 = Control is by digital inputs (P051 to P055 or P356 - refer to Expert mode)

1 = Front panel (keypad) control enabled. However, the level of control enabled from the keypad is determined by the values of P121 and P124 (refer to Expert mode).

P012	Minimum motor frequency	0.0 - 150.0	0.00	Hz

This value sets the minimum motor frequency and must logically be less then the value of P013 (see below

P013	Minimum motor frequency	0.0 - 150.0	50.00 60.0 (North America)	Hz

This value sets the maximum motor frequency. To maintain stable operation, this value should not generally exceed the nominal rating plate motor nominal frequency when operating pumps and fans.

P016	Start on the fly	0 or 2	0	

Flying restart

P016=0 Flying restart disabled

P016=2 Flying restart enabled

Allows the inverted to start onto a spinning motor.

Always enter the correct motor nameplate details when enabling this feature.

P081	Motor rating plate nominal frequency	0 - 150.0	50.00 60.0 (North America)	**Hz**
P082	Motor rating plate nominal speed	0 - 999	Depends on inveter rating	RPM
P083	Motor rating plate nominal current	0.1 - 300.0	Depends on inveter rating	A
P084	Motor rating plate nominal voltage	0 - 1000	Depends on inverter rating	V
P085	Motor rating plate nominal power	0.12 - 250.00	Depends on inverter rating	kW (hp - North America)

*** Parameters P081 to P085 - Notes**

- These parameters must be set for the particular motor being controlled by the inverter. You must use the data provided on the motor's rating plate.
- Perform an automatic calibration (P088 = 1 - refer to Expert mode) if any of the parameters P081 to P085 are changed from their factory default settings.
- When the inverter is set-up for North America operation (P101 = 1 - refer to Expert mode), P081 will default to 60 Hz and P085 will indicate in hp (range = 016 to 250).

Parameter	Function	Range	Default	Units
P199	Access to Expert mode	0 or 1	-	-

This value enables or disables access to Expert mode parameters.

0 = Normal mode parameter values only can be changed.

1 = Expert mode parameter values can be changed in addition to the Normal mode parameters.

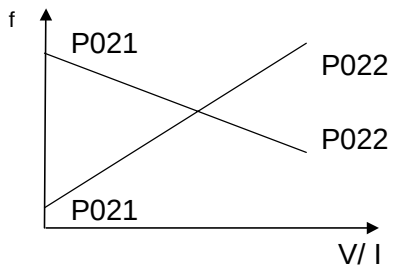
It is possible to reset all parameter values to their factory default settings using expert parameter P944.

EXPERT MODE PARAMETERS

In the following parameter table:

'•' Indicates parameters that can be changed during operation.
'☆☆☆' Indicates that the value of this factory setting depends on the rating of the inverter.

Parameter	Function	Range [default]	Description / Notes
P001	Display mode	0 - 8 [0]	Display selection: 0 = Output frequency (Hz) 1 = Frequency setpoint (i.e. speed at which inverter is set to run) (Hz) 2 = Motor current (A) 3 = DC-link voltage (V) 4 = Motor torque (% nominal) 5 = Motor speed (rpm) 6 = USS serial bus status *(see section 9.2)* 7 = PID Feedback signal (%) 8 = Output voltage (V) The display can be scaled via P010.
P005	Digital frequency setpoint (Hz)	0 - 150.0 [50] (60)North America	Sets the frequency that the inverter will run at when operated in digital mode. Only effective if P006 = 0 or 3.
P010	Display scaling	0.01 - 500.0 [1.00]	Scale factor for display selected when P001 = 0, 1, 4, 5, 7 or 9.
P014	Skip frequency 1 (Hz) (Not applicable in PID mode)	0 - 150.0 [0.0]	A skip frequency can be set with this parameter to avoid the effects of resonance of the inverter. Frequencies within +/- (the value of P019) of this setting are suppressed. Stationary operation is not possible within this suppressed frequency range - the range is just passed through. Setting P014=0 disables this function.

P015	Automatic re-start after mains break	0 -1 [1]	0 = No re-start after mains break - run signal must be re-generated 1 = Automatic re-start after mains break if run signal is present
P018	Automatic restart after fault	0 - 1 [0]	Automatic restart after fault: 0 = Disabled 1 = The inverter will attempt to restart up to 5 times after a fault. If the fault is not cleared after the 5th attempt, the inverter will remain in the fault state. The display flashes during this condition. **WARNING:** While waiting to re-start, the display will flash. This means that a start is pending and may happen at any time. Fault codes can be observed in P930.
P019	Skip frequency bandwidth (Hz)	0.0 - 10.0 [2.0]	Frequencies set by P014, P027, P028 and P029 that are within +/- the value of P019 of all skip frequencies are suppressed.
P021	Minimum analogue frequency (Hz)	0 - 150.0 [0.0]	Frequency corresponding to the lowest analogue input value, i.e.0 V/0 mA or 2 V/4 mA, determined by P023 and the settings of the DIP selector switches 1, 2 and 3 (*see the DIP Selector Switches figure in this section).* This can be set to a higher value than P022 to give an inverse relationship between analogue input and frequency output *(see diagram in P022).*
P022	Maximum analogue frequency (Hz)	0 - 150.0 [50.0] (60)North America	Frequency corresponding to the highest analogue input value, i.e.10 V or 20 mA, determined by P023 and the setting of the DIP selector switches 1, 2 and 3 (*see the DIP Selector Switches figure in this section).* This can be set to a lower value than P021 to give an inverse relationship between analogue input and frequency output. i.e.  Note: The output frequency is limited by values entered for P012/P013.

P023	Analogue input 1 type	0 - 2 [0]	Sets analogue input type for analogue input 1, in conjunction with the settings of the DIP selector switches 1, 2 and 3 (See *see the DIP Selector Switches figure in this section)* 0 = 0 V to 10 V/ 0 to 20 mA Unipolar input 1 = 2 V to 10 V/ 4 to 20 mA Unipolar input 2 = 2 V to 10 V/ 4 to 20 mA Unipolar input with controlled start/stop when using analogue input control.
P025	Analogue output 1 Models above 7.5kW only	0 - 105 [0]	This provides a method of scaling the analogue output 1 in accordance with the following table: Use range 0 - 5 if minimum output value = 0 mA. Use range 100 - 105 if minimum output value = 4 mA

P025= Range	Selection	Analogue Output Limits
		0/4 mA
0/100	Output frequency	0 Hz
1/101	Frequency setpoint	0 Hz
2/102	Motor current	0A
3/103	DC-link voltage	0 V
4/104	Motor torque	-250%
5/105	Motor RPM	0

P026.	Analogue output 2 (MDV only)	0 - 105 [2]	This provides a method of scaling the analogue output 2 in accordance with the table shown in P025.
P027.	Skip frequency 2 (Hz)	0 - 150.0 [0.0]	*See P014.*
P028.	Skip frequency 3 (Hz)	0 - 150.0 [0.0]	*See P014.*
P029.	Skip frequency 4 (Hz)	0 - 150.0 [0]	*See P014.*
P041.	Fixed frequency1 (Hz)	0 - 150.00 [5.00]	Valid if P006 = 2 and P055 = 6 or 18
P042.	Fixed frequency 2 (Hz)	0 - 150.00 [10.00]	Valid if P006 = 2 and P054 = 6 or 18
P043.	Fixed frequency 3 (Hz)	0 - 150.00 [15.00]	Valid if P006 = 2 and P053 = 6 or 18

P044.	Fixed frequency 4 (Hz)	0 - 150.00 [20.00]	Valid if P006 = 2 and P052 = 6 or 18.
P046.	Fixed frequency 5 (Hz)	0 - 150.00 [25.0]	Valid if P006 = 2 and P051 = 6 or 18..
P047.	Fixed frequency 6 (Hz)	0 - 150.00 [30.0]	Valid if P006 = 2 and P356 = 6 or 18.
P051	Selection control function, DIN1 (terminal 5), fixed frequency 5.	0 - 24 [1]	See table overleaf
P052	Selection control function, DIN2 (terminal 6), fixed frequency 4.	0 - 24 [10]	See table overleaf
P053	Selection control function, DIN3 (terminal 7), fixed frequency 3.	0 - 24 [6]	See table overleaf
P054	Selection control function, DIN4 (terminal 8), fixed frequency 2.	0 - 24 [6]	See table overleaf
P055	Selection control function, DIN5 (terminal 16), fixed frequency 1.	0 - 24 [6]	See table overleaf
P056	Selection control function, DIN6 (terminal 17), fixed frequency 6.	0 - 24 [6]	See table overleaf

Value	Function of P051 to P055 and P356	Function, low state (0V)	Function, high state (>10V)
0	Input disabled	-	-
1	On right	Off	On right
4	OFF2	OFF2	On
5	OFF3	OFF3	On
6	Fixed frequencies 1-6	Off	On
9	USS operation (P910 = 1 or 3)	Local (see P006, P007)	USS control
10	Fault reset	Off	Reset on rising edge
11	Increase frequency*	Off	Increase
12	Decrease frequency*	Off	Decrease
13	Switch between analogue input frequency setting and digital/keypad frequency setting	Analogue setpoint	Digital setpoint
14	Disable the ability to change parameters	'P' enabled	'P' disabled
18	Fixed frequencies 1-6, but input high will also request RUN when P007 = 0	Off	On
19	External trip	Off	On
22	Download parameter set 0 from Ope***	Off	Download
23	Download parameter set 1 from OPe***	Off	Download
24	Switch analogue setpoint	Analogue input 1 active	Analogue input 2 active

* Only effective when P007 = 0.

** Not available on P051, P052 or P356.

*** The motor must be stopped before downloading begins.

Downloading takes approx. 30 seconds.

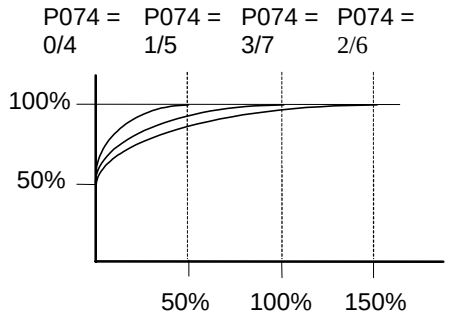
P061	Selection relay output RL1	0 - 13 [6]	Sets the relay function, output RL1 (terminals 18,19 and 20)

Value	Relay function	Active [3]
0	No function assigned (relay not active)	Low
1	Inverter is running	High
2	Inverter frequency 0.0 Hz	Low
5	Inverter frequency less than or equal to minimum frequency	Low
6	Fault indication [1]	Low
7	Inverter frequency greater than or equal to setpoint	High
9	Output current greater than or equal to P065	High
12	PID closed loop motor LOW speed limit	High
13	PID closed loop motor HIGH speed limit	High

[1] Inverter switches off (see parameter P930 and P140 to P143 and section 7).
[2] Inverter does not trip(see parameter P931).
[3] 'Active low' = relay OFF/ de-energised or 'Active high' = relay ON/ energised

P062	Selection relay output RL2. Models above 7.5kW only	0 - 13 [1]	Sets the relay function, output RL2 (terminals 21and 22) *(refer to the table in P061)*.
P065	Current threshold for relay (A)	0.0-300.0 [1.0]	This parameter is used when P061 = 9. The relay switches on when the motor current is greater than the value of P065 and switches off when the current falls to 90% of the value of P065 (hysteresis).
P066	Compound braking	0 - 250 [0]	0 = Off 1 to 250 = Defines the level of DC superimposed on the AC waveform, expressed as a percentage of P083. Generally, increasing this value improves braking performance, however, with 400V inverters, a high value in this parameter could cause F001 trips.

P073.	DC injection braking (%)	0 - 200 [0] Range is Variant dependent	This rapidly stops the motor by applying a DC braking current and holds the shaft stationary until the end of the braking period. Additional heat is generated within the motor. Braking is effective for the period of time set by P003. The DC brake can be activated using DIN1 to DIN6 *(see P051 to P055 and P356)*. **WARNING:** Frequent use of long periods of DC injection braking can cause the motor to overheat. If DC injection braking is enabled via a digital input then DC current is applied for as long as the digital input is high. This causes heating of the motor.

P074.	I^2t motor protection	0 - 7 [1]	Selects the most appropriate curve for the motor de-rating at low frequencies due to the reduced cooling effect of the shaft mounted cooling fan.  I_N = Nominal motor current (P083) F_N = Nominal motor frequency (P081) I_N = Nominal motor current (P083) F_N = Nominal motor frequency (P081) 0 = No de-rating. Suitable for motors with separately powered cooling or no fan cooling which dissipate the same amount of heat regardless of speed. 1 = For 2 or 4-pole motors which generally have better cooling due to their higher speeds. The inverter assumes that the motor can dissipate full power at • 50% nominal frequency. 2 = Suitable for special motors not continuously rated at nominal current at nominal frequency.. 3 = For 6 or 8-pole motors. The inverter assumes that the motor can dissipate full power at • nominal frequency. 4 = As P074 = 0 but the inverter trips (F074) instead of reducing the motor torque / speed. 5 = As P074 = 1 but the inverter trips (F074) instead of reducing the motor torque / speed. 6 = As P074 = 2 but the inverter trips (F074) instead of reducing the motor torque / speed. 7 = As P074 = 3 but the inverter trips (F074) instead of reducing the motor torque / speed.

P076.	Pulse frequency	0 - 7 [0]	Sets the pulse frequency (from 2 to 16 kHz) and the PWM mode. If silent operation is not absolutely necessary, the losses in the inverter as well as the RFI emissions can be reduced by selecting lower pulse frequencies. 0/1 = 16 kHz (230 V default) 2/3 = 8 kHz 4/5 = 4 kHz (400 V default) 6/7 = 2 kHz Even numbers = normal modulation technique. Odd numbers = lower loss modulation technique used when operating mainly at speeds above 5 Hz. (Not generally for fan and pump applications)

Due to higher switching losses at increased frequencies, certain inverters may have their maximum continuous current (100%) derated if the switching frequency is changed from the default value.

Model	% of full load de-rating	
	16 kHz	8 kHz
MICROMASTER		
ECO1-110/3	50	80
ECO1-150/3	50	80
ECO1-220/3	80	100
ECO1-300/3	50	80
ECO1-400/3	50	80
ECO1-550/3	50	80
ECO1-750/3	50	80

If switching frequency is 2 kHz or 4 kHz then derating does not occur on the above inverters.

Model	% of full load de-rating	
	16 kHz	8 kHz
MIDIMASTER		
ECO1-550/2	60	90
ECO1-750/2	55	90
ECO1-1100/2	64	90
ECO1-1500/2	60	100
ECO1-1850/2	47	80
ECO1-2200/2	43	79
ECO1-1100/3	57	90
ECO1-1500/3	50	83
ECO1-1850/3	64	90
ECO1-2200/3	55	75
ECO1-3000/3	50	90
ECO1-3700/3	47	88
ECO4500/3	40	75
ECO1-750/4	75	100
ECO1-1100/4	55	100
ECO1-1500/4	39	75
ECO1-1850/4	64	90
ECO1-2200/4	55	75

On all FS6 575V and all FS7 MIDIMASTER Eco inverters, the switching frequency can only be either 2kHz or 4kHz.

P079	Starting boost	0 -250 [50]	Sets additional current during ramping to ensure consistent starting and to overcome stiction effects
P080	Nominal rating plate motor power factor (cosφ)	0.00-1.00 [☆☆☆]	If efficiency is shown on the motor rating plate, calculate the power factor as follows: pf = If neither power factor nor efficiency are shown on the motor rating plate - set P080 = 0.
P086.	Motor current limit (%)	0 - 200 [100]	Defines the motor overload current as a % of the Nominal motor current (P083) allowed for up to one minute. With this parameter and P186, the motor current can be limited and overheating of the motor prevented. If this set value is exceeded for one minute, the output frequency is reduced until the current falls to that set in P083.The inverter can be made to trip by using the relay in conjunction with P074. The maximum value that P086 can be set to is automatically limited by the rating of the inverter.
P087	Motor PTC enable	0 -1 0]	0 = disabled 1 = enabled (inverter will trip F004 if external PTC input goes high impedance)
P088	Automatic calibration	0 - 1 [1]	The motor stator resistance is used in the inverter's internal current monitoring calculations. When P088 is set to ‘1’ and the RUN button is pressed, the inverter performs an automatic measurement of motor stator resistance; stores it in P089 and then resets P088 to ‘0’. If the measured resistance is too high for the size of inverter (e.g. motor not connected or unusually small motor connected), the inverter will trip (fault code F188) and will leave P088 set to ‘1’. If this happens, set P089 manually and then set P088 to ‘0’.

P089	Stator resistance (Ω)	0.01-199.99 [☆☆☆]	Can be used instead of P088 to set the motor stator resistance manually. The value entered should be the resistance measured across any two motor phases. **WARNING:** The measurement should be made at the inverter terminals with power off. If the value of P089 is too high then an overcurrent trip (F002) may occur.
P091	Serial link slave address	0 - 30 [0]	Up to 31 inverters can be connected via the serial link and controlled by a computer or PLC using the USS serial bus protocol. This parameter sets a unique address for the inverter.
P092	Serial link baud rate	3 - 7 [6]	Sets the baud rate of the RS485 serial interface (USS protocol): 3 = 1200 baud 4 = 2400 baud 5 = 4800 baud 6 = 9600 baud 7 = 19200 baud Some RS232 to RS485 converters are not capable of baud rates higher than 4800.
P093	Serial line time-out (seconds)	0 - 240 [0]	This is the maximum permissible period between two incoming data telegrams. This feature is used to turn off the inverter in the event of a communications failure. Timing starts after a valid data telegram has been received and if a further data telegram is not received within the specified time period, the inverter will trip and display fault code F008. Setting the value to zero switches off the control.
P094	Serial link nominal system setpoint (Hz)	0 - 150.0 [50.0] (60)North America	Setpoints are transmitted to the inverter via the serial link as percentages. The value entered in this parameter represents 100% (HSW = 4000H).
P095	USS compatibility	0 - 2 [0]	0 = Compatible with 0.1 Hz resolution 1 = Enable 0.01 Hz resolution 2 = HSW is not scaled but represents the actual frequency value to a resolution of 0.01 Hz (e.g. 5000 = 50 Hz).

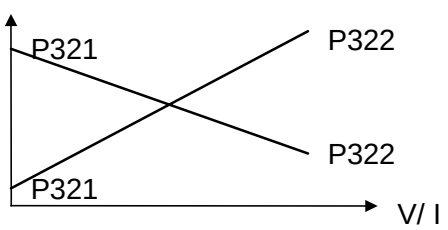
P101	Operation for Europe or North America Factory Default 0 for 230V Eco 2 for 380V to 500V Eco 2 for 525V to 575V Eco	0 - 2 [0 or 2]	This sets the inverter for European or North America supply and nominal rating plate frequency for the motor to: 0 = Europe (50 Hz and power ratings to kW) 1 = North America NEMA (60 Hz and power ratings to hp) 2 = Automatic Selection based on mains voltage mains voltage <450V goes to 0 mains voltage >450V goes to 1 After setting P101 =0 or 1 the inverter must be re-set to factory defaults, i.e. P944 = 1 to automatically set P013 = 60Hz, P081 = 60Hz, P082 = 1680rpm and P085 will be displayed in hp. After setting P101 =2 the inverter will automatically re-set to factory defaults, i.e. P944 = 1
P111	Inverter power rating (kW/hp)	1.1 - 90.0 [☆☆☆]	Read-only parameter that indicates the variable torque power rating of the inverter in kW. E.g. 7.5=7.5kW If P101 = 1 then the rating is displayed in hp.
P112	Inverter type	1 - 10 [☆☆☆]	Read-only parameter. 1 = MICROMASTER 2nd Generation (MM2) 2 = COMBI MASTER 3 = MIDIMASTER 4 = MICROMASTER Junior (MMJ) 5 = MICROMASTER 3rd Generation (MM3) 6 = MICROMASTER Vector (MMV) 7 = MIDIMASTER Vector (MDV) 8 = COMBIMASTER 2nd Generation 9 = MICROMASTER Eco 10 = MIDIMASTER Eco

P113	Drive model	0 - 47 [☆☆☆]	Read-only parameter; indicates the power rating according to the type range indicated by P112.

P113	P112 =9	P112=10	P113	P112=10
0		ECO110/2	26	ECO5500/3
1		ECO150/2	27	ECO7500/3
2		ECO220/2	28	ECO9000/3
3		ECO300/2	*29*	*ECO11000/3*
4		ECO400/2	*30*	*ECO13200/3*
5	ECO110/2	ECO550/2	*31*	*ECO16000/3*
6	ECO150/2	ECO750/2	*32*	*ECO20000/3*
7	ECO220/2	ECO1100/2	*33*	*ECO25000/3*
8	ECO300/2	ECO1500/2	*34*	*ECO31500/3*
9	ECO400/2	ECO1850/2	35	
10		ECO2200/2	*36*	ECO220/4
11		ECO3000/2	*37*	ECO300/4
12		ECO3700/2	*38*	ECO400/4
13		ECO4500/2	*39*	ECO550/4
14	ECO110/3		*40*	ECO750/4
15	ECO150/3	ECO300/3	*41*	ECO1100/4
16	ECO220/3	ECO400/3	42	ECO1500/4
17	ECO300/3	ECO550/3	43	ECO1850/4
18	ECO400/3	ECO750/3	44	ECO2200/4
19	ECO550/3	ECO1100/3	45	ECO3000/4
20	ECO750/3	ECO1500/3	46	ECO3700/4
21		ECO1850/3	47	ECO4500/4
22		ECO2200/3		
23		ECO3000/3		
24		ECO3700/3		
25		ECO4500/3		

P121	Enable/disable RUN button	0 - 1 [1]	0 = RUN button disabled 1 = RUN button enabled (only possible if P007 = 1)
P124	Enable/disable Δ and ∇ buttons	0 - 1 [1]	0 = Δ and ∇ buttons disabled 1 = Δ and ∇ buttons enabled (only possible if P007 = 1) This applies for frequency adjustment only. The buttons can still be used to change parameter values.
P128	Fan switch-off delay time (seconds) (MMV only)	0 - 600 [120]	Time taken for the fan to switch off following an OFF command.

P131	Frequency setpoint (Hz)	0.0-150.0[-]	
P132	Motor current (A)	0.0 - 300.0 [-]	Read-only parameters. These are copies of the values stored in P001 but can be accessed directly via the serial link.
P133	Motor torque (% nominal torque)	0 - 250 [-]	
P134	DC link voltage (V)	0 - 1000 [-]	
P135	Motor RPM	0 - 9999 [-]	
P136	Output voltage (V)	0 - 1000 [-]	
P140	Most recent fault code	0 - 255 [-]	Read only. The last recorded fault code (see 'Fault Codes') is stored in this parameter. It is cleared when the inverter is reset. This is a copy of the code stored in P930.
P141	Most recent fault code -1	0 - 255 [-]	Read only. This parameter stores the last recorded fault code prior to that stored in P140/P930.
P142	Most recent fault code -2	0 - 255 [-]	Read only. This parameter stores the last recorded fault code prior to that stored in P141.
P143	Most recent fault code -3	0 - 255 [-]	Read only. This parameter stores the last recorded fault code prior to that stored in P142.
P201	PID closed loop mode	0 - 1 [0]	0 = Normal operation (closed loop process control disabled). 1 = Closed loop process control using analogue input 2 as feedback.
P202•	P gain	0.0-999.9 [1.0]	Proportional gain.
P203•	I gain	0.00-99.9 [0]	Integral gain.
P204•	D gain	0.0-999.9 [0]	Derivative gain.
P205•	Integral gain scaling	1 - 2400 [1]	The integral action time is multiplied by this value
P206•	Transducer filtering	0 - 255 [0]	0 = Filter off. 1 - 255 = Low pass filtering applied to transducer.
P207•	Integral capture range (%)	0 - 100 [100]	Percentage error above which integral term is reset to zero.

P208	Transducer type	0 - 1 [0]	0 = An increase in motor speed causes an increase in transducer voltage/current output. 1 = A increase in motor speed causes an decrease in transducer voltage/current output.
P210	Transducer reading (%) (unscaled)	0.00-100.00 [-]	Read-only. Value is a percentage of full scale of the selected signal input (i.e. 10 V or 20 mA).
P211•	0% setpoint	0.0 - 100.00 [0.0]	Value of P210 to be maintained for 0% setpoint.
P212•	100% setpoint	0.0 - 100.00 [100.00]	Value of P210 to be maintained for 100% setpoint.
P220	PID frequency cut-off.	0 - 1 [0]	0 = Normal operation. 1 = Switch off inverter output at or below minimum frequency. For correct operation of P220 ensure that P202 >0.
P321•	Minimum analogue frequency for analogue setpoint 2 (Hz)	0 - 150.0 [0.0]	Frequency corresponding to the lowest analogue input value, i.e. 0 V/0 mA or 2 V/4 mA, determined by P323 and the settings of the DIP selector switches 4 and 5 (*see the DIP Selector Switches figure in this section)*. This can be set to a higher value than P322 to give an inverse relationship between analogue input and frequency output *(see diagram in P322)*.
P322•	Maximum analogue frequency for analogue setpoint 2 (Hz)	0 - 150.0 [50.0] (60) North America	Frequency corresponding to the highest analogue input value, i.e. 10 V or 20 mA, determined by P323 and the setting of the DIP selector switches 4 and 5 (*see the DIP Selector Switches figure in this section)*. This can be set to a lower value than P321 to give an inverse relationship between analogue input and frequency output. i.e. 

P323.	Analogue input 2 type	0 - 2 [0]	Sets analogue input type for analogue input 2, in conjunction with the settings of the DIP selector switches 4 and 5 (*see the DIP Selector Switches figure in this section)* : 0 = 0 V to 10 V/ 0 to 20 mA Unipolar input 1 = 2 V to 10 V/ 4 to 20 mA Unipolar input 2 = 2 V to 10 V/ 4 to 20 mA Unipolar input with controlled start / stop when using analogue input control. Setting P323 = 2 will not work unless the inverter is under full local control (i.e. P910 = 0 or 4) and V ≥ 1 V or 2mA. **WARNING:** The inverter will automatically start when voltage goes above 1V. This equally applies to both analogue and digital control (i.e. P006 = 0 or 1)
P356	Digital input 6 configuration	0 - 24 [6]	Control function selection, DIN 6 See P051 - P055 for description.
P386	Inertia compensation	0.1-20.0 [1.0]	To ensure reliable starting on the fly this term may need to be adjusted dependent on load inertia. For high inertia loads increase the setting until reliable re-start occurs following short mains breaks.
P720.	Direct input/output functions	0 - 7 [0]	Allows direct access to the relay outputs and the analogue output via the serial link (USS): 0 = Normal operation 1 = Direct control of relay 1 2 = Direct control of relay 2 3 = Direct control of relay 1 and relay 2 4 = Direct control of analogue output 1 only 5 = Direct control of analogue output 1 and relay 1 6 = Direct control of analogue output 1 and relay 2 7 = Direct control of analogue output 1, relay 1 and relay 2
P721	Analogue input 1 voltage (V)	0.0 - 10.0 [-]	Read only. Displays the analogue input 1 voltage (approximate).
P722.	Analogue output 1 current (mA)	0.0 - 20.0 [0.0]	Allows direct control of the output current if P720 = 4, 5, 6 or 7.

P723	State of digital inputs	0 - 3F [-]	Read-only. Provides a HEX representation of a 6-digit binary number of which the LSB = DIN1 and the MSB = DIN6 (1 = ON, 0 = OFF). e.g. If P723 = B, this represents '001011' - DIN1, DIN2 and DIN4 = ON, DIN3 , DIN5 and DIN6 = OFF.
P724.	Relay output control	0 - 3 [0]	Enables control of the output relays. Used in conjunction with P720, e.g. setting P724 = 1 (relay 1 = ON) has no effect unless P720 = 1, 3, 5,or 7. 0 = Both relays OFF / de-energised 1 = Relay 1 ON / energised 2 = Relay 2 ON / energised 3 = Both relays ON / energised
P725	Analogue input 2 voltage (V)	0.0-10.0 [-]	Read only. Displays the analogue input 2 voltage (approximate) only when analogue input 2 is active (P051 to P055 or P356 = 24 and the respective digital input is high).
P726	Analogue output 2 current (mA) Models above 7.5kW only	0.0-20.0 [0.0]	Allows direct control of the analogue output 2 current if P720 = 4, 5, 6 or 7.
P910.	Local/USS mode	0 - 4 [0]	Sets the inverter for local control or USS control over the serial link: 0 = Local control 1 = Remote control (and setting of parameter values) 2 = Local control (but USS control of frequency) 3 = USS control (but local control of frequency) 4 = Local control (but USS read and write access to parameters and facility to reset trips) When operating the inverter via remote control (P910 = 1 or 2), the analogue input remains active when P006 = 1 and is added to the setpoint.
P922	Software version	0.00 - 99.99 [-]	Contains the software version number and cannot be changed.
P923.	Equipment system number	0 - 255 [0]	You can use this parameter to allocate a unique reference number to the inverter. It has no operational effect.

P930	Most recent fault code	0 - 255 [-]	Read only. The last recorded fault code (see 'Fault Codes') is stored in this parameter. It is cleared when the inverter is reset.(see P140)
P944	Reset to factory default settings	0 - 1 [0]	Set to '1' and then press P to reset all parameters except P101 to the factory default settings. Previously set parameters will be overwritten including the motor parameters P080 - P085

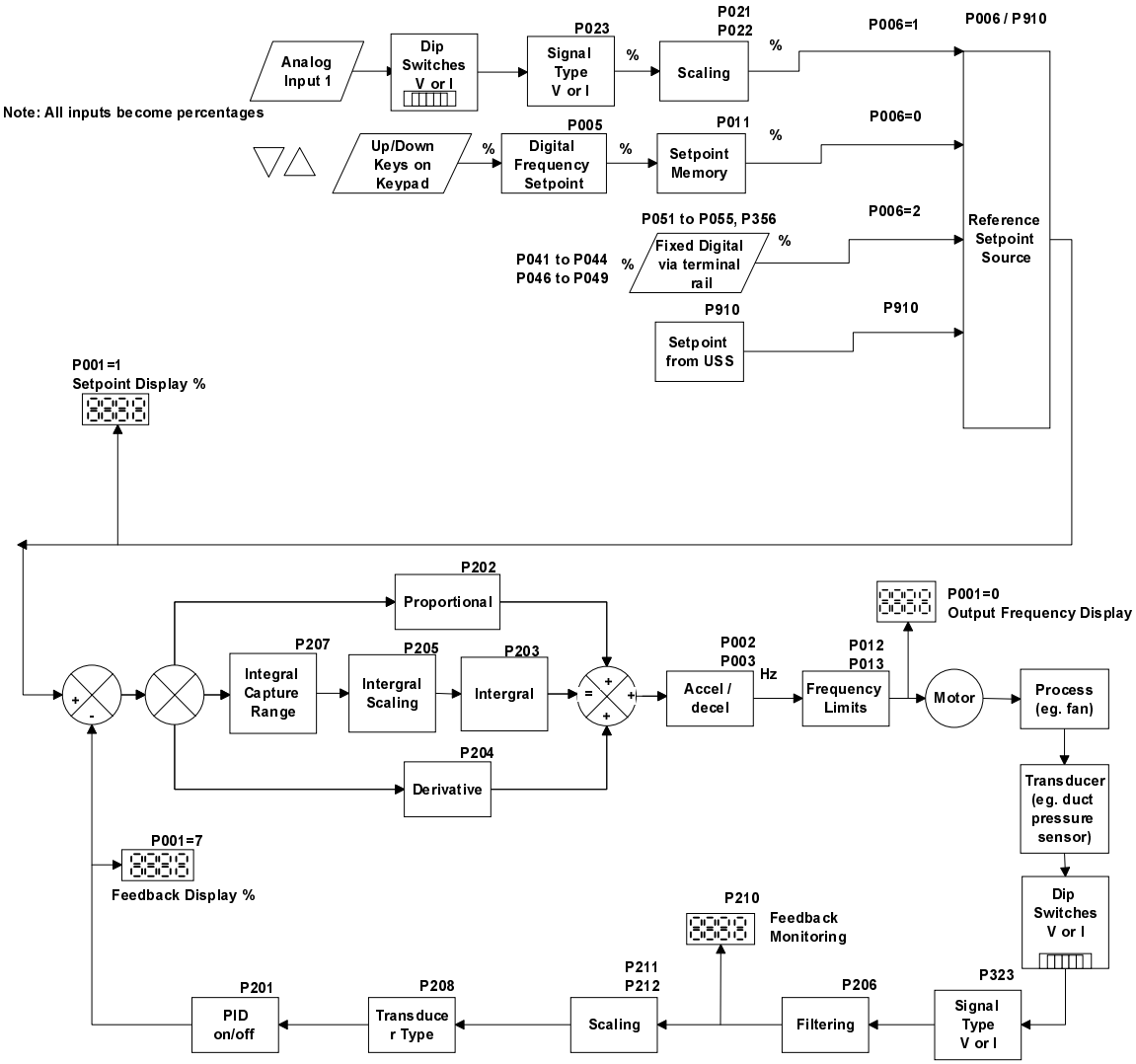
FAULT CODES

Fault Code	Cause	Corrective Action
F001	Overvoltage	Check whether supply voltage is within the limits indicated on the rating plate. Increase the Ramp-down time (P003) or apply braking resistor (option). Check whether the required braking power is within the specified limits.
F002	Overcurrent	Check whether the motor power corresponds to the inverter power. Check that the cable length limits have not been exceeded. Check motor cable and motor for short-circuits and earth faults. Check whether the motor parameters (P080 - P085) correspond with the motor being used. Check the stator resistance (P089). Increase the ramp-up time (P002). Reduce the boost set in P078 and P079. Check whether the motor is obstructed or overloaded.
F003	Overload	Check whether the motor is overloaded. Increase the maximum motor frequency if a motor with high slip is used.
F004	Overheating of motor (monitoring with PTC)	Check if motor is overloaded. Check the connections to the PTC. Check that P087 has not been set to 1 without a PTC being connected.
F005	Inverter overtemperature (internal PTC)	Check that the ambient temperature is not too high. Check that the air inlet and outlet are not obstructed. Check that the inverter's integral fan is working
F008	USS protocol time-out	Check the serial interface. Check the settings of the bus master and P091 - P093. Check whether the time-out interval is too short (P093).
F010	Initialisation fault	Check the entire parameter set. Set P009 to `0000' before power down.
F011	Internal interface fault [1]	Switch off power and switch on again.
F012	External trip	Source of trip is digital input (configured as an external trip input) going low - check the external source.
F013	Programme fault [1]	Switch off power and switch on again.
F016	Flying Start Instability	Disable flying restart Ensure that P080 to P085 correspond to the name plate motor details. Adjust P386. Note that flying restart will not operate correctly with multi-motors.
F018	Auto-restart after fault	Automatic re-start after fault (P018) is pending. **WARNING:** Inverter may start at any time.

Fault Code	Cause	Corrective Action
F074	Motor overtemperature by I^2t calculation	Trip occurs only if P074 = 4, 5, 6 or 7. Check that the motor current does not exceed the value set in P083 and P086.
F106	Parameter fault P006	Parameterise fixed frequency(ies) on the digital inputs.
F012	Parameter fault P012/P013	Set parameter P012 < P013.
F151 F156	Digital input parameter fault	Change the settings of digital inputs P051 to P055 and P356.
F188	Automatic calibration failure	Motor not connected to inverter - connect motor. If the fault persists, set P088 = 0 and then enter the measured stator resistance of the motor into P089 manually.
F212	Parameter fault P211/P212	Set parameter P211 < P212.
F231	Output current measurement imbalance	Check motor cable and motor for short-circuits and earth faults.

PID PROCESS CONTROL

Together with open loop motor control, PID closed loop process control can be applied to any process which is a function of motor speed and for which a transducer is available to provide a suitable feedback signal (*see Figure below*). When closed loop process control is enabled (P201 = 001), all setpoints are calibrated between zero and 100%, i.e. a setpoint of 50.0 = 50%.



Closed Loop Process Control

HARDWARE SET-UP

Make sure that the DIP selector switches 4 and 5 are correctly set (*see the DIP Selector Switches figure in this section*) and in agreement with P323 for unipolar voltage or current feedback signal inputs. Connect feedback transducer between control terminals 10 and 11 (analogue input 2). This analogue input accepts a 0/2 - 10 V or a 0/4 - 20 mA input signal (determined by the setting of the DIP selector switches 4 and 5 and P323) has 10-bit resolution and permits a differential (floating) input. Make sure that the values of parameters P006, P024 are set to 000.

15 V dc power for the feedback transducer can be supplied from terminal 9 on the control terminal block.

PARAMETER SETTINGS

Closed loop process control cannot be used unless P201 is first set to 001. Most of the parameters associated with closed loop process control are shown in the Closed Loop Process Control figure. Other parameters which are also associated with closed loop process control are as follows:

P010 Scaling of display(only if P001 = 1, 4, 5, 7 or 9)

P061 Relay output to indicate when controller has reached output limits (value = 012 or 013)

P220 Auto switch off inverter output when control has reached minimum output level.

14. DE-RATING INFORMATION

THERMAL PROTECTION AND AUTOMATIC DE-RATING

Losses within the power module rise with increasing switching frequencies, leading to higher heatsink temperatures. If the inverter operates outside its recommended ambient operating temperature it would normally trip, with an over-temperature fault code. To avoid such nuisance tripping, the MICROMASTER Eco/MIDIMASTER Eco automatically reduces it's switching frequency (e.g. from 16kHz to 8kHz). This reduces the temperature of the heatsink, enabling the application to continue running - trip free. Should the load or ambient temperature then reduce, the inverter will first check to see if it is safe to increase the switching frequency again and then do so.

See parameter P076 for a list of de-ratings applicable to particular ratings.

MAXIMUM MOTOR CABLE LENGTHS

The tables shown below give an indication of the maximum motor cable allowed to be connected to the inverter without the use of additional output chokes.

I is the motor current and I_N is the nominal motor current (P083). Many application do not require 150% overload i.e. $I/I_N = 1.5$, therefore this ratio may be reduced using P186 (instantaneous current limit) offering the added benefit of driving longer cable lengths.

Standard MICROMASTER Eco units have a maximum value of $I/I_N = 1.5$ (i.e. 150% overload).

For cable lengths greater than those specified in the tables, an external choke is required.

Maximum cable lengths and derating with respect to load current

208/240V MICROMASTER Eco:

Un-screened cable
F_{max}= 16kHz

Current (I/I_N)	ECO1-110/2	ECO1-150/2	ECO1-220/2	ECO1-300/2	ECO1-400/2
	Cable length (m)				
1.5	200	200	185	185	185
1.4	200	200	200	200	200
1.3	200	200	200	200	200
1.2	200	200	200	200	200
1.1	200	200	200	200	200
1.0	200	200	200	200	200

208/240V MICROMASTER Eco:

Screened cable

F_{max}= 16kHz

Current (I/I_N)	ECO1-110/2	ECO1-150/2	ECO1-220/2	ECO1-300/2	ECO1-400/2
	Cable length (m)				
1.5	200	200	155	150	145
1.4	200	200	200	200	200
1.3	200	200	200	200	200
1.2	200	200	200	200	200
1.1	200	200	200	200	200
1.0	200	200	200	200	200

380V/500V MICROMASTER Eco:

Un-screened cable

F_{max}= 4kHz

Current (I/I_N)	ECO1-110/3		ECO1-150/3		ECO1-220/3		ECO1-300/3		ECO1-400/3		ECO1-550/3		ECO1-750/3	
	Cable Length (m)													
	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V
1.5	110	180	110	100	170	165	165	160	200	200	200	200	200	200
1.4	120	110	120	110	175	170	170	165	200	200	200	200	200	200
1.3	130	115	130	115	175	170	170	165	200	200	200	200	200	200
1.2	140	120	140	120	175	170	170	165	200	200	200	200	200	200
1.1	150	130	150	130	175	170	170	165	200	200	200	200	200	200
1.0	160	140	160	140	175	170	170	165	200	200	200	200	200	200

380V/500V MICROMASTER Eco:

Screened cable

F_{max}= 4kHz

Current (I/I_N)	ECO1-110/3		ECO1-150/3		ECO1-220/3		ECO1-300/3		ECO1-400/3		ECO1-550/3		ECO1-750/3	
	Cable Length (m)													
	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V	440V	550V
1.5	80	70	80	70	140	140	135	135	200	200	200	200	200	200
1.4	85	80	85	80	145	145	140	140	200	200	200	200	200	200
1.3	95	80	95	80	145	145	140	140	200	200	200	200	200	200
1.2	100	80	100	80	145	145	140	140	200	200	200	200	200	200
1.1	100	80	100	80	145	145	140	140	200	200	200	200	200	200
1.0	100	80	100	80	145	145	140	140	200	200	200	200	200	200

MAXIMUM OUTPUT CURRENT AT ELEVATED TEMPERATURES - VARIABLE TORQUE APPLICATIONS

Maximum Inverter Output Current With High Ambient Temperature - 25m of Screened Cable or 50m of Unscreened Cable Maximum, Variable Torque Applications (110% overload for 1 minute in every 5 minutes)

	40 deg C				50 deg C				60 deg C				70 deg C			
Model Number	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**
ECO1-550/2 @ 264V	22	22	16.5	8.8	22	22	16.5	8.6	22	22	16.5	8.6	20	17.3	16.5	8.6
ECO1-750/2 @ 264V	28.0	28.0	21	10.9	28	28	21	10.9	28	25.9	21	10.9	20	17.3	17.3	8.8
ECO1-1100/2 @ 264V	42.0	42.0	31.5	23.1	42	42	31.5	23.1	39.9	38.9	31.5	23.1	24.4	24.3	21.3	21.2
ECO1-1500/2 @ 264V	54	54	(a)	(a)	49.7	49.7	(a)	(a)	46.6	46.6	(a)	(a)	37.3	35.4	(a)	(a)
ECO1-1850/2 @ 264V	68.0	68.0	(a)	(a)	52.8	52.8	(a)	(a)	49.5	49.5	(a)	(a)	39.6	37.5	(a)	(a)
ECO1-2200/2 @ 264V	80.0	80.0	(a)	(a)	62.1	62.1	(a)	(a)	58.2	58.2	(a)	(a)	46.6	44.1	(a)	(a)
ECO1-3000/2 @ 264V	95.0	95.0	(a)	(a)	73.7	73.7	(a)	(a)	69.1	69.1	(a)	(a)	55.3	52.4	(a)	(a)
ECO1-3700/2 @ 264V	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	129.2	119.9	(a)	(a)
ECO1-4500/2 @ 264V	154.0	154.0	(a)	(a)	154	154	(a)	(a)	154	154	(a)	(a)	153	142	(a)	(a)
ECO1-1100/3 @ 460V	23.5	23.5	23.5	12.9	21.0	20.4	23.3	12.9	18.6	17.8	21.8	12.9	10.5	10.4	7.0	(b)
ECO1-1500/3 @ 460V	30.0	30.0	22.5	11.7	28.8	26	22.3	11.7	23.7	22.7	20.9	11.7	13.4	13.3	6.7	(b)
ECO1-1850/3 @ 460V	37.0	37.0	33.3	23.7	33.2	30.3	28.3	15.1	24.2	24.2	27.4	15.1	8.4	8.4	10.8	10.1
ECO1-2200/3 @ 460V	43.5	43.5	30	22	39	35.6	25.5	14	28.4	28.4	24.7	14	9.9	9.9	9.7	9.4
ECO1-3000/3 @ 460V	58.0	58.0	(a)	(a)	51.8	51.8	(a)	(a)	35.9	35.9	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 460V	71.0	71.0	(a)	(a)	63.4	63.4	(a)	(a)	44.0	44.0	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 460V	84.0	84.0	(a)	(a)	75	75	(a)	(a)	52	52	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-5500/3 @ 460V	102.0	102.0	(a)	(a)	102.0	100.8	(a)	(a)	102.0	91.7	(a)	(a)	93.5	82.6	(a)	(a)
ECO1-7500/3 @ 460V	138.0	138.0	(a)	(a)	138.0	136.4	(a)	(a)	138.0	124.0	(a)	(a)	126.5	111.7	(a)	(a)
ECO1-9000/3 @ 460V	168.0	168.0	(a)	(a)	168	166	(a)	(a)	168	151	(a)	(a)	154	136	(a)	(a)
ECO1-1100/3 @ 550V	21.1	21.1	21.1	11.6	20.3	18.9	21.1	(b)	16.3	14.8	19.5	(b)	(b)	(b)	(b)	(b)
ECO1-1500/3 @ 550V	27.0	27.0	19.5	8.7	26	24.2	19.5		20.9	18.9	18	(b)	(b)	(b)	(b)	(b)
ECO1-1850/3 @ 550V	33.3	33.3	30	21.3	29.8	28.8	22.5	13.6	22.7	17.9	10.2	10.0	12.1	(b)	(b)	(b)
ECO1-2200/3 @ 550V	39.1	39.1	28.3	19.6	35	33.8	21.2	12.5	26.7	21	9.6	9.2	14.2	(b)	(b)	(b)
ECO1-3000/3 @ 550V	52.2	52.2	(a)	(a)	44.2	44.2	(a)	(a)	31.1	31.1	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 550V	63.9	63.9	(a)	(a)	54.1	54.1	(a)	(a)	38.0	38.0	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 550V	75.6	75.6	(a)	(a)	64	64	(a)	(a)	45	45	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-5500/3 @ 550V	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)	91.8	88.6	(a)	(a)	89.9	79.5	(a)	(a)
ECO1-7500/3 @ 550V	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)	124.2	119.9	(a)	(a)	121.6	107.6	(a)	(a)
ECO1-9000/3 @ 550V	151.2	151.2	(a)	(a)	151.2`	151.2	(a)	(a)	151.2	146	(a)	(a)	148	131	(a)	(a)
ECO1-400/4 @ 660V	6.1	6.1	6.1	6.1												
ECO1-550/4 @ 660V	9.0	9.0	9.0	8.2												
ECO1-750/4 @ 660V	11.0	11.0	11.0	8.2												
ECO1-1100/4 @ 660V	17.0	17.9	17.0	9.3												
ECO1-1500/4 @ 660V	22.0	22.0	16.5	8.6												
ECO1-1850/4 @ 660V	27.0	27.0	24.3	17.3												
ECO1-2200/4 @ 660V	32.0	32.0	24.0	17.6												
ECO1-3000/4 @ 660V	41.0	41.0	(a)	(a)	41.0	41.0	(a)	(a)	36.2	36.2	(a)	(a)	22.6	22.6	(a)	(a)
ECO1-3700/4 @ 660V	52.0	52.0	(a)	(a)	52.0	52.0	(a)	(a)	46.0	46.0	(a)	(a)	28.6	28.6	(a)	(a)
ECO1-4500/4 @ 660V	62.0	62.0	(a)	(a)	62	62	(a)	(a)	54.8	54.8	(a)	(a)	34.1	34.1	(a)	(a)

Notes: (a) Switching frequency not available

(b) Not Possible

MAXIMUM OUTPUT CURRENT WITH LONG UNSCREENED CABLES - VARIABLE TORQUE APPLICATIONS

Maximum Inverter Output Current With Long Unscreened Cable Lengths - 40°C Ambient Temperature Maximum, Variable Torque Applications (110% overload for 1 minute in every 5 minutes)

	up to 50m				up to 100m				up to 200m				up to 300m			
Model Number	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**	**2kHz**	**4kHz**	**8kHz**	**16kHz**
ECO1-550/2 @ 264V	22.0	22.0	16.5	8.6	22.0	22.0	16.5	8.6	21.4	21.1	16.5	8.6	20.8	20.4	16.5	8.6
ECO1-750/2 @ 264V	28.0	28.0	21	10.9	28.0	28.0	21.0	10.9	28.0	27.9	21.0	10.9	27.9	27.9	21.0	10.9
ECO1-1100/2 @ 264V	42.0	42.0	37.8	26.9	42.0	42.0	37.8	26.9	42.0	42.0	37.8	26.9	42.0	41.9	37.8	26.9
ECO1-1500/2 @ 264V	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)
ECO1-1850/2 @ 264V	68.0	68.0	(a)	(a)	57.3	57.3	(a)	(a)	57.3	57.3	(a)	(a)	57.3	57.3	(a)	(a)
ECO1-2200/2 @ 264V	80.0	80.0	(a)	(a)	67.4	67.4	(a)	(a)	67.4	67.4	(a)	(a)	67.4	67.4	(a)	(a)
ECO1-3000/2 @ 264V	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)
ECO1-3700/2 @ 264V	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)
ECO1-4500/2 @ 264V	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)
ECO1-1100/3 @ 460V	23.5	23.5	23.5	12.9	21.9	20.8	23.2	12.9	21.5	20.1	23.0	(b)	21.2	19.5	20.1	(b)
ECO1-1500/3 @ 460V	30.0	30.0	22.5	11.7	28.0	26.6	22.2	11.7	27.5	25.7	22.0	(b)	27.1	24.9	19.2	(b)
ECO1-1850/3 @ 460V	37.0	37.0	33.3	23.7	34.0	33.1	28.2	14.9	33.9	32.1	28.0	14.0	33.3	31.1	27.8	13.1
ECO1-2200/3 @ 460V	43.5	43.5	30	22	40.0	38.9	25.4	13.8	39.9	37.7	25.2	13.0	39.2	36.6	25.0	12.2
ECO1-3000/3 @ 460V	58.0	58.0	(a)	(a)	55.2	55.2	(a)	(a)	55.2	55.2	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 460V	71.0	71.0	(a)	(a)	67.6	67.6	(a)	(a)	67.6	67.5	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 460V	84.0	84.0	(a)	(a)	80.0	80.0	(a)	(a)	80.0	79.9	(a)	(a)	79.9	79.9	(a)	(a)
ECO1-5500/3 @ 460V	102.0	102.0	(a)	(a)	102.0	102.0	(a)	(a)	102.0	102.0	(a)	(a)	102.0	102.0	(a)	(a)
ECO1-7500/3 @ 460V	138.0	138.0	(a)	(a)	138.0	138.0	(a)	(a)	138.0	138.0	(a)	(a)	138.0	138.0	(a)	(a)
ECO1-9000/3 @ 460V	168.0	168.0	(a)	(a)	168.0	168.0	(a)	(a)	168.0	168.0	(a)	(a)	168.0	168.0	(a)	(a)
ECO1-1100/3 @ 550V	21.1	21.1	21.1	11.6	20.2	19.5	21.1	(b)	20.2	18.1	(b)	(b)	(b)	(b)	(b)	(b)
ECO1-1500/3 @ 550V	27.0	27.0	19.5	8.7	25.9	24.9	19.5	(b)	25.9	23.2	(b)	(b)	25.8	21.7	(b)	(b)
ECO1-1850/3 @ 550V	33.3	33.3	30	21.3	32.4	31.3	26.9	14.7	32.3	29.9	26.6	8.9	31.5	(b)	(b)	(b)
ECO1-2200/3 @ 550V	39.1	39.1	28.3	19.6	38.0	36.8	25.4	13.5	37.9	35.1	25.1	8.2	37.0	33.5	22.9	(b)
ECO1-3000/3 @ 550V	52.2	52.2	(a)	(a)	52.2	52.2	(a)	(a)	52.2	52.2	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 550V	63.9	63.9	(a)	(a)	63.9	63.9	(a)	(a)	63.9	63.9	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 550V	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)
ECO1-5500/3 @ 550V	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)
ECO1-7500/3 @ 550V	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)
ECO1-9000/3 @ 550V	151.2	151.2	(a)	(a)	151.2`	151.2	(a)	(a)	151.2	151.2	(a)	(a)	151.2	151.2	(a)	(a)
ECO1-400/4 @ 660V	6.1	6.1	6.1	6.1												
ECO1-550/4 @ 660V	9.0	9.0	9.0	8.2												
ECO1-750/4 @ 660V	11.0	11.0	11.0	8.2												
ECO1-1100/4 @ 660V	17.0	17.0	17.0	9.3												
ECO1-1500/4 @ 660V	22.0	22.0	16.5	8.6												
ECO1-1850/4 @ 660V	27.0	27.0	24.3	17.3												
ECO1-2200/4 @ 660V	32.0	32.0	24.0	17.6												
ECO1-3000/4 @ 660V	41.0	41.0	(a)	(a)	41.0	40.9	(a)	(a)	40.9	40.9	(a)	(a)	40.9	40.8	(a)	(a)
ECO1-37o0/4 @ 660V	52.0	52.0	(a)	(a)	52.0	51.9	(a)	(a)	51.9	51.8	(a)	(a)	51.9	51.7	(a)	(a)
ECO1-4500/4 @ 660V	62.0	62.0	(a)	(a)	62	61.9	(a)	(a)	61.9	61.8	(a)	(a)	61.9	61.7	(a)	(a)

Notes: (a) Switching frequency not available
(b) Not Possible

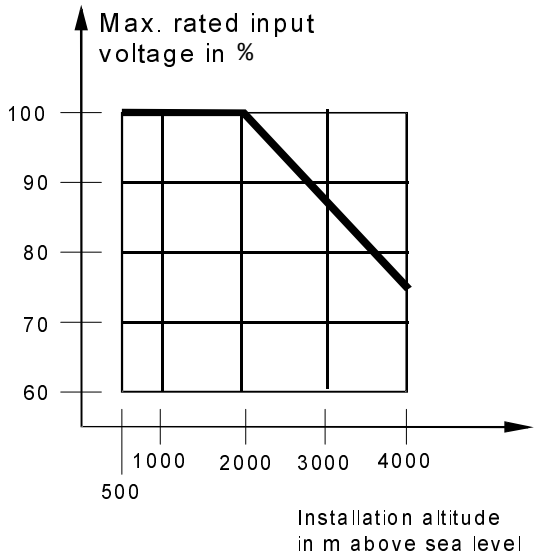
MAXIMUM OUTPUT CURRENT WITH LONG SCREENED CABLES - VARIABLE TORQUE APPLICATIONS

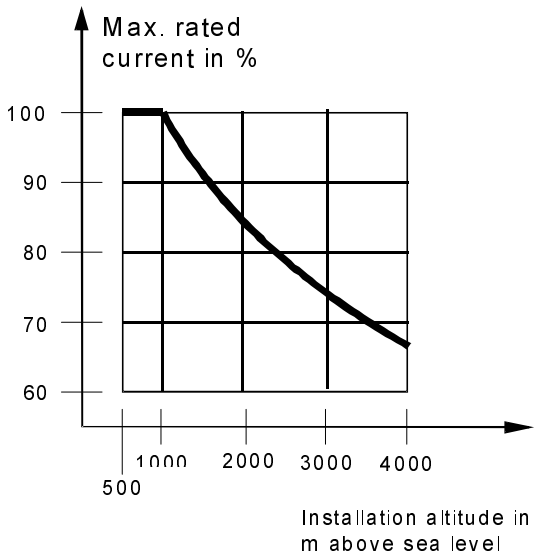
Maximum Inverter Output With Current Long Screened Cable Lengths - 40°C Ambient Temperature Maximum, Variable Torque Applications (110% overload for 1 minute in every 5 minutes)

	up to 50m				up to 100m				up to 200m				up to 300m			
Model Number	2kHz	4kHz	8kHz	16kHz	2kHz	4kHz	8kHz	16kHz	2kHz	4kHz	8kHz	16kHz	2kHz	4kHz	8kHz	16kHz
ECO1-550/2 @ 264V	22.0	22.0	16.5	8.6	21.4	21.0	16.5	8.6	20.2	19.8	16.5	8.6	19.3	18.7	16.5	8.6
ECO1-750/2 @ 264V	28.0	28.0	21	10.9	28.0	28.0	21.0	10.9	28.0	27.9	21.0	10.9	27.9	27.9	21.0	10.9
ECO1-1100/2 @ 264V	42.0	42.0	37.8	26.9	42.0	42.0	37.8	26.9	42.0	41.7	37.8	26.9	41.3	40.8	37.8	26.9
ECO1-1500/2 @ 264V	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)	54.0	54.0	(a)	(a)
ECO1-1850/2 @ 264V	68.0	68.0	(a)	(a)	57.3	57.3	(a)	(a)	57.3	57.3	(a)	(a)	57.3	57.3	(a)	(a)
ECO1-2200/2 @ 264V	80.0	80.0	(a)	(a)	67.4	67.4	(a)	(a)	67.4	67.4	(a)	(a)	67.4	67.4	(a)	(a)
ECO1-3000/2 @ 264V	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)	104.0	104.0	(a)	(a)
ECO1-3700/2 @ 264V	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)	130.0	130.0	(a)	(a)
ECO1-4500/2 @ 264V	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)	154.0	154.0	(a)	(a)
ECO1-1100/3 @ 460V	23.5	23.5	23.5	12.9	21.6	20.5	20.4	(b)	21.2	19.6	20.2	(b)	20.8	18.6	(b)	(b)
ECO1-1500/3 @ 460V	30.0	30.0	22.5	11.7	27.6	26.2	19.5	(b)	27.1	25.0	19.3	(b)	26.6	23.8	(b)	(b)
ECO1-1850/3 @ 460V	37.0	37.0	33.3	23.7	34.0	32.4	28.1	14.5	33.3	31.0	27.8	13.1	32.4	29.8	27.4	11.6
ECO1-2200/3 @ 460V	43.5	43.5	30	22	40.0	38.1	25.3	13.5	39.1	36.5	25.0	12.2	38.1	35.0	24.7	10.8
ECO1-3000/3 @ 460V	58.0	58.0	(a)	(a)	55.2	55.2	(a)	(a)	55.2	55.2	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 460V	71.0	71.0	(a)	(a)	67.6	67.6	(a)	(a)	67.6	67.5	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 460V	84.0	84.0	(a)	(a)	80.0	80.0	(a)	(a)	80.0	79.9	(a)	(a)	79.9	79.8	(a)	(a)
ECO1-5500/3 @ 460V	102.0	102.0	(a)	(a)	102.0	102.0	(a)	(a)	102.0	102.0	(a)	(a)	102.0	101.9	(a)	(a)
ECO1-7500/3 @ 460V	138.0	138.0	(a)	(a)	138.0	138.0	(a)	(a)	138.0	138.0	(a)	(a)	138.0	137.9	(a)	(a)
ECO1-9000/3 @ 460V	168.0	168.0	(a)	(a)	168.0	168.0	(a)	(a)	168.0	168.0	(a)	(a)	168.0	167.9	(a)	(a)
ECO1-1100/3 @ 550V	21.1	21.1	21.1	11.6	20.2	18.8	18.7	(b)	20.2	17.0	(b)	(b)	(b)	(b)	(b)	(b)
ECO1-1500/3 @ 550V	27.0	27.0	19.5	8.7	25.9	24.1	17.3	(b)	25.8	21.7	(b)	(b)	25.3	19.0	(b)	(b)
ECO1-1850/3 @ 550V	33.3	33.3	30	21.3	32.3	30.4	26.7	14.1	31.4	28.3	23.4	(b)	30.3	(b)	(b)	(b)
ECO1-2200/3 @ 550V	39.1	39.1	28.3	19.6	37.9	35.7	25.2	13.0	36.9	33.2	22.1	(b)	35.6	30.9	13.8	(b)
ECO1-3000/3 @ 550V	52.2	52.2	(a)	(a)	52.2	52.2	(a)	(a)	52.2	52.2	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-3700/3 @ 550V	63.9	63.9	(a)	(a)	63.9	63.9	(a)	(a)	63.9	63.9	(a)	(a)	(b)	(b)	(a)	(a)
ECO1-4500/3 @ 550V	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)	75.6	75.6	(a)	(a)
ECO1-5500/3 @ 550V	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)	91.8	91.8	(a)	(a)
ECO1-7500/3 @ 550V	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)	124.2	124.2	(a)	(a)
ECO1-9000/3 @ 550V	151.2	151.2	(a)	(a)	151.2`	151.2	(a)	(a)	151.2	151.2	(a)	(a)	151.2	151.2	(a)	(a)
ECO1-400/4 @ 660V	6.1	6.1	6.1	6.1												
ECO1-550/4 @ 660V	9.0	9.0	9.0	8.2												
ECO1-750/4 @ 660V	11.0	11.0	11.0	8.2												
ECO1-1100/4 @ 660V	17.0	17.0	17.0	9.3												
ECO1-1500/4 @ 660V	22.0	22.0	16.5	8.6												
ECO1-1850/4 @ 660V	27.0	27.0	24.3	17.3												
ECO1-2200/4 @ 660V	32.0	32.0	24.0	17.6												
ECO1-3000/4 @ 660V	41.0	41.0	(a)	(a)	40.9	40.9	(a)	(a)	40.9	40.8	(a)	(a)	40.9	40.7	(a)	(a)
ECO1-3700/4 @ 660V	52.0	52.0	(a)	(a)	51.9	51.9	(a)	(a)	51.9	51.7	(a)	(a)	51.8	51.7	(a)	(a)
ECO1-4500/4 @ 660V	62.0	62.0	(a)	(a)	61.9	61.9	(a)	(a)	61.9	61.7	(a)	(a)	61.8	61.6	(a)	(a)

Notes: (a) Switching frequency not available
(b) Not Possible

VOLTAGE AND CURRENT DE-RATING WITH RESPECT TO ALTITUDE





15. OPTIONS

The MICROMASTER Eco and MIDIMASTER Eco can be enhanced by a range of specially designed options, with various IP ratings:

Accessory	IP Rating	Availability	
		MICROMASTER Eco	MIDIMASTER Eco
Multilingual Clear Text Operator Panel OPe	IP54	Yes	Standard
EMC Filter for EN55011A	IP21 IP21	Standard (1phase) Footprint (3 phase)	Integrated
EMC Filter for EN55011B	IP20	Footprint	External
Motor Chokes for long motor cables	IP00	Yes	
Motor dV/dt filters	IP00	No	Yes
Mains input reactors	IP00	Yes	

These options are described separately below.

CLEAR TEXT OPERATING PANEL OPe

The clear text operating panel consists of a control and display unit that fits directly on top of the MICROMASTER Eco or MIDIMASTER Eco Control panel. A D-Type socket connects directly onto the D-type connector on the front of the unit so that the OPe can take power from and communicate with the drive via the RS485 interface.

The OPe offers the following features:

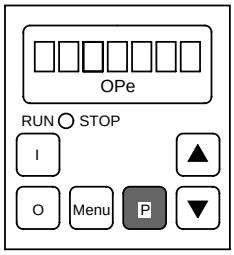
- Seven language (English, German, French, Italian, Spanish, Dutch, Danish) text operation with explanation of parameters, faults etc.
- Diagnostics - help with fault finding.
- Upread/download up to 10 parameter sets from units to OPe and back. This allows fast, reliable programming and copying of parameter sets.
- OPe mounts directly on MICROMASTER Eco and MIDIMASTER Eco.
- Door mounting kit with IP54 protection included.
- Built in RS232 to RS485 Converter for simple connection to computer.
- External supply connector for remote operation and off line programming.
- The OPe has several practical uses; for example:
- The OPe may be mounted directly onto the inverter and used to control the drive directly.
- The OPe can be mounted on a separate panel (using an optional cable of up to 5m) to enable remote control and monitoring of the drive.
- If an external power supply is connected to the OPe, remote control over distances greater than 5m is permissible
- The built in RS232 to RS485 connector can be used to allow communication between a PC and the drive.
- Parameter sets can be stored in the OPe and uploaded or downloaded as required. This is particularly useful where many inverters require programming in production.

(D) OPe - GEBRAUCHSANWEISUNG
(GB) OPe - OPERATING INSTRUCTIONS
(F) OPe - MODE D'EMPLOI
(I) OPe - ISTRUZIONI PER L'USO
(E) OPe - INSTRUCCIONES PARA EL USO
(NL) OPe - BEDININGSHANDLEIDING
(DK) OPe - BETJENINGSREJLEDNING

6SE9590-0XX87-8BFO

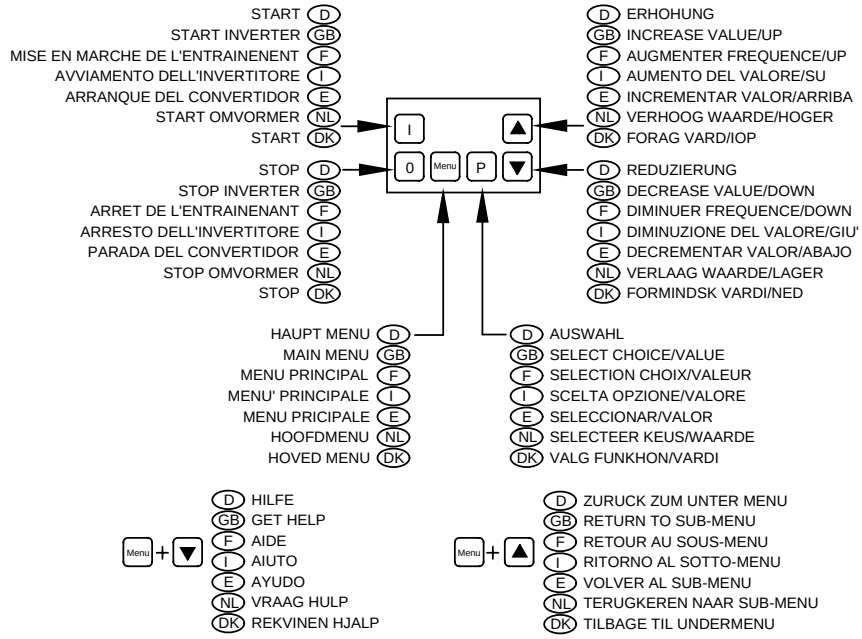
G85139-J1762-U500-A1			Iss	Desc.	Date
Iss	Desc.	Date			
A1	PROD ISSUE	12.06.98			

1

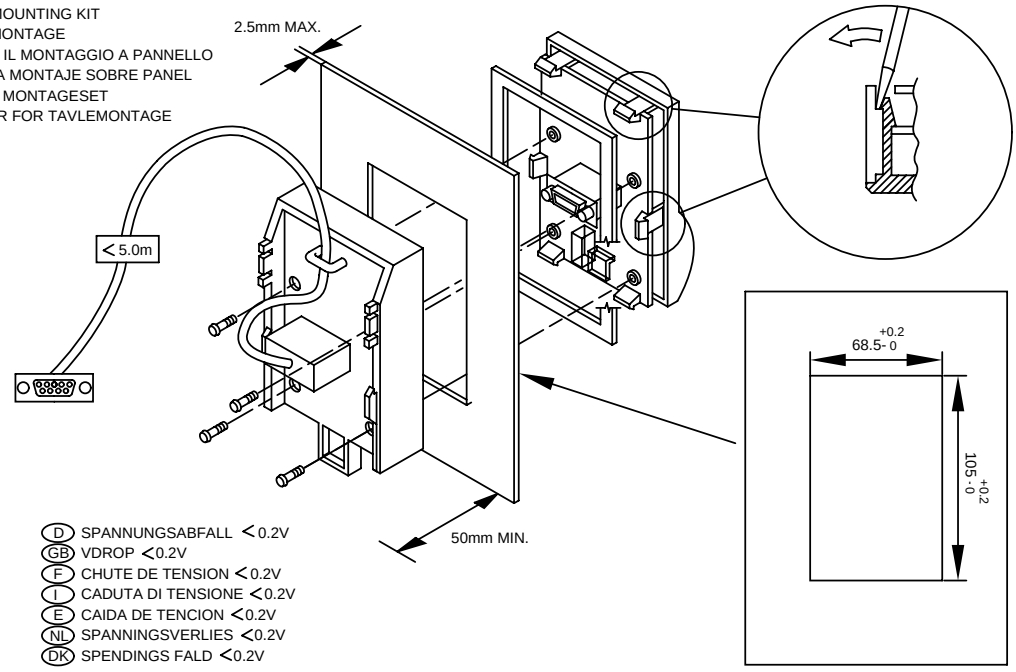


2

3

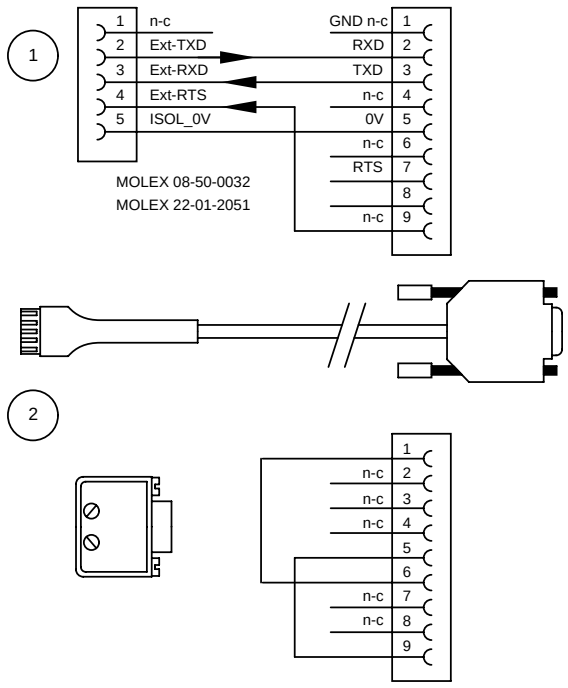


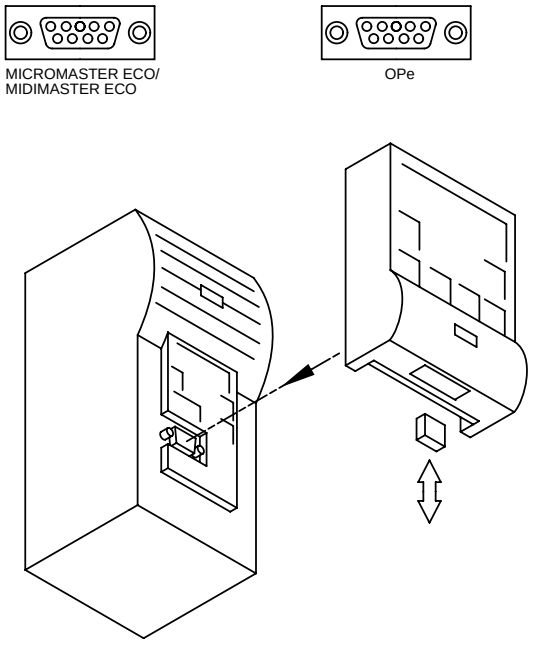
(D) MONTAGE BAUSATZ
(GB) PANEL MOUNTING KIT
(F) KIT DE MONTAGE
(I) KIT PER IL MONTAGGIO A PANNELLO
(E) KIT PARA MONTAJE SOBRE PANEL
(NL) INBOUW MONTAGESET
(DK) ADAPTER FOR TAVLEMONTAGE

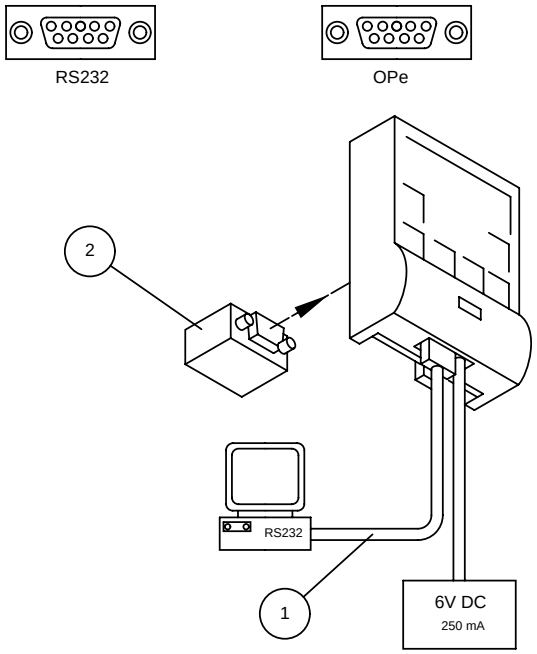


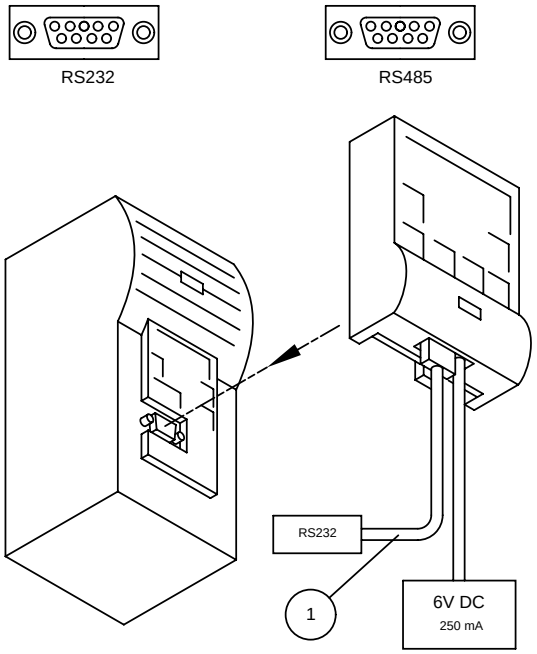
(D) SPANNUNGSABFALL < 0.2V
(GB) VDROP < 0.2V
(F) CHUTE DE TENSION < 0.2V
(I) CADUTA DI TENSIONE < 0.2V
(E) CAIDA DE TENCION < 0.2V
(NL) SPANNINGSVERLIES < 0.2V
(DK) SPENDINGS FALD < 0.2V

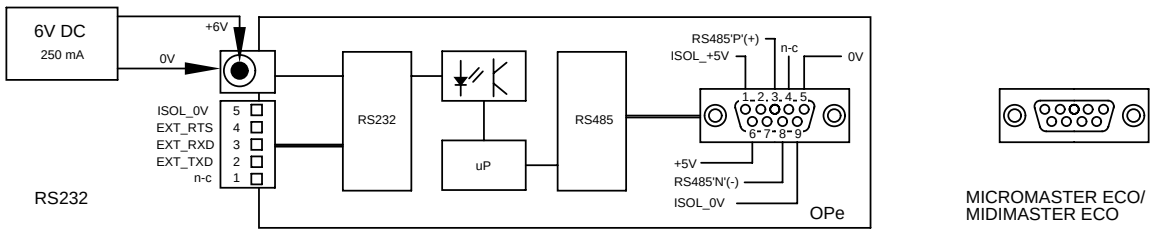
KIT: 6SE3290-0XX87-8SO











EMC FILTERS

RFI Suppression Filters.

MICROMASTER Eco and MIDIMASTER Eco inverters are designed to minimise conducted and radiated radio frequency interference. However, they are power electronic products and generate significant levels of interference over a wide electromagnetic spectrum.

In many applications it is possible to operate without filters or with the built-in filter. However, in order to achieve higher levels of attenuation an external filter may be required. In particular, in order to meet residential, commercial and light industrial levels, an external filter will be needed.

The purpose of RFI filters is to reduce the conducted levels of interference from the inverter to the supply. It is not intended to reduce radiated interference or attenuate interference into the inverter. It should be fitted to the mains input to the inverter only and will be damaged if installed in the inverter output.

The filters are designed to mount underneath the MICROMASTER Eco to minimise space requirements. MIDIMASTER Eco inverters have external separate filters; MIDIMASTER Eco units are also available with built-in filters. Full installation instructions and information concerning the appropriate filters are given below.

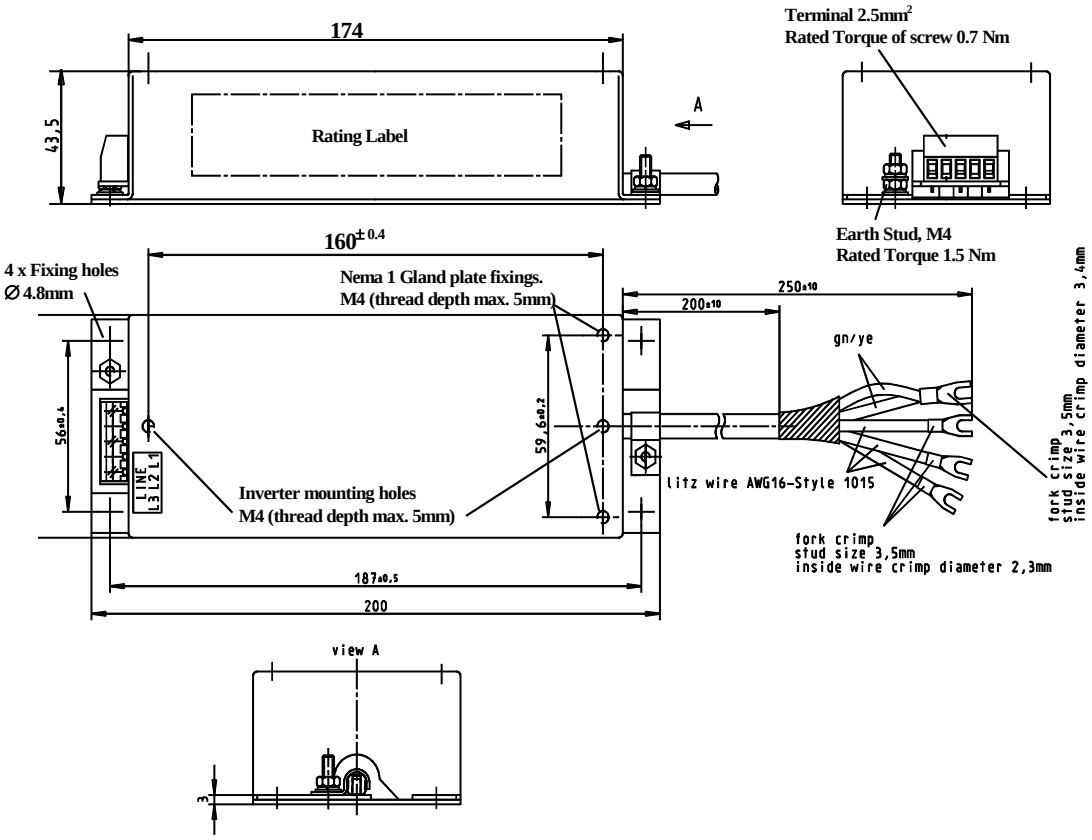
Input EMC Filter Order Numbers

Model/Type	Maximum Variable Torque Continuous Input Current (A)	Frame Size	EMC Input Filter Class A Order Code	EMC Input Filter Class B Order Code
208-240V +/- 10% 3ac	**3ac**		**208-240V +/-10% 3ac**	**208-240V +/-10% 3ac**
ECO1-110/2	6.4	B	6SE3290-ODB87-OFA3	6SE3290-ODB87-OFB3
ECO1-150/2	8.3	B	6SE3290-ODB87-OFA3	6SE3290-ODB87-OFB3
ECO1-220/2	11.7	C	6SE3290-ODC87-OFA4	6SE3290-ODC87-OFB4
ECO1-300/2	16.3	C	6SE3290-ODC87-OFA4	6SE3290-ODC87-OFB4
ECO1-400/2	21.1	C	6SE3290-ODC87-OFA4	6SE3290-ODC87-OFB4
ECO1-550/2	28	4	6SE3290-0DG87-0FA5	6SE2100-1FC20
ECO1-750/2	32	4	6SE3290-0DG87-0FA5	6SE2100-1FC20
ECO1-1100/2	45	5	6SE3290-0DH87-0FA5	6SE2100-1FC20
ECO1-1500/2	61	6	6SE3290-0DJ87-0FA6	6SE2100-1FC21
ECO1-1850/2	75	6	6SE3290-0DJ87-0FA6	6SE2100-1FC21
ECO1-2200/2	87	6	6SE3290-0DJ87-0FA6	6SE2100-1FC21
ECO1-3000/2	105	7	6SE3290-0DK87-0FA7	not available
ECO1-3700/2	113	7	6SE3290-0DK87-0FA7	not available
ECO1-4500/2	152	7	6SE3290-0DK87-0FA7	not available

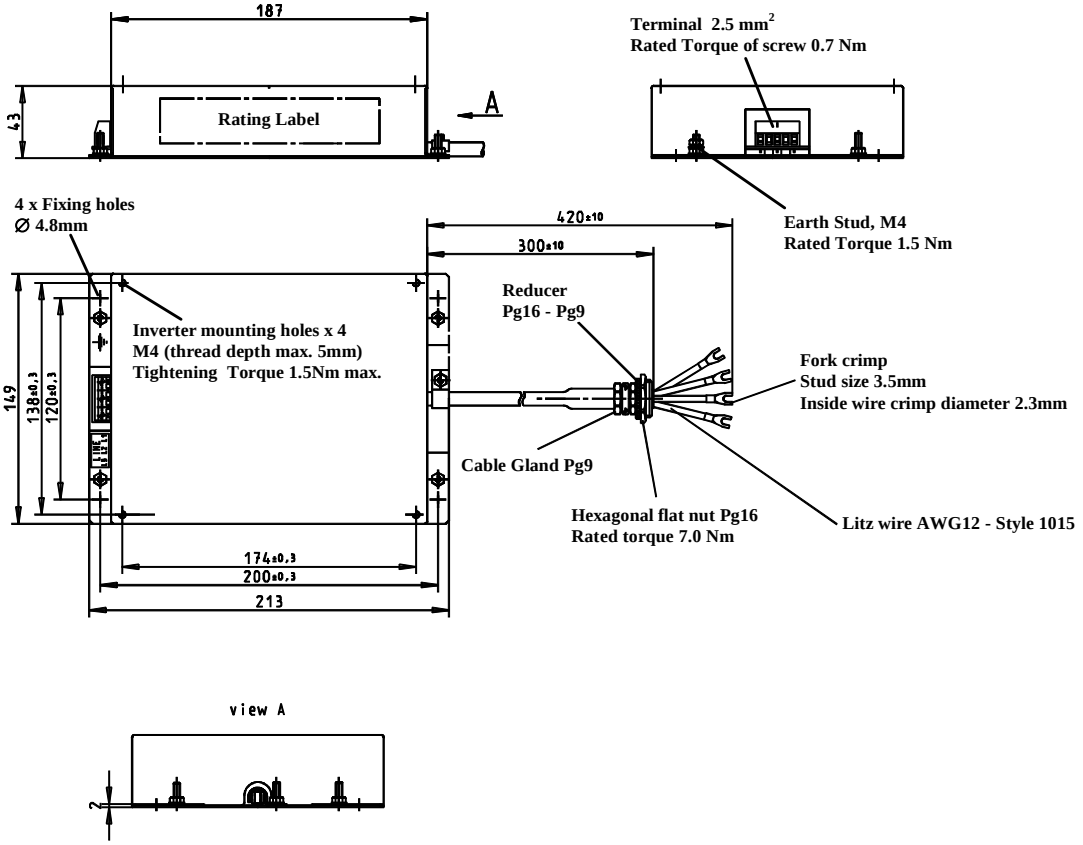
380-500V +/- 10% 3ac			380-460V +/-10% 3ac	380-460V +/-10% 3ac
ECO1-110/3	4.9	A	6SE3290-0DA87-0FA1	6SE3290-0DA87-0FB1
ECO1-150/3	5.9	A	6SE3290-0DA87-0FA1	6SE3290-0DA87-0FB1
ECO1-220/3	8.8	B	6SE3290-0DB87-0FA3	6SE3290-0DB87-0FB3
ECO1-300/3	11.1	B	6SE3290-0DB87-0FA3	6SE3290-0DB87-0FB3
ECO1-400/3	13.6	C	6SE3290-0DC87-0FA4	6SE3290-0DC87-0FB4
ECO1-550/3	17.1	C	6SE3290-0DC87-0FA4	6SE3290-0DC87-0FB4
ECO1-750/3	22.1	C	6SE3290-0DC87-0FA4	6SE3290-0DC87-0FB4
ECO1-1100/3	30	4	6SE3290-0DG87-0FA5	6SE2100-1FC20
ECO1-1500/3	32	4	6SE3290-0DG87-0FA5	6SE2100-1FC20
ECO1-1850/3	41	5	6SE3290-0DH87-0FA5	6SE2100-1FC20
ECO1-2200/3	49	5	6SE3290-0DH87-0FA5	6SE2100-1FC20
ECO1-3000/3	64	6	6SE3290-0DJ87-0FA6	6SE2100-1FC21
ECO1-3700/3	79	6	6SE3290-0DJ87-0FA6	6SE2100-1FC21
ECO1-4500/3	96	6	6SE3290-0DJ87-0FA6	not available
ECO1-5500/3	113	7	6SE3290-0DK87-0FA7	not available
ECO1-7500/3	152	7	6SE3290-0DK87-0FA7	not available
ECO1-9000/3	185	7	6SE3290-0DK87-0FA7	not available
525-575V +/- 15% 3ac				
ECO1-400/4	7	4	not available	not available
ECO1-550/4	10	4	not available	not available
ECO1-750/4	12	4	not available	not available
ECO1-1100/4	18	4	not available	not available
ECO1-1500/4	24	4	not available	not available
ECO1-1850/4	29	5	not available	not available
ECO1-2200/4	34	5	not available	not available
ECO1-3000/4	45	6	not available	not available
ECO1-3700/4	55	6	not available	not available
ECO1-4500/4	65	6	not available	not available

Installation of Filters

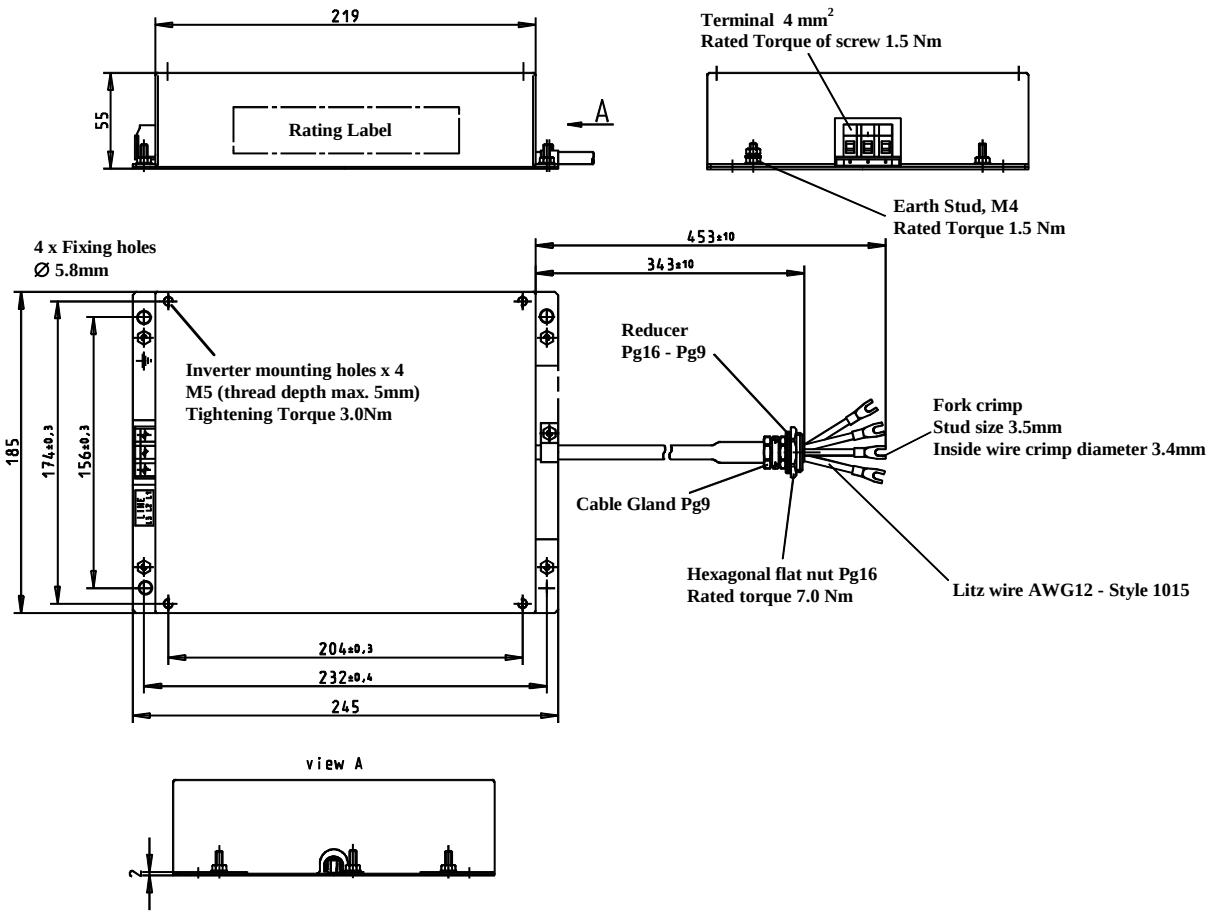
6SE3290-0DA87-0FA1,6SE3290-0DA87-0FB



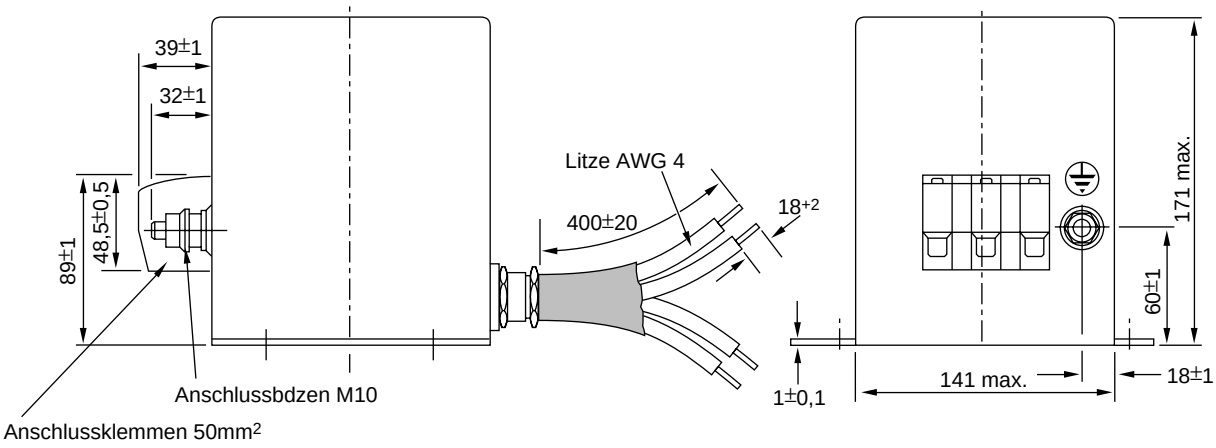
6SE3290-0DB87-0FA3, 6SE3290-0DB87-0FB3

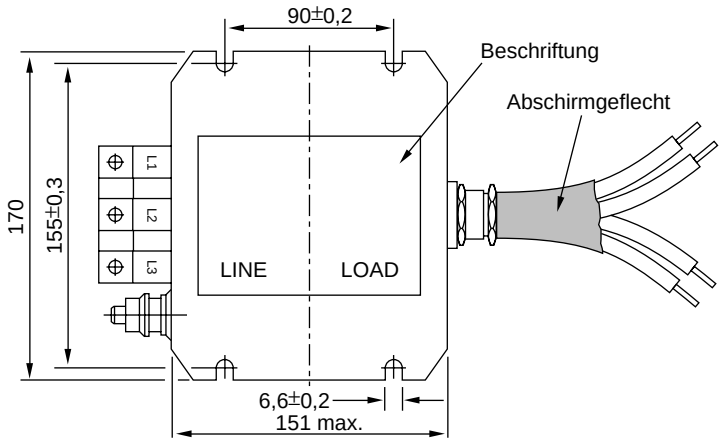


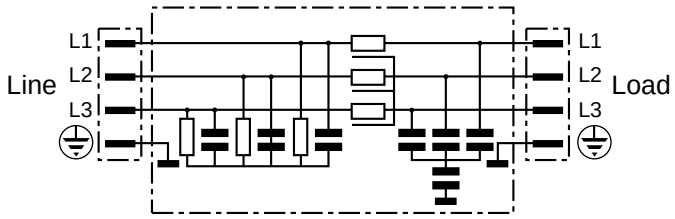
6SE3290-0DC87-0FA4, 6SE3290-0DC87-0FB4



6SE3290-ODJ87-OFA6



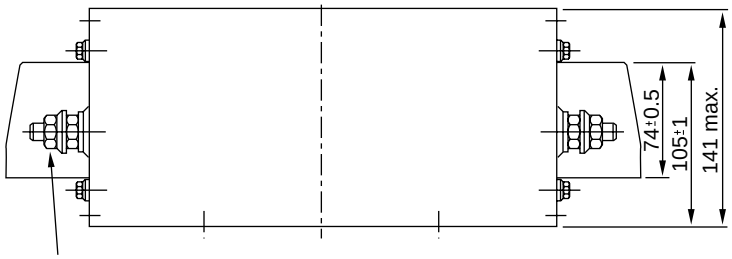


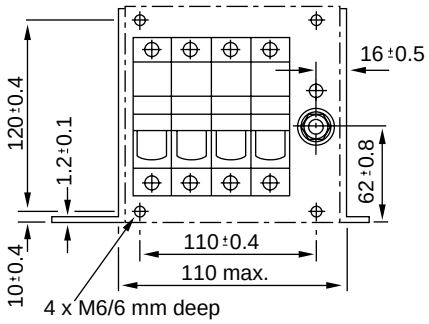


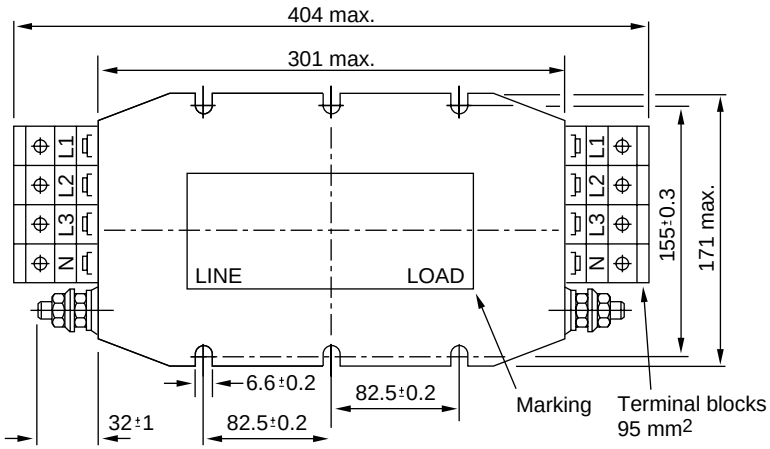
Technical Data

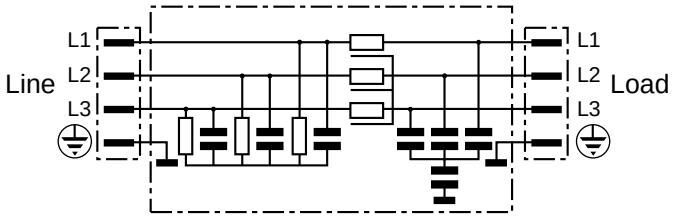
Rated Voltage	440/250V~50/60 Hz
Rated Current	96A Referred ambient 40°C
Test Voltage	1770 V-, 2s (line/line) 2700 V-, 2s (line/case)
IEC Climatic Category	In accordance with IEC 68-1
Feeder Resistor	
Leakage Current	
Approx. Weight	

6SE3290-ODK87-OFA7

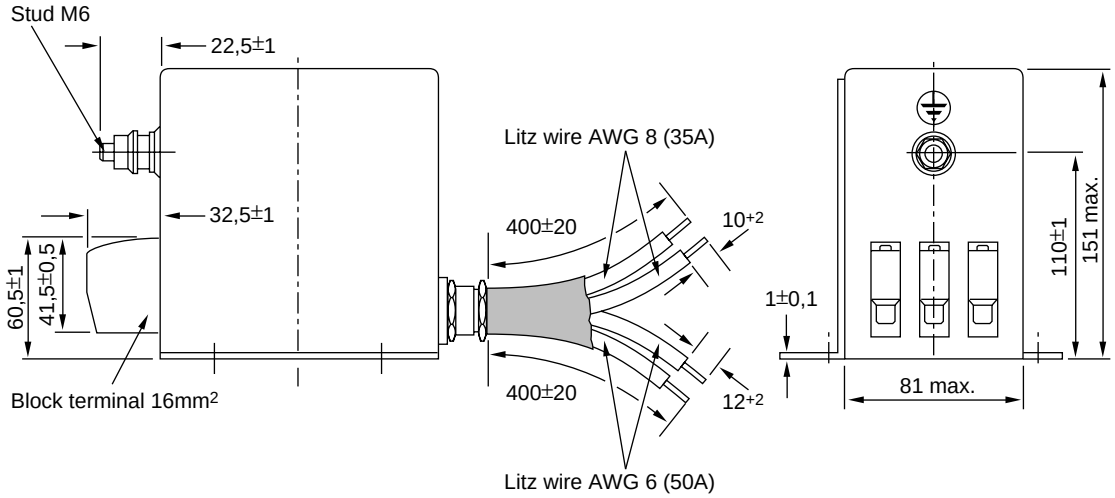


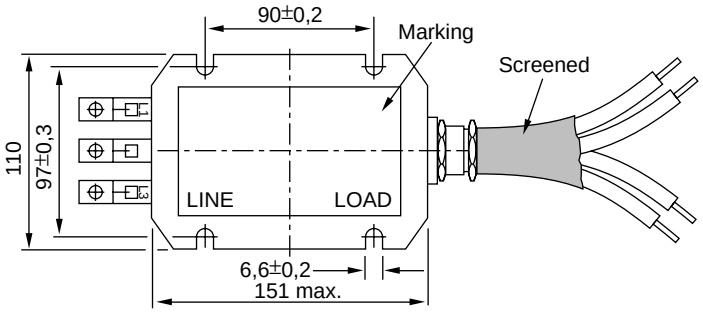


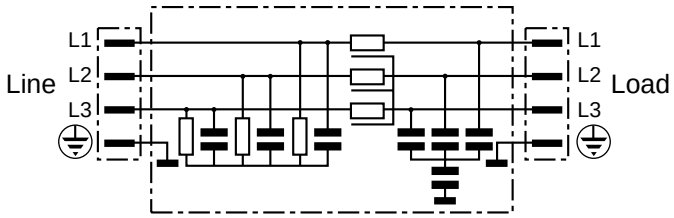




6SE3290-ODG87-OFA5



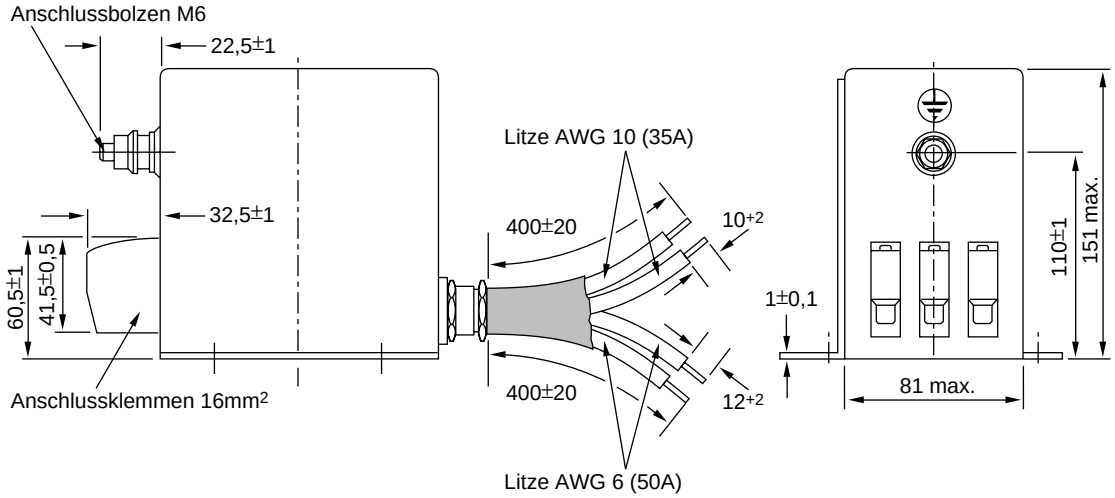


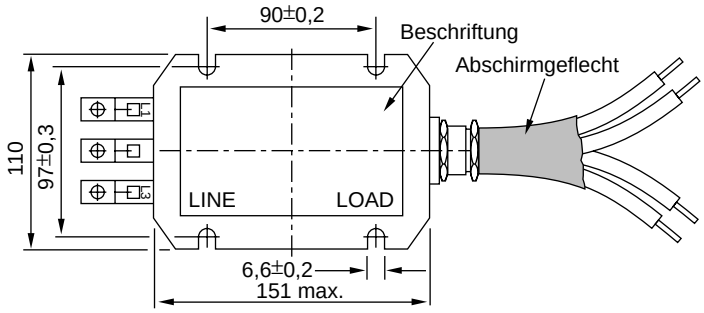


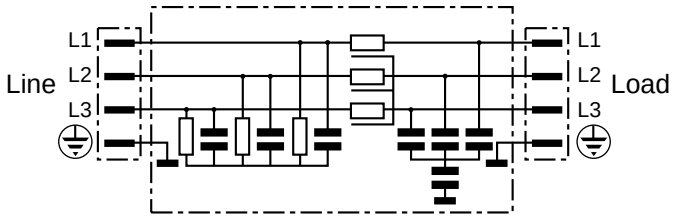
Technical Data

Rated Voltage	440/250V~50/60 Hz
Rated Current	35A Referred ambient 40°C
Test Voltage	1770 V-, 2s (line/line)
	2700 V-, 2s (line/case)
IEC Climatic Category	In accordance with IEC 68-1
Feeder Resistor	
Leakage Current	
Approx. Weight	

6SE3290-ODH87-OFA5



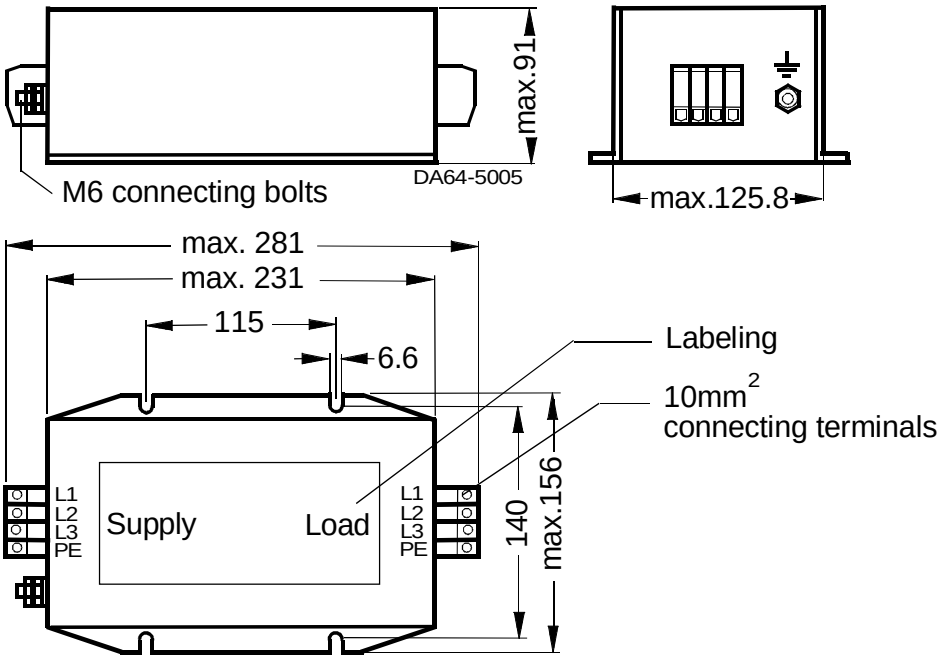




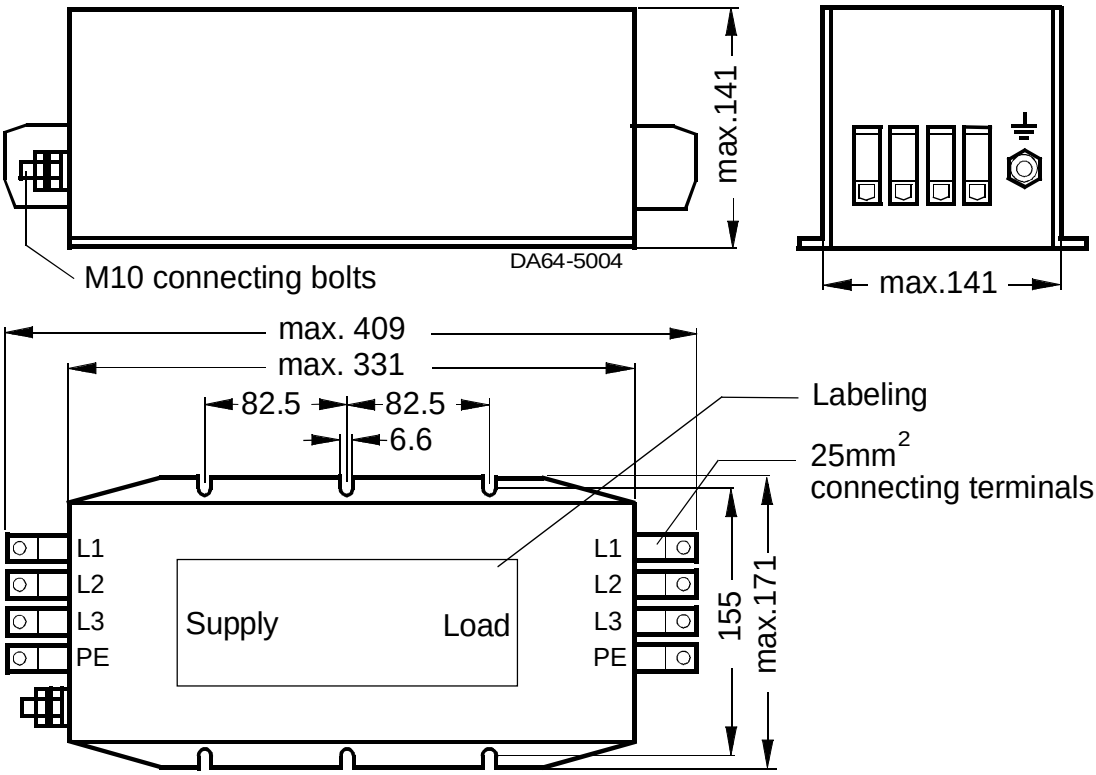
Technical Data

Rated Voltage	440/250V~50/60 Hz
Rated Current	50A Referred ambient 40°C
Test Voltage	1770 V-, 2s (line/line)
	2700 V-, 2s (line/case)
IEC Climatic Category	In accordance with IEC 68-1
Feeder Resistor	
Leakage Current	
Approx. Weight	

6SE2100-1FC20 Class B EMC Input Filter



6SE2100-1FC21 Class B EMC Input Filter



Inverter type Supply Voltage	Harmonic number	Typical harmonic current with 1% mains impedance (%)	Typical harmonic current with 2% mains impedance (%)	Typical harmonic current with 4% mains impedance (%)
208-240V 3ac	Fundamental	100%	100%	100%
Type ECO1-2200/2	5	72.9	56.3	39.4
and below	7	48.4	31.3	14.7
	11	10.6	6.6	6.9
	13	5.5	6.6	3.4
208-240V 3ac	Fundamental	100%	100%	100%
Type ECO1-3000/2	5	32	29.2	26.0
and above	7	9.6	7.9	6.9
	11	7.8	7.0	5.9
	13	3.7	3.6	3.4
380/500V 3ac	Fundamental	100%	100%	100%
Type ECO1-4500/3	5	72.5	62.0	41.0
and below	7	52.6	36.7	16.5
	11	17.0	7.4	7.3
	13	7.2	6.2	3.2
380/500V 3ac	Fundamental	100%	100%	100%
Type ECO1-5500/3	5	42.7	37.8	32.6
and above	7	17.7	13.2	9.2
	11	6.7	7.1	6.9
	13	4.0	3.5	3.3

HARMONIC INPUT CHOKES

Mains Harmonics

When the inverter is operating it draws a non-sinusoidal current from the mains supply which includes harmonics of the fundamental 50/60Hz current. The approximate percentage of the fundamental of these harmonics, based on a 1% mains impedance, is shown in the table below. The amplitude of the harmonics can be reduced by fitting input chokes. The order numbers of suitable chokes providing an additional impedance of 2% or 4% are shown in the tables below.

Supply Impedance

The impedance of the mains supply should not be less than 0.5%. This means that the voltage drop when the inverter is fully loaded should be greater than or equal to 0.5% of the nominal voltage. If the mains impedance is below this value the lifetime of the electrolytic capacitors could be reduced. To overcome this effect, 2% input chokes should be fitted. If a further reduction of harmonic currents is required, 4% input chokes can be fitted.

Input Choke Order Numbers

Model/Type	Maximum Variable Torque Continuous Input Current (A)	Input Reactor 2%	Input Reactor 4%
208-240V +/- 10% 3ac	**3 phase**	**208-240V 50/60 Hz**	**208-240V 50/60Hz**
ECO1-110/2	6.4		4EP3200-1US
ECO1-150/2	8.3		4EP3400-1US
ECO1-220/2	11.7		4EP3400-1US
ECO1-300/2	16.3		4EP3500-0US
ECO1-400/2	21.1		4EP3600-4US
ECO1-550/2	23		4EP3600-5US
ECO1-750/2	32		4EP3700-2US
ECO1-1100/2	45		4EP3800-2US
ECO1-1500/2	62		4EP3800-7US
ECO1-1850/2	75		4EP3900-2US
ECO1-2200/2	87		4EP3900-2US
ECO1-3000/2	100		4EP4000-2US
ECO1-3700/2	143		4EU2451-2UA00
ECO1-4500/2	170		4EU2551-4UA00

380-500V +/- 10% 3ac		380-500V	380-500V
ECO1-110/3	4.9	4EP3200-2US (4EP3200-2US)	3 X 4EM4605-4CB
ECO1-150/3	5.9	4EP3200-1US (4EP3200-1US)	3 X 4EM4605-6CB
ECO1-220/3	8.8	4EP3200-1US (4EP3200-2US)	3 X 4EM4605-6CB
ECO1-300/3	11.1	4EP3400-2US (4EP3300-0US)	3 X 4EM4807-4CB
ECO1-400/3	13.6	4EP3400-1US (4EP3400-3US)	3 X 4EM4807-6CB
ECO1-550/3	17.1	4EP3500-0US (4EP3600-8US)	4EP3700-7US (4EP3800-8US)
ECO1-750/3	22.1	4EP3600-4US (4EP3600-2US)	4EP3801-0US (4EP3800-8US)
ECO1-1100/3	30	4EP3600-5US (4EP3600-3US)	4EP3900-5US (4EP4001-0US)
ECO1-1500/3	32	4EP3700-2US (4EP3700-6US)	4EP3900-5US (4EP4001-0US)
ECO1-1850/3	41	4EP3700-5US (4EP3700-1US)	4EP4001-1US (4EP4001-2US)
ECO1-2200/3	49	4EP3800-2US (4EP3801-2US)	4EU2451-4UA00 (4EU2451-5UA00)
ECO1-3000/3	64	4EP3800-7US (4EP3900-1US)	4EU2451-4UA00 (4EU2551-1UB00)
ECO1-3700/3	79	4EP3900-2US (4EP4000-1US)	4EU2551-2UB00 (4EU2551-3UB00)
ECO1-4500/3	96	4EP4000-2US (4EP4000-8US)	4EU2751-1UB00 (4EU2551-3UB00)
ECO1-5500/3	113	4EP4000-6US (4EP4000-8US)	4EU2751-1UB00 (4EU2751-3UB00)
ECO1-7500/3	152	4EU2451-2UA00 (4EU2551-2UA00)	4EU2751-1UB00 (4EU2751-6UB00)
ECO1-9000/3	185	4EU2551-4UA00 (4EU2551-6UA00)	4EU2751-2UB00 (4EU3051-0UB00)

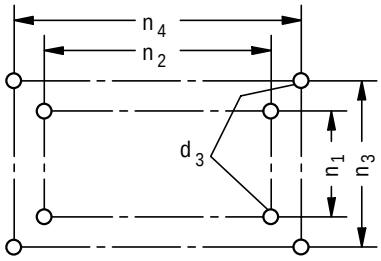
525-575V +/- 15% 3ac		525-575V	525-575V
ECO1-400/4	7	4EP3400-3US	3 x 4EM4807-1CB
ECO1-550/4	10	4EP3600-8US	3 x 4EM4911-7CB
ECO1-750/4	12	4EP3600-2US	4EP3800-8US
ECO1-1100/4	18	4EP3600-3US	4EP3800-8US
ECO1-1500/4	24	4EP3700-6US	4EP4001-0US
ECO1-1850/4	29	4EP3700-1US	4EP4001-0US
ECO1-2200/4	34	4EP3801-2US	4EP4001-2US
ECO1-3000/4	45	4EP3800-1US	4EP4001-2US
ECO1-3700/4	55	4EP3900-1US	4EU2551-1UB00
ECO1-4500/4	65	4EP4000-7US	4EU2551-1UB00

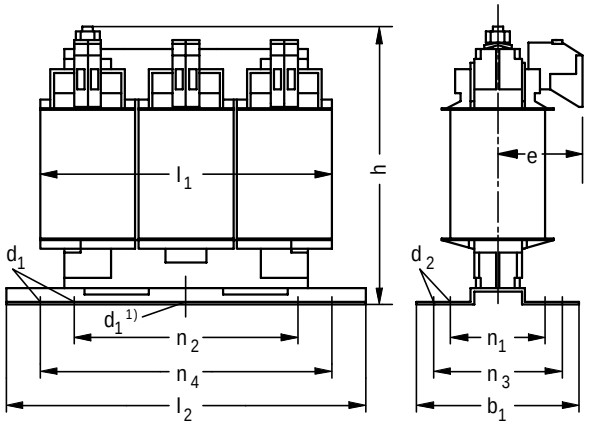
4EP three-phase line reactors

$I_{LN} \leq 35.5$ A

11 Dimensions

With terminals, for any arrangement of the reactor





n_3 and n_4 mounting holes acc. to EN 60852-4

n_1 and n_2 mounting holes acc. to DIN 41308

Three-phase line reactor Type	b_1 max. mm	d_1 mm	d_2 mm	d_3 mm	e max. mm	h max. mm	l_1 max. mm	l_2 max. mm	n_1 ±IT12 mm	n_2 ±IT12 mm	n_3 ±IT12 mm	n_4 ±IT12 mm
4EP32	57,5	4,8	9	M4	56	108	78	88,5	34	1)	42,5	79,5
4EP33	64	4,8	9	M4	55	122	96	124	33	1)	44	112
4EP34	73	4,8	9	M4	59	122	96	124	42	1)	53	112
4EP35	68	4,8	9	M4	57	139	120	148	39	90	48	136
4EP36	78	4,8	9	M4	62	139	120	148	49	90	58	136
4EP37	73	5,8	11	M5	60	159	150	178	49	113	53	166
4EP38	88	5,8	11	M5	67	159	150	178	64	113	68	166
4EP39	99	7	13	M6	62	181	182	219	56	136	69	201
4EP40	119	7	13	M6	72	181	182	219	76	136	89	201

Retaining slot at the center of the foot

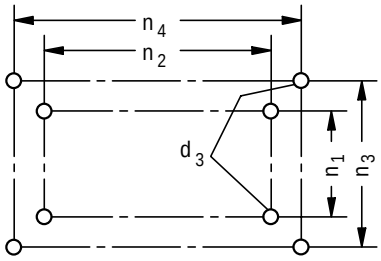
Terminal 8WA9200 (for $I_{Ln} \leq 15$ A)	Cross-sections:	Solid	0,5 mm² to 6,0 mm²
		Stranded	1,5 mm² to 4,0 mm²
Terminal RKW 110 or TRKSD 10	Cross-sections:	Solid	1.0 mm² to 16.0 mm²
(for I_{Ln} 16 A to 35.5 A)		Stranded	1.0 mm² to 10.0 mm²
Grounding terminal, M6 x 12		Solid	2,5 mm² to 10,0 mm²
		Stranded	4,0 mm² to 10,0 mm²

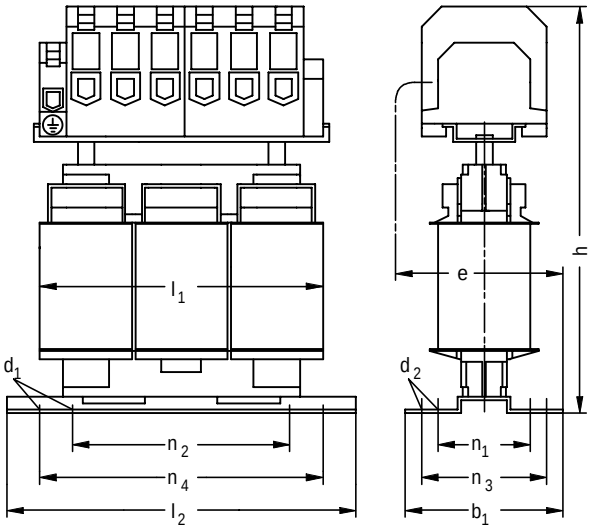
4EP three-phase line reactors

I_{LN} 36 A to 50 A

Dimensions

With terminals, for any arrangement of the reactor





n_3 and n_4 mounting holes acc. to EN 60852-4

n_1 and n_2 mounting holes acc. to DIN 41308

Three-phase line reactor Type	b_1 max. mm	d_1 mm	d_2 mm	d_3 mm	e max. mm	h max. mm	l_1 max. mm	l_2 max. mm	n_1 ±IT12 mm	n_2 ±IT12 mm	n_3 ±IT12 mm	n_4 ±IT12 mm
4EP38	88	5,8	11	M5	86	193	150	178	64	113	68	166
4EP39	99	7	13	M6	91,5	220	182	219	56	136	69	201
4EP40	119	7	13	M6	101,5	220	182	219	76	136	89	201

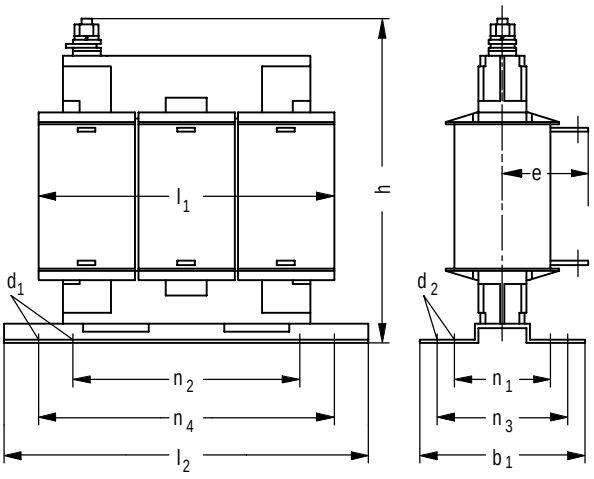
Terminal 8WA1304 (for I_{Ln} 40 A to 50 A)	Cross-sections:	Solid	1.0 mm² to 16.0 mm²
		Stranded	10.0 mm² to 25.0 mm²
		Stranded	2.5 mm^2 to 16.0 mm^2
Associated grounding terminal, EK 16/35		Solid	2,5 mm² to 16,0 mm²
		Stranded	4,0 mm² to 16,0 mm²

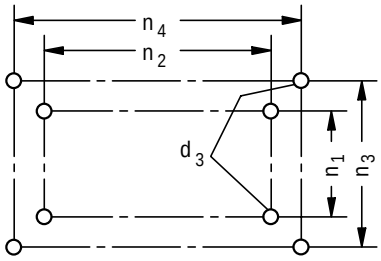
4EP three-phase line reactors

$I_{LN} \geq 51$ A

Dimensions

With terminals, for any arrangement of the reactor

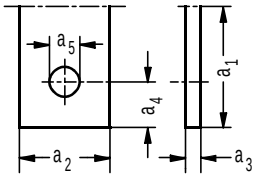




n_3 and n_4 mounting holes acc. to EN 60852-4

n_1 and n_2 mounting holes acc. to DIN 41308

Three-phase line reactor Type	b_1 max. mm	d_1 mm	d_2 mm	d_3 mm	e max. mm	h max. mm	l_1 max. mm	l_2 max. mm	n_1 ±IT12 mm	n_2 ±IT12 mm	n_3 ±IT12 mm	n_4 ±IT12 mm
4EP38	88	5,8	11	M5	76	153	150	178	64	113	68	166
4EP39	99	7	13	M6	73	179	182	219	56	136	69	201
4EP40	119	7	13	M6	83	179	182	219	76	136	89	201

Flat Connector	Rated current I_{Ln} A			a_1 mm	a_2 mm	a_3 mm	a_4 mm	a_5 mm
	51	to	80	30	20	3	10	9
	81	to	200	35	25	5	12,5	11

OUTPUT CHOKES

Chokes are fitted to the output of the inverter to allow operation with long cables. The choke compensates for the stray capacitance of the cables. Recommended chokes for different cable lengths and inverters are available.

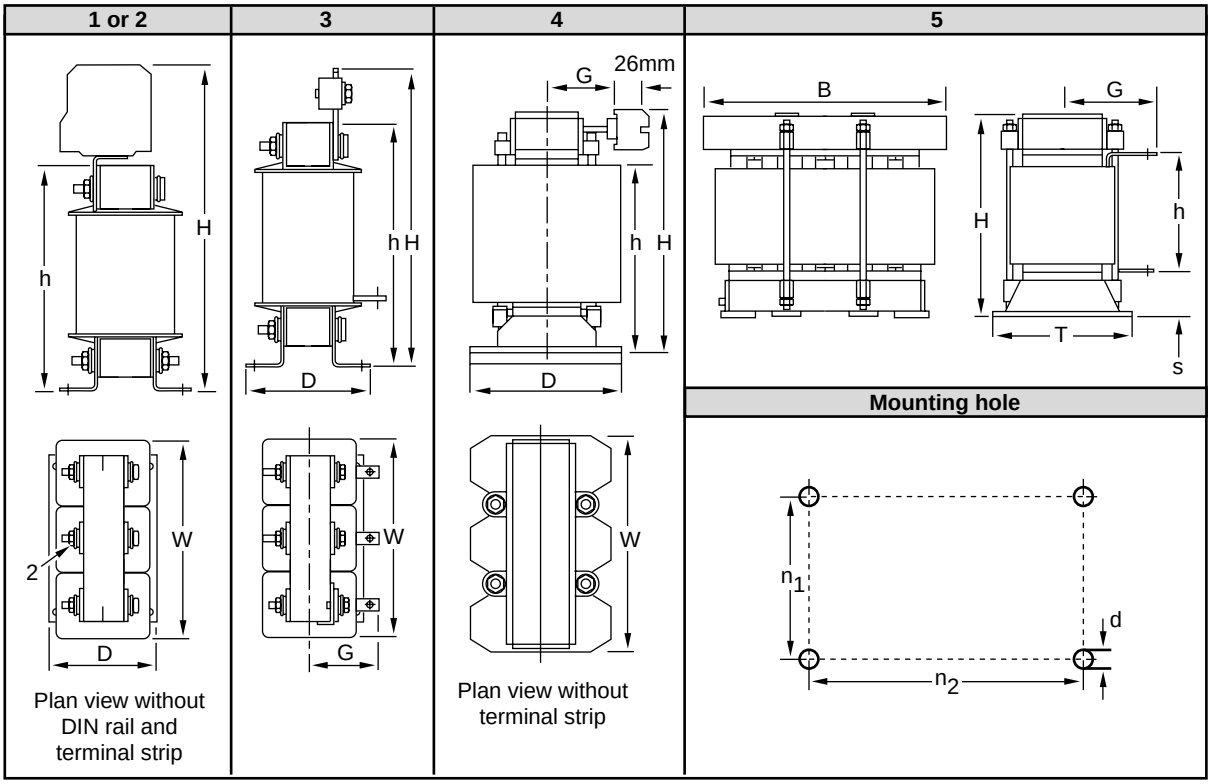
Output Choke Order Numbers

The maximum switching frequency must be limited to 2kHz for iron cored chokes and 4kHz for ferrite cored chokes.

Inverter Power Rating (kW)	Iron Cored Choke Part Number	Ferrite Cored Choke Part Number
ECO1-110/3 (1.1)	6SE7016-1ES87-1FE0	6SE7016-1ES87-1FF1
ECO1-150/3 (1.5)	6SE7016-1ES87-1FE0	6SE7016-1ES87-1FF1
ECO1-220/3 (2.2)	6SE7016-1ES87-1FE0	6SE7016-1ES87-1FF1
ECO1-300/3 (3.0)	6SE7021-8ES87-1FE0	6SE7021-8ES87-1FF1
ECO1-400/3 (4.0)	6SE7021-8ES87-1FE0	6SE7021-8ES87-1FF1
ECO1-555/3 (5.5)	6SE7021-8ES87-1FE0	6SE7021-8ES87-1FF1
ECO1-750/3 (7.5)	6SE7021-8ES87-1FE0	6SE7021-8ES87-1FF1
ECO1-1100/3 (11)	6SE7022-6ES87-1FE0	6SE7022-6ES87-1FF0
ECO1-1500/3 (15)	6SE7023-4ES87-1FE0	6SE7023-4ES87-1FF0
ECO1-1850/3 (18.5)	6SE7024-7ES87-1FE0	6SE7024-7ES87-1FF0
ECO1-2200/3 (22)	6SE7024-7ES87-1FE0	6SE7024-7ES87-1FF0
ECO1-3000/3 (30)	6SE7027-2ES87-1FE0	6SE7027-2ES87-1FF0
ECO1-3700/3 (37)	6SE7027-2ES87-1FE0	6SE7027-2ES87-1FF0
ECO1-4500/3 (45)	6SE7031-0ES87-1FE0	6SE7031-0ES87-1FF0
ECO1-5500/3 (55)	6SE7031-5ES87-1FE0	6SE7031-5ES87-1FF0
ECO1-7500/3 (75)	6SE7031-5ES87-1FE0	6SE7031-5ES87-1FF0
ECO1-9000/3 (90)	6SE7031-8ES87-1FE0	6SE7031-8ES87-1FF0

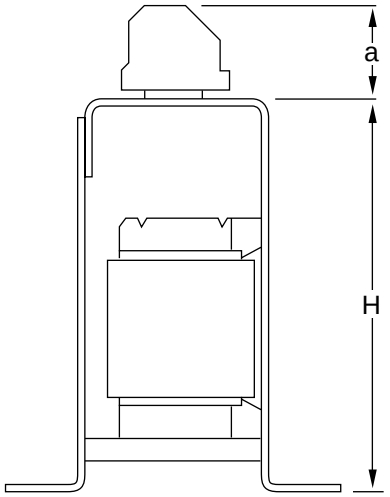
Installation of Output Chokes

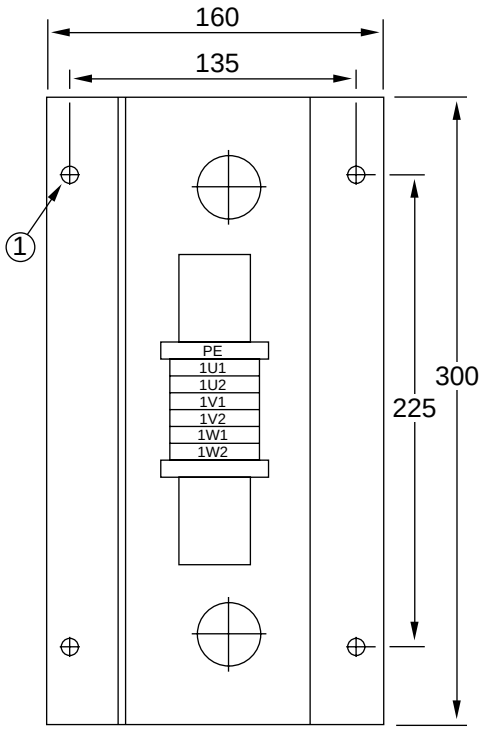
Output Chokes (Iron core)



Type	Drawing	H (mm) max	h (mm) max	W (mm) max	D (mm) max	c_1 (mm) max	n_1 (mm) max	n_2 (mm) max	c^2 (mm) max	d	Weight (kg)
6SE7016-1ES87-1FE0	2	153	140	178	73	-	53	166	-	M5	4.4
6SE7021-8ES87-1FE0	2	180	165	219	99	-	69	201	-	M6	8.0
6SE7022-6ES87-1FE0	2	180	165	219	119	-	89	201	-	M6	9.2
6SE7023-4ES87-1FE0	2	265	206	267	107	-	77	249	-	M6	11
6SE7024-7ES87-1FE0	5	220	103	197	104	69	70	176	55	M6	20
6SE7027-2ES87-1FE0	3	221	206	267	107	77	77	249	-	M6	11
6SE7031-0ES87-1FE0	3	221	206	267	107	77	77	249	-	M6	17
6SE7031-5ES87-1FE0	5	220	100	197	128	81	94	176	59	M6	25
6SE7031-8ES87-1FE0	5	250	119	281	146	98	101	200	65	M8	30

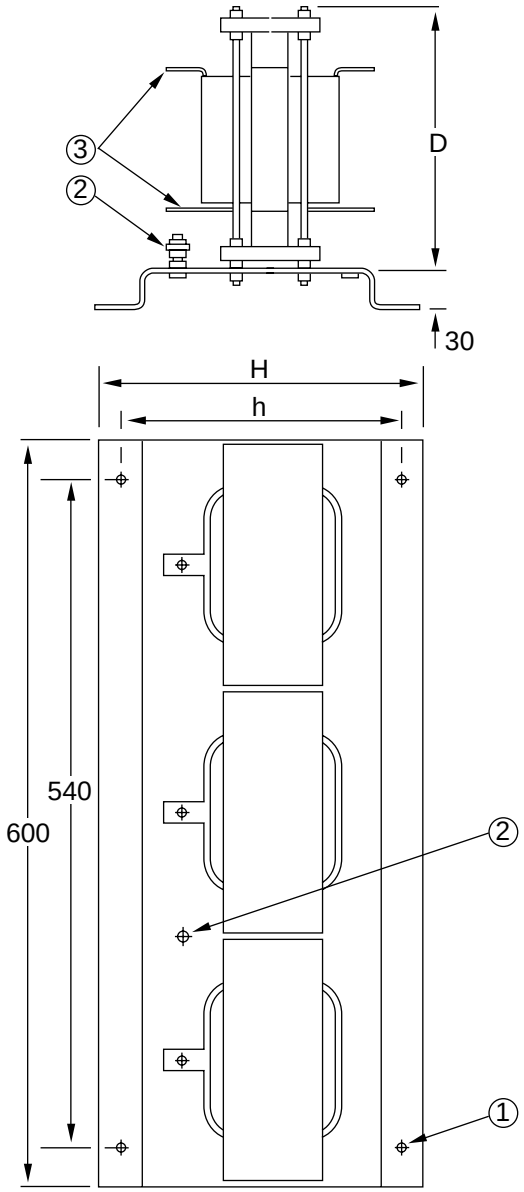
Output Chokes (Ferrite core)





Type	H (mm)	a (mm)	Weight appr. (kg)
6SE7016-1ES87-1FF1	230	max. 50	8.5
6SE7021-8ES87-1FF1	230	max. 50	8.5
6SE7022-6ES87-1FF0	280	max. 50	9.5
6SE7023-4ES87-1FF0	280	max. 50	12.0
6SE7024-7ES87-1FF0	280	max. 60	16.4
6SE7027-2ES87-1FF0	280	max. 50	14.0
6SE7031-0ES87-1FF0	280	max. 60	16.7

Output reactors (ferrite core)



① Hole 7.5 mm diameter for M6 bolt.
② M6x23 earthing bolts
③ Power connections for
M6 bolts (rated current up to 63 A)
M8 bolts (rated current from 63 A to 100 A)
M10 bolts (rated current from 100 A to 400 A)

Type	H (mm)	D (mm)	h (mm	Weight appr. (kg)
6SE7031-5ES87-1FF0	255	max. 260	225	23
6SE7031-8ES87-1FF0	255	max. 260	225	31

dV/dt OUTPUT FILTERS

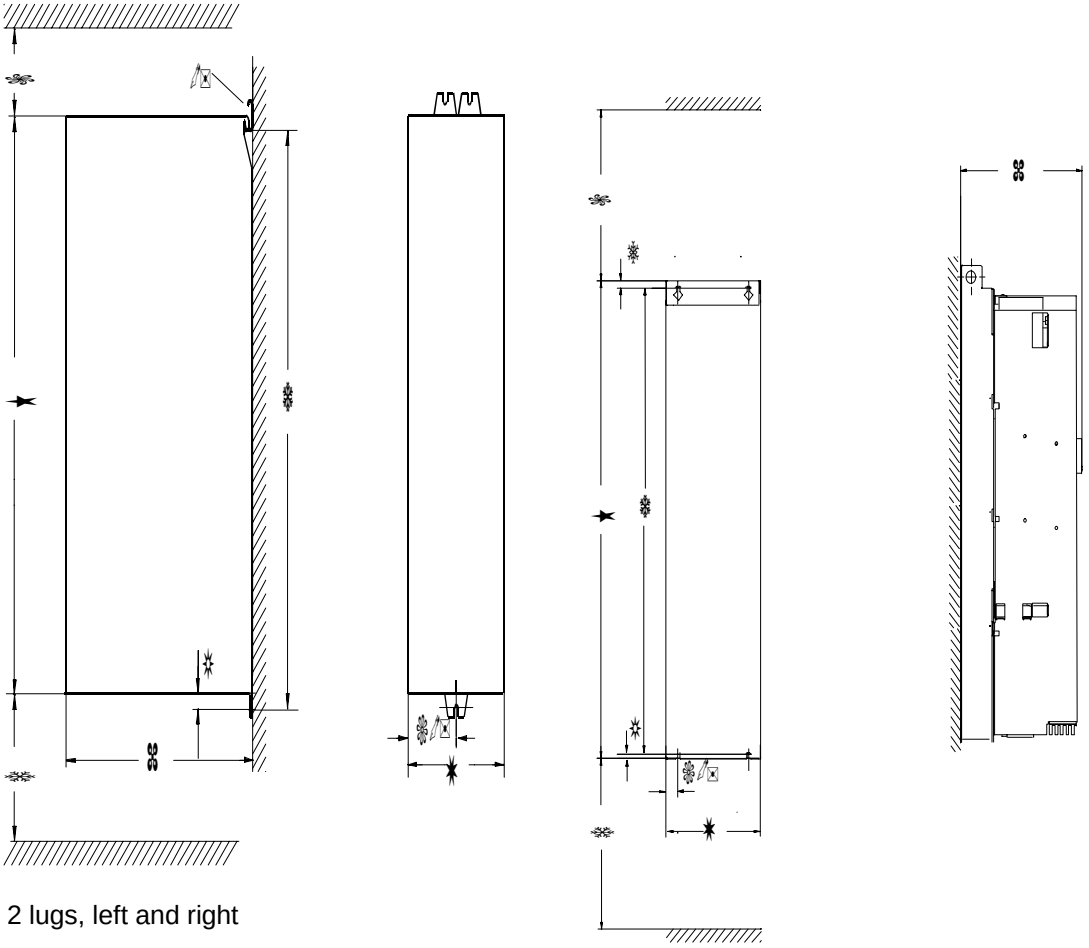
dV/dt Filter Order Numbers

For dV/dt filters the output frequency must be limited to 2kHz.

Inverter Power Rating (kw)	dV/dt Filter part Number
ECO1-110/3 (1.1)	6SE7016-2FB87-1FD0
ECO1-150/3 (1.5)	6SE7016-2FB87-1FD0
ECO1-220/3 (2.2)	6SE7016-2FB87-1FD0
ECO1-300/3 (3.0)	6SE7021-5FB87-1FD0
ECO1-400/3 (4.0)	6SE7021-5FB87-1FD0
ECO1-555/3 (5.5)	6SE7021-5FB87-1FD0
ECO1-750/3 (7.5)	6SE7021-5FB87-1FD0
ECO1-1100/3 (11)	6SE7022-2FC87-1FD0
ECO1-1500/3 (15)	6SE7023-4FC87-1FD0
ECO1-1850/3 (18.5)	6SE7024-7FC87-1FD0
ECO1-2200/3 (22)	6SE7024-7FC87-1FD0
ECO1-3000/3 (30)	6SE7026-0HE87-1FD0
ECO1-3700/3 (37)	6SE7028-2HE87-1FD0
ECO1-4500/3 (45)	6SE7031-2HS87-1FD0
ECO1-5500/3 (55)	6SE7031-7HS87-1FD0
ECO1-7500/3 (75)	6SE7031-7HS87-1FD0
ECO1-9000/3 (90)	6SE7032-3HS87-1FD0

Installation of dV/dt Output Filters

dV/dt Output Filters Frame Sizes B, C and E



1) 2 lugs, left and right

dV/dt Output Filter Frame Size B and C:

Frame Size	B	C	E
H [mm]	425	600	1050
W [mm]	135	180	250
D [mm]	350	350	350
a [mm]	67.5	90	45 [1])
b [mm]	16	16	10
c [mm]	100	100	350
d [mm]	250	250	400
f [mm]	425	600	1025
Weight approx. [kg]	20	27	55

dV/dt Output Filter Frame Size E:

dV/dt Filter part Numbers	
B	6SE7016-2FB87-1FD0
	6SE7021-5FB87-1FD0
C	6SE7022-2FC87-1FD0
	6SE7023-4FC87-1FD0
	6SE7024-7FC87-1FD0
E	6SE7026-0HE87-1FD0
	6SE7028-2HE87-1FD0

Technical Specification for VARIABLE SPEED DRIVES (VSD)

Heating, Ventilation and Air Conditioning (HVAC)

Scope

The document in this section is the recommended Technical Specification for Variable Speed Drives (VSD) when used within HVAC applications.

The specification covers the VSD design, operation, performance, testing and support requirements for the project.

The specification may be used in whole or in part by Building Services Consultants in order to assist with the preparation of tender documentation.

Technical Tender Specification

Table of Contents

Page

1. General

2. Design

3. Quality Assurance and Standards

4. Performance Requirements

5. Basic Parameter Settings

6. Expert / Advanced Parameter Settings

7. Protection Functions & Features

8. Control Signals

9. Communication

10. Harmonics on Mains Supply System

11. EMC

12. Output chokes

13. Commissioning & Documentation

14. Equipment Preference

1. General

- The VSD shall be purposely designed and manufactured for HVAC (Heating Ventilation and Air Conditioning) applications. The VSD shall be suitable for all loads with variable torque characteristics, such as fans and pumps.
- The VSD shall be capable of starting and running high inertia loads such as centrifugal fan equipment.
- The VSD supplier shall carry a comprehensive range of spares which shall continue to be available for at least 5 years after the production of the particular VSD model has been discontinued.
- The VSD and motor shall preferably be manufactured by the same firm in order to ensure VSD and motor performance matching as well as optimum total system efficiency.
- The VSD shall also be compatible for use with the various asynchronous squirrel cage induction motors typically used by manufacturers of HVAC equipment.
- The VSD shall be of sufficient capacity and shall produce a quality low distortion output waveform so as to achieve full rated nameplate shaft power output of the motor. The VSD shall be capable of operating any standard squirrel cage induction motor of the specified VSD power rating without any modifications to the motor or the VSD.

2. Design

- The VSD shall be fully digitally controlled utilising PCB surface mounting technology and VLSI.
  - The VSD shall consist of the following major components:
  1. Full-wave bridge 6 pulse Rectifier.
  2. DC link capacitors.
  3. Inverter stage with Insulated Gate Bipolar Transistor (IGBT) power modules across the entire range (GTO or BJT devices shall not be acceptable).
  4. Control and display panel.
- The VSD shall have high efficiency and have low maintenance requirements. The VSD shall provide an adjustable output frequency and voltage utilising the principles of Pulse Width Modulation (PWM) design. This technique shall provide full nameplate motor voltage as well as distortion free sinusoidal currents at the terminals of the motor in order to obtain full motor rated torque at rated frequency. The PWM strategy shall be of the Space Vector Modulation type implemented through a microprocessor and ASIC in order to operate with optimum power and efficiency, minimise acoustic noise produced by the motor and reduce motor heating created by output harmonics.
  The operating characteristics shall not exceed those which are recommended by the motor manufacturer.
- The mechanical design of VSD shall adhere to the following guidelines;
  1. The internal layout of the VSD shall maintain separation between the control signals and the power conductors in order to minimise EMC noise related problems
  2. The VSD shall be assembled in such a way as to facilitate easy maintenance
  3. Control signal wiring installation shall be simplified through the use of screwless terminal design.
  4. The location of the nameplate or label of the VSD shall be easily accessible and contain all the necessary information in order to determine the VSD rating and to also assist with identification

5. All incoming and outgoing cables shall enter and exit from the bottom of the VSD. Gland plates shall be provided as standard for the correct fitting of cables with cable glands to ensure safety and reliable operation.
6. The VSD shall be of compact design and have the ability to be mounted side-by-side without separation for greater space saving.

- The VSD enclosure shall be protected to IP20 (NEMA1). An optional IP56 (NEMA4/12) VSD enclosure shall be available if further environmental protection is required

3. Quality Assurance & Standards

- The VSD shall be supplied by a manufacturer who has considerable experience in the design and manufacturing of VSD of the ratings specified for a period of at least ten (10) years.
- The VSD shall be designed and constructed in accordance with the requirements of the IEEE and NEMA standards. (The VSD shall be rated for compatibility with NEMA design B premium efficiency motors.)
- The VSD shall be designed and manufactured to a quality management system in accordance with ISO 9001.
- The VSD shall be UL and CUL listed for power conversion equipment 5B33 for use in pollution degree 2 environments and labelled accordingly.
- The VSD shall comply with the requirements of the Low Voltage Directive 73/23/EEC as amended by Directive 98/68/EEC and shall be CE marked accordingly.
- The VSD units shall be certified for compliance with the following standards:
  EN-60146-1-1 Semiconductor converters - General requirements and line commutated converters
  EN-60204-1 Safety of machinery - Electrical equipment of machines

The VSD, when installed in accordance with the recommendations and guidelines of the VSD manufacturer, shall comply with the requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN61800-3.

- The VSD shall be routinely factory tested upon real asynchronous induction motors using a variety of user parameters. The factory tests shall simulate operation within actual VSD installations. The VSD supplier shall be able to provide copies of the Certificates of Type Test, upon request
- The VSD shall meet or exceed the following standards:

  1. Degree of protection to EN60 529 (DIN VDE 0470, Part 1) standard IP20/21 optional IP56
  2. Environmental class to BS2011, BS EN 60068-2-1
  3. Shock Protection to DIN 40046 Part 7, BS EN 6006-2

4. Performance Requirement

The VSD shall be designed to operate correctly when installed within the following service conditions:

- **Elevation:**
  Up to 1000 metre (3300 feet) altitude without derating.
- **Ambient Temperature:**
  0°C to 40°C above 7.5kW
  0°C to 50°C up to 7.5kW (380V and above)
- **Storage Temperature:**
  -40°C to 70°C BS EN 60068-2-3 Moisture and condensation not permissible.
- **Relative Humidity:**
  Up to 90% non-condensing.
- **Input Voltage:**
  230V +/-10%, 380-500 VAC +/-10%, 525V-575V +/-15%, 3AC
- **Input frequency tolerance:**
  47 to 63Hz (Europe and USA)
- **Output Voltage:**
  230V +/-10%, 380-500 VAC +/-10%, 525V-575V +/-15%, 3AC
- **Output voltage stability:**
  +/- 1%
- **Service factor:**
  1.0
- **Power unit rating:**
  100% rated continuous current.
- **Power factor:**
  At least 0.98 prime power factor or better.
- **Efficiency:**
  Minimum level at 97% at 100% load.
- **Digital stability:**
  < 1%
- **Analogue stability:**
  < 0.02%
- **Frequency stability:**
  +/- 0.05%
- **Overload capability:**
  110% for 60 seconds

5. Basic Parameter Settings

The VSD shall have at least the following adjustable settings easily accessible within the Basic Mode of set-up and operation;

- Maximum frequency 0-150 Hz
- Minimum frequency 0-150 Hz
- Acceleration time 0-150 sec
- Deceleration time 0-150 sec
- Start-on-the-fly enabling the VSD to synchronise on to a spinning motor (bi-directional)
- Output frequency setpoint selection (e.g. 0 -10V)
- Run/stop command selection
- Motor nameplate details (kW, V, rpm, A, Hz)

6. Expert / Advanced Parameter Settings

The VSD shall have at least the following adjustable settings easily accessible within the Expert Mode of set-up and operation;

- Motor current limit: 0-250%
- Starting voltage/torque boost: 0-200%
- Switching frequency for acoustic noise control: 2-16 kHz
  (higher kW rated VSD may have limited max. switching freq.)
- (4) Skip frequencies with adjustable band width to prevent mechanical resonance.
- Energy Control Optimisation or Multi-Motor mode selection.
- DC injection braking intensity.
- Compound braking.
- (8) programmable fixed frequencies.
- Direct serial communication monitoring of digital input status and direct control of digital relay outputs and analogue outputs.
- Adjustable display scaling factor for display of temperature and pressure.

7. Protection Functions and Features

The VSD shall include the following protective features in order to ensure the security and safe operation of the equipment:

- Line to line and line to ground instantaneous short circuit over-current
- Over-voltage
- Under-voltage
- VSD overload
- VSD over-current
- RAM/EPROM/EPROM malfunction
- Serial communication time out
- Digital input external fault
- VSD power stage over-temperature
- Motor I2t overload protection
- Motor PTC input facility for motor winding temperature monitoring
- Memory register for storage of the last four fault codes
- Memory register for storage of the last warning event

The VSD shall have at least the following additional features:

- Ability to disable panel buttons whilst in remote control mode
- Parameter protection with 2 levels of setting
- Automatic restart after a fault, etc.
- Expansion to serial communication network using RS485 and simple protocol (USS).
- Closed loop internal PID control for pressure and temperature regulation.
  Setpoint may be from an analogue, digital or serial input.
  Feedback may be either 0-10V or 0/4-20mA.
  A 15Vdc power supply shall be provided for a transducer.
- Ability to reset to factory default settings.
- Ability to have selection between MANUAL and AUTO through use of selector via VSD digital input terminals.
- Ability to provide optional AC line reactors for power factor improvement, harmonic control, prevention of zero voltage notching or surge protection from low impedance supplies.
- Factory default parameter settings. Automatic selection of either European or North American defaults.

8. Control Signals

The VSD shall have two (2) analogue inputs (0-10V or 0/4-20mA) and six (6) fully programmable digital inputs.

The VSD shall accept any of the following speed setting input signals from the Building Management System (BMS) or other controls;

- 0-10V DC
- 0-20 mA or 4-20 mA
- Motorised potentiometer using up/down digital inputs
- Fixed frequencies using digital inputs
- RS485
- Keypad display for local hand operation

The VSD shall have at least one analogue output signal (0/4-20mA) which can be programmed to:

- Output frequency.
- Output current (load).
- DC-link voltage.
- Motor torque.
- Motor rpm.
- Setpoint frequency.

The VSD shall incorporate two (2) volt-free relay outputs (240VAC, 1A) for remote indication of the following:

- Motor running.
- Setpoint speed reached.
- Fault and Warning indication (over-temperature, over-current, etc.).
- PID high and/or low speed limits reached.

9. Communications

The VSD shall have an RS485 interface as standard allowing the VSD to be used in conjunction with an external system within a multi-drop LAN configuration. The interface shall allow all the various parameter settings of the VSD to be programmed via BMS control. In addition, the VSD shall have the capability to retain these setting within the non-volatile EEPROM memory.

The VSD shall incorporate a clear and easy to operate user-interface panel. The preferred design is to have a 4 digit green LED display with a membrane keypad.
An optional multi-language back-lit LCD keypad display (at least 4 lines of 16 character alpha-numeric text) shall be available. It shall be able to be panel door mounted to a protection rating of IP54 or alternatively used as a portable module and be able to upload, download and store up to 10 different parameter sets.

The information to be displayed in the VSD display mode shall be:

- Output frequency (Hz)
- Speed of motor (RPM)
- Status of motor (Running, Stop, Fault, etc.)
- Motor current (A)
- Motor torque (Nm)
- Fault or warning status (Code)
- PID feedback signal (%)
- DC-link voltage (Vdc)
- Setpoint frequency (Hz)
- Motor output voltage (V)
- Serial link status -

10. Harmonics on Mains Supply System

The VSD and their installation shall comply with the following reference standards:

- IEEE 519 - "Guide for Harmonic Control and Reactive Compensation of Static Power Converters."
- Engineering Recommendation G5/3 of the Electrical Council (UK).

11. Electromagnetic Compatibility (EMC)

When installed according to the recommendations of the manufacturer the VSD product range shall fulfil all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN61800-3.

The VSD shall have a level of performance to allow the assembler to self- certify their apparatus for compliance with the EMC directive for the industrial environment as regards the EMC performance characteristics of the power drive system. Performance limits are as specified in the Generic Industrial Emission and Immunity standards EN50081-2 and EN50082-2.

Emissions

Radiated Emissions
EN55011, Level A1

Conducted Emissions
EN55011, Level A1

Immunity

Supply Voltage Distortion
IEC 1000-2-4 (1993)

Voltage Fluctuations, Dips, Unbalance
Frequency Variations
IEC 1000-2-1

Magnetic Fields
EN 61000-4-8,
50Hz, 30A/m

Electrostatic Discharge
EN 61000-4-2,
8kV air discharge

Burst Interference
EN 61000-4-4, 2 kV power cables, 2 kV control

Surge Immunity
EN61000-4-5, 4kV common mode, 2kV differential

Radio frequency electromagnetic field, amplitude modulated
ENV 50 140, 80-1`000Mhz, 10 V/m, 80% AM, power and signal lines

Radio-frequency electromagnetic field, pulse modulated
ENV 50 204, 900 MHz, 10V/m 50% duty cycle, 200Hz repetition rate

Preference shall be given to VSD that utilise dedicated RFI filters and are integrated into the VSD design. The design of the EMC filters must minimise any additional space requirement and shall preferably be filters which fit to the footprint of the VSD

The VSD shall have the ability to be fitted with RFI filters to Class B1.

Where RFI filters are supplied from a separate supply source, documentation showing the test results of the RFI filter and VSD combination and its compliance to EN55011 (BS800) shall be supplied as evidence of conformity.

If external RFI filters are used, they shall have metal enclosures to a minimum protection rating of IP20 (NEMA 1), and located as close to the VSD input terminals as possible. Motor cables shall be segregated from the mains supply cables and the RFI filter by at least 30cm. Where motor cables cross the mains cables they must cross at right angles.

12. Output Chokes

The VSD should be capable of operating normally (without the need for an output choke or reactor) when connected to the motor with a screened / unscreened motor cable length of up to 100m

A range of output motor choke options shall be available for the VSD to enable operation with longer motor cable lengths.

13. Commissioning & Documentation

The keypad display should include only the pushbuttons required for setting up the VSD for standard fan and pump applications. The pushbuttons layout should include:

- a start and a stop pushbutton
- an up and a down pushbutton to control the speed
- a pushbutton to access the VSD program

Operating Instructions shall be enclosed and shipped with the VSD. Further documentation and literature shall be made available upon request.

The Operating Instructions shall be kept small and simple so that the commissioning and installation of standard fan and pump applications can be easily and quickly completed.

The information within the Operating Instructions shall be:

- safety and CE / UL compliance
- introduction
- mechanical installation
- electrical installation
- application examples
- keypad
- display parameters
- basis parameters for HVAC applications
- Important additional parameters for HVAC applications
- complete parameter listing
- fault codes
- empty table to document own parameter settings.

A Quick Set Up card shall be included so that commissioning and installation personnel can get an overview of all the most important HVAC parameters.

14. Preference

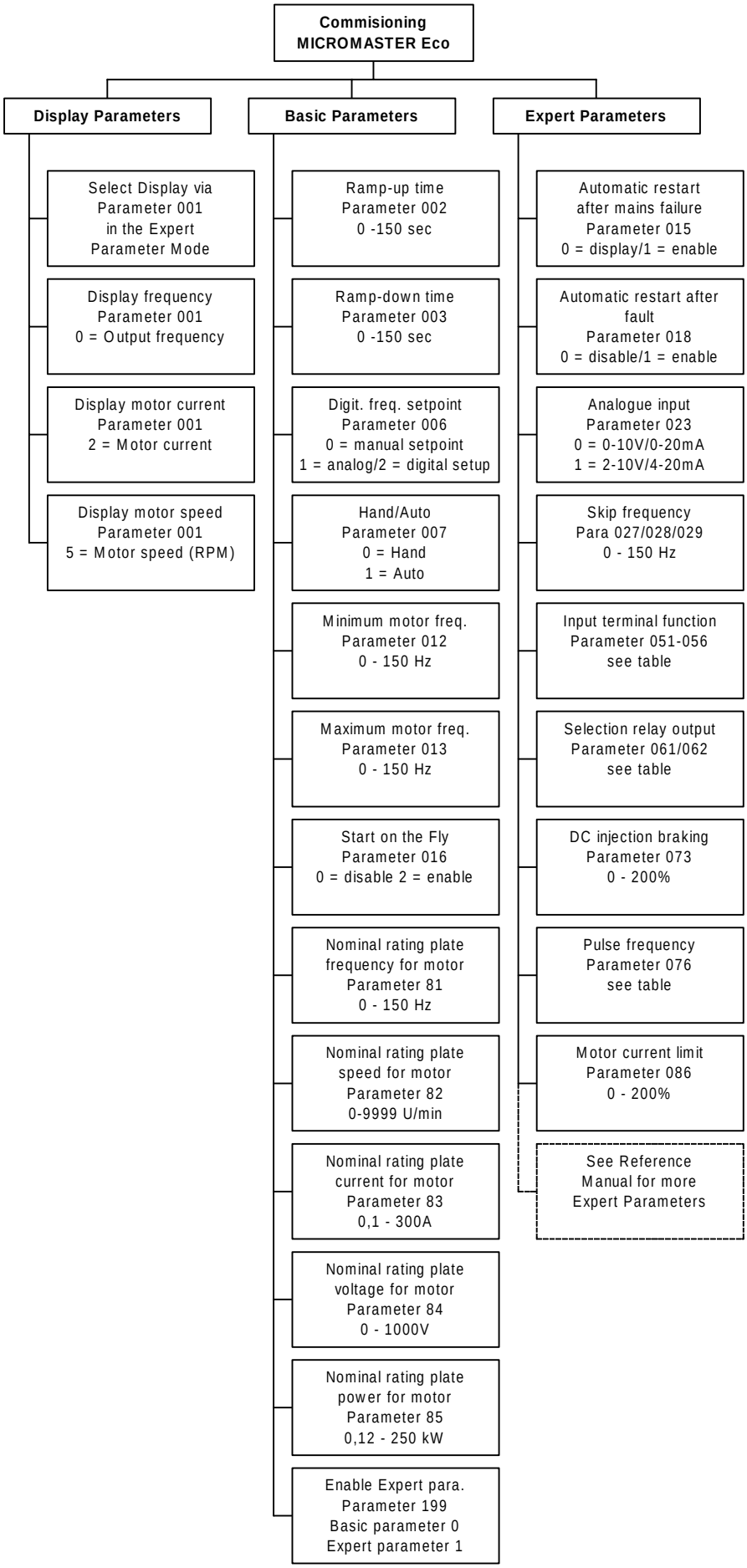
The VSDs shall be MICROMASTER Eco units manufactured by Siemens, or equivalent.

17. YOUR PARAMETER SETTINGS

Parameter	Default	Your setting
P000	-	
P001	0	
P002	20.0	
P003	20.2	
P004	30	
P005	50 (60 North America)	
P006	0	
P007	1	
P010	1.00	
P012	0.0	
P013	50.0	
P014	0.0	
P015	1	
P016	0	
P018	0	
P019	2.0	
P021	0.0	
P022	50, (60 North America)	
P023	0	
P025	0	
P026	2	
P027	0.0	
P028	0.0	
P029	0.0	
P041	5.00	
P042	10.00	
P043	15.00	
P044	20.00	
P046	25.00	
P047	30.00	
P051	1	
P052	10	
P053	6	
P054	6	
P055	6	
P061	6	
P062	1	
P065	1.0	
P066	0	
P073	0 Range is variant dependent	
P074	1	
P076	0	
P077	4	
P079	150	
P080	✶✶✶	
P081	✶✶✶	
P082	✶✶✶	
P083	✶✶✶	
P084	✶✶✶	
P085	✶✶✶	
P086	100	
P087	0	
P088	1	

✶✶✶ - Value depends on rating of the inverter

Parameter	Default	Your setting
P089	✶✶✶	
P091	0	
P092	6	
P093	0	
P094	50.0 (60 North America)	
P095	0	
P101	2 Go to either 0 or 1 after first energised	
P111	✶✶✶	
P112	✶✶✶	
P113	✶✶✶	
P121	1	
P124	1	
P128	120	
P131	-	
P132	-	
P133	-	
P134	-	
P135	-	
P137	-	
P140	-	
P141	-	
P142	-	
P143	-	
P199	-	
P201	0	
P202	1.0	
P203	0	
P204	0	
P205	1	
P206	0	
P207	100	
P208	0	
P210	-	
P211	0.0	
P212	100.00	
P220	0	
P321	0.00	
P322	50.0 (60 North America)	
P323	0	
P356	6	
P386	1.0	
P720	0	
P721	-	
P722	0.0	
P723	-	
P724	0	
P725	0	
P726	0.0	
P910	0	
P922	-	
P923	0	
P930	-	
P944	0	


Commisioning
MICROMASTER Eco
Display Parameters
Basic Parameters
Expert Parameters
Select Display via Parameter 001 in the Expert Parameter Mode
Display frequency Parameter 001 0 = Output frequency
Display motor current Parameter 001 2 = Motor current
Display motor speed Parameter 001 5 = Motor speed (RPM)
Ramp-up time Parameter 002 0 -150 sec
Ramp-down time Parameter 003 0 -150 sec
Digit. freq. setpoint Parameter 006 0 = manual setpoint 1 = analog/2 = digital setup
Hand/Auto Parameter 007 0 = Hand 1 = Auto
Minimum motor freq. Parameter 012 0 - 150 Hz
Maximum motor freq. Parameter 013 0 - 150 Hz
Start on the Fly Parameter 016 0 = disable 2 = enable
Nominal rating plate frequency for motor Parameter 81 0 - 150 Hz
Nominal rating plate speed for motor Parameter 82 0-9999 U/min
Nominal rating plate current for motor Parameter 83 0,1 - 300A
Nominal rating plate voltage for motor Parameter 84 0 - 1000V
Nominal rating plate power for motor Parameter 85 0,12 - 250 kW
Enable Expert para. Parameter 199 Basic parameter 0 Expert parameter 1
Automatic restart after mains failure Parameter 015 0 = display/1 = enable
Automatic restart after fault Parameter 018 0 = disable/1 = enable
Analogue input Parameter 023 0 = 0-10V/0-20mA 1 = 2-10V/4-20mA
Skip frequency Para 027/028/029 0 - 150 Hz
Input terminal function Parameter 051-056 see table
Selection relay output Parameter 061/062 see table
DC injection braking Parameter 073 0 - 200%
Pulse frequency Parameter 076 see table
Motor current limit Parameter 086 0 - 200%
See Reference Manual for more Expert Parameters

ALPHA-INDEX

A

Application examples 11-1
Accessing parameters 13-3

B

Basic mode parameters 13-4

C

Control and regulation 4-1
Clear text operating panel OPe 15-1

D

Dimensions 9-3
Direction of rotation 10-6
Dip selector switches 13-1
Display mode parameters 13-3

E

Energy savings 4-1
Energy savings 6-1
EMC directive 12-1
Emissions 12-2
EMI 12-3
European low voltage directive 1-2
European machinery directive 1-2
European EMC directive 1-2
Eco operating instruction manual 2-1
Eco reference manual 2-1
Equipment rationalization 4-2
Energy control optimization 6-1
Environmental considerations 8-10
Electrical installation 10-1
EMC compatibility 12-1
Expert mode parameters 13-6
EMC filters 15-2

Index

F

Frame sizes 9-2
Fuse ratings 10-5
Fault codes 13-22

H

Hardware set-up 13-24
Harmonic input chokes 15-13

I

Induction motors 3-1

K

Keypad 13-1

L

Load considerations 8-7
Low frequency harmonics 8-3

M

Motor limitations 8-5
Multi-motor connection 10-7
Motor overload protection 10-7
Motor cable lengths 14-1

N

Noise 4-1

O

Output chokes 15-16
Output filters 15-22

P

Pulse width modulation 3-4
Pulse width modulation 7-1
Product description and applications 2-1
PID - internal 4-1
Programming 13-1
Parameters 13-2
PID process controls 13-23

R

RFI filters 15-2

S

Serial communication 4-2
Standard features 5-1
Switching frequency for low motor noise 7-1
Supply tolerance 8-1
Supply distribution 8-2
Star or delta motor connections 10-6

T

Terminals (motor) 10-2
Terminals (control) 10-8
Technical features 5-2
Thermal protection and automatic de-rating 14-1

U

Ungrounded supplies 8-3

V

Variable speed drives 3-1
Variable speed drives 16-1
Variable torque applications 8-8
Variable frequency inverter 3-3
Voltage and current de-rating (altitude) 14-4

W

Wear and tear 4-1
Wiring guidelines to minimize effects of EMI 12-4

For further Technical Support Information, and to submit your suggestions for improvements, see our Web Site:

http:/www.con.siemens.co.uk

G85139-H1750-U630A
August 1998
English

SIEMENS plc
Automation & Drives
Varey Road, Congleton, Cheshire,
Great Britain CW12 1PH

Order Code: 6SE9586-4AB86
Specifications subject to change without prior notice.