**SSD DRIVES**

# 690+ Series
# AC Drive
## Frame B, C, D, E & F

## Installation Product Manual

HA465492U005  Issue 3

Compatible with Version 5.x Software

# WARRANTY

SSD Drives warrants the goods against defects in design, materials and workmanship
for the period of 12 months from the date of delivery on the terms
detailed in SSD Drives Standard Conditions of Sale IA058393C.

SSD Drives reserves the right to change the content and product specification without notice.

# Safety Information



## Requirements

**IMPORTANT:** Please read this information BEFORE installing the equipment.

### Intended Users

This manual is to be made available to all persons who are required to install, configure or service equipment described herein, or any other associated operation.

The information given is intended to highlight safety issues, and to enable the user to obtain maximum benefit from the equipment.

Complete the following table for future reference detailing how the unit is to be installed and used.

| INSTALLATION DETAILS | |
|---|---|
| **Serial Number** *(see product label)* | |
| **Where installed** *(for your own information)* | |
| **Unit used as a:** *(refer to Certification for the Drive)* | ❏ Component          ❏ Relevant Apparatus |
| **Unit fitted:** | ❏ Wall-mounted          ❏ Enclosure |

### Application Area

The equipment described is intended for industrial motor speed control utilising AC induction or AC synchronous machines.

### Personnel

Installation, operation and maintenance of the equipment should be carried out by qualified personnel. A qualified person is someone who is technically competent and familiar with all safety information and established safety practices; with the installation process, operation and maintenance of this equipment; and with all the hazards involved.

# Safety Information

## Hazards

> **WARNING!**
> This equipment can endanger life through rotating machinery and high voltages.
> Failure to observe the following will constitute an ELECTRICAL SHOCK HAZARD.
> This is a product of the restricted sales distribution class according to IEC 61800-3.
> In a domestic environment this product may cause radio interference in which case
> the user may be required to take adequate measures.
> This product is designated as "professional equipment" as defined in EN61000-3-2.
> Permission of the supply authority shall be obtained before connection to the low
> voltage supply.

- The equipment must be **permanently earthed** due to the high earth leakage current.
- The drive motor must be connected to an appropriate safety earth.
- The equipment contains high value capacitors which take time to discharge after removal of the mains supply.
- Before working on the equipment, ensure isolation of the mains supply from terminals L1, L2 and L3. Wait for at least 3 minutes for the dc link terminals (DC+ and DC-) to discharge to safe voltage levels (<50V). Measure the DC+ and DC- terminal voltage with a meter to confirm that the voltage is less than 50V.
- Never perform high voltage resistance checks on the wiring without first disconnecting the drive from the circuit being tested.
- When replacing a drive in an application and before returning to use, it is essential that all user defined parameters for the product's operation are correctly installed.
- This equipment contains electrostatic discharge (ESD) sensitive parts. Observe static control precautions when handling, installing and servicing this product.

**IMPORTANT:** Metal parts may reach a temperature of 90 degrees centigrade in operation.

### Application Risk

The specifications, processes and circuitry described herein are for guidance only and may need to be adapted to the user's specific application.

SSD Drives does not guarantee the suitability of the equipment described in this Manual for individual applications.

### Risk Assessment

Under fault conditions, power loss or other operating conditions not intended, the equipment may not operate as specified. In particular:

- The motor speed may not be controlled
- The direction of rotation of the motor may not be controlled
- The motor may be energised

### Guards

The user must provide guarding and /or additional safety systems to prevent risk of injury and electric shock.

### Protective Insulation

- All control and signal terminals are SELV, i.e. protected by double insulation. Ensure all wiring is rated for the highest system voltage.

*Note:* *Thermal sensors contained within the motor must be double insulated.*

- All exposed metalwork in the Drive is protected by basic insulation and bonding to a safety earth.

### RCDs

These are not recommended for use with this product but ,where their use is mandatory, only Type B RCDs should be used.

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# GETTING STARTED

## Introduction

The 690+ Series AC Drive is designed for speed control of standard 3-phase induction motors. Larger models are available in a range of ratings for constant torque and quadratic torque applications. This dual mode feature provides a cost effective solution to general industrial applications, as well as the control of pumps and fans.

- The unit can be controlled remotely using configurable analogue and digital inputs and outputs, requiring no optional equipment.
- Controlling the unit locally using the 6901 Keypad, or remotely using ConfigEd Lite (or other suitable PC programming tool) gives access to parameters, diagnostic messages, trip settings and full application programming. Other features also become available, such as the advanced sensorless vector control scheme which gives high torque, low speed operation; selectable switching frequencies; and a unique Quiet Pattern control system that minimises audible noise from the motor.
- Technology Options can be fitted to the drive to give serial communications, closed loop speed control, and the factory-fitted dynamic braking functions.
- A factory-fitted System Board enables the drive for high end web processing or mini PLC replacement applications.

The optional internal RFI filters offer enhanced EMC compliance without the need for additional external components (where fitted).

**IMPORTANT:** Motors used must be suitable for drive duty.

*Note:* Do not attempt to control motors whose rated current is less than 25% of the drive rated current. Poor motor control or Autotune problems may occur if you do.

## Equipment Inspection

- Check for signs of transit damage
- Check the product code on the rating label conforms to your requirement.

If the unit is not being installed immediately, store the unit in a well-ventilated place away from high temperatures, humidity, dust, or metal particles.

Refer to Chapter 2: "An Overview of the Drive" to check the rating label/product code.
Refer to Chapter 7: "Routine Maintenance and Repair" for information on returning damaged goods.

## Packaging and Lifting Details

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**Caution**
The packaging is combustible and, if disposed of in this manner incorrectly, may lead to the generation of lethal toxic fumes.

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Save the packaging in case of return. Improper packaging can result in transit damage.

Use a safe and suitable lifting procedure when moving the drive. Never lift the drive by its terminal connections.

Prepare a clear, flat surface to receive the drive before attempting to move it. Do not damage any terminal connections when putting the drive down.

Refer to Chapter 3: "Installing the Drive" - Mechanical Installation for unit weights.

# About this Manual

This manual is intended for use by the installer, user and programmer of the 690+ drive. It assumes a reasonable level of understanding in these three disciplines.

*Note:*   *Please read all Safety Information before proceeding with the installation and operation of this unit.*

Enter the "Model Number" from the rating label into the table at the front of this manual. There is also a column for you to record your application's parameter settings in the Parameter Specification Table in the Software Product Manual. It is important that you pass these manuals on to any new user of this unit.

## Initial Steps

Use the manuals to help you plan the following:

### Installation
Know your requirements:
* certification requirements, CE/UL/CUL conformance
* wall-mount or enclosure?
* conformance with local installation requirements
* supply and cabling requirements

### Operation
Know your operator:
* how is it to be operated, local and/or remote?
* what level of user is going to operate the unit?
* decide on the best menu level for the Keypad (where supplied)

### Programming (Keypad or suitable PC programming tool only)
Know your application:
* install the most appropriate macro
* plan your "block diagram programming"
* enter a password to guard against illicit or accidental changes
* customise the keypad to the application

## How the Manual is Organised

The information is arranged in to separate "Installation" and "Software" Product Manuals. The Installation Product Manual is considered to be Volume 1, the Software Product Manual is Volume 2. Each manual is divided into chapters and paragraphs. Page numbering restarts with every chapter, i.e. 5-3 is Chapter 5, page 3.

### Application Block Diagrams
You will find the appropriate diagrams at the rear of each manual. The pages unfold to show a complete block diagram, these will become your programming tool as you become more familiar with the 690+ unit's software.

### Quick-Start Guide



Chapters 3 and 4 install and run the product

Chapter 5 details the Operator Station and menu system

Chapter 8 holds many of the technical details

**Installation Product Manual**

Chapter 1 explains all the function blocks

Chapter 2 lists all the parameters

Chapter 5 has all the macro details

**Software Product Manual**
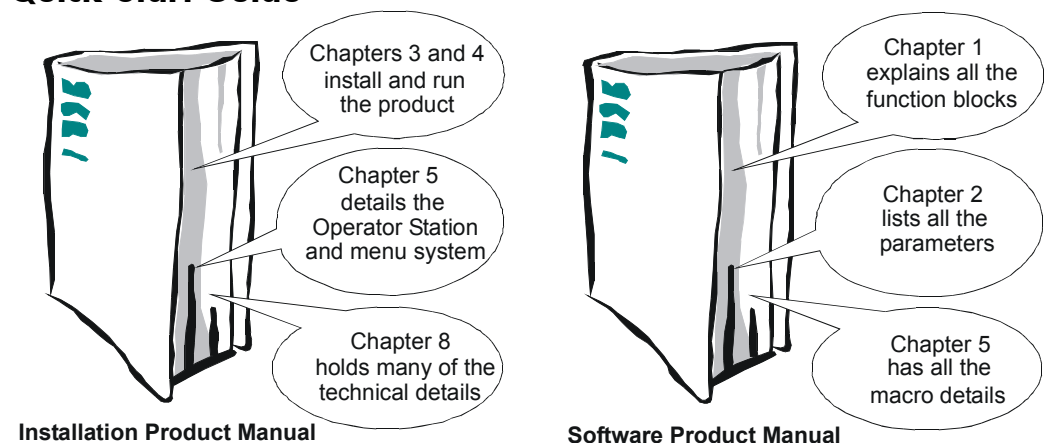
## Information for Users without a Keypad

DEFAULT

This symbol identifies important text for users operating the drive using the default (factory) set-up. If the text is italic, *such as this*, then the information is especially for users without the keypad or suitable PC programming tool.

# AN OVERVIEW OF THE DRIVE

## Component Identification
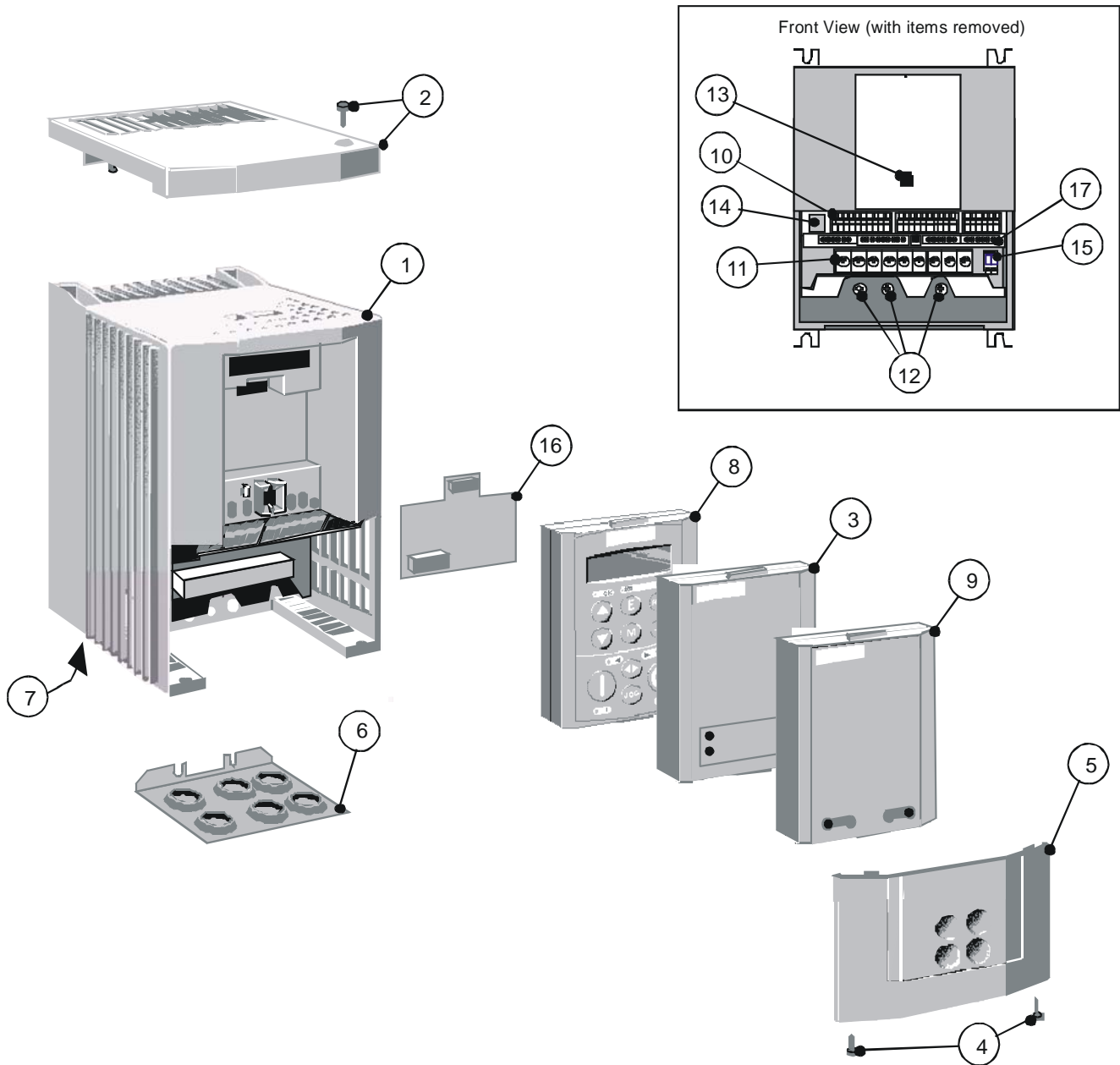


**Figure 2-1  690+ AC Drive,  Frame B   0.75 - 4.0kW**

| | | | |
|---|---|---|---|
| **1** | Main drive assembly | **10** | Control terminals |
| **2** | Top cover (optional) | **11** | Power terminals |
| **3** | 6053 technology box (optional) | **12** | Earth terminals |
| **4** | Terminal cover retaining screw | **13** | Keypad port (P3) |
| **5** | Terminal cover | **14** | Future communications option (P8) |
| **6** | Gland plate | **15** | Thermistor connection |
| **7** | Cooling fan | **16** | Speed feedback board (optional) |
| **8** | 6901 Keypad | **17** | System Board (optional) |
| **9** | Blank cover (Part Number: LA389836U001) | | |

Front View (with items removed)
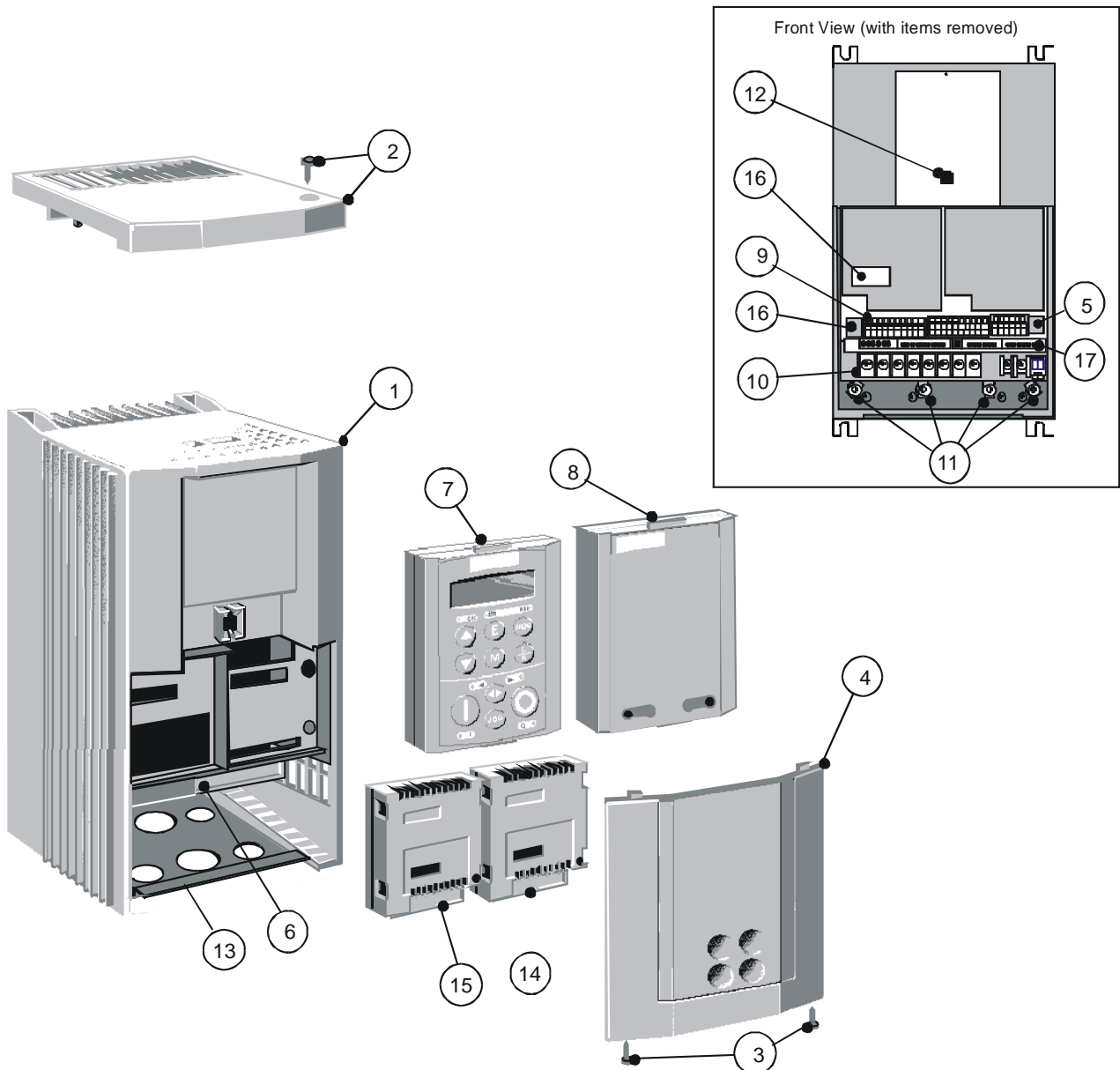
**Figure 2-2  690+ AC Drive, Frame C  5.5 - 11.0kW**

| **1** | Main drive assembly | **10** | Power terminals |
|---|---|---|---|
| **2** | Top cover (optional) | **11** | Earthing points |
| **3** | Terminal cover retaining screw | **12** | Keypad port (P3) |
| **4** | Terminal cover | **13** | Gland plate |
| **5** | RS232 programming port (P3) | **14** | Comms technology box (optional) |
| **6** | Power terminal shield | **15** | Speed feedback technology box (optional) |
| **7** | 6901 Keypad | **16** | Future communications option (P8) |
| **8** | Blank cover (Part Number: LA389836U001) | **17** | System Board (optional) |
| **9** | Control terminals | | |

*Through-panel fixing plate and screws not illustrated*

Front View (with items removed)
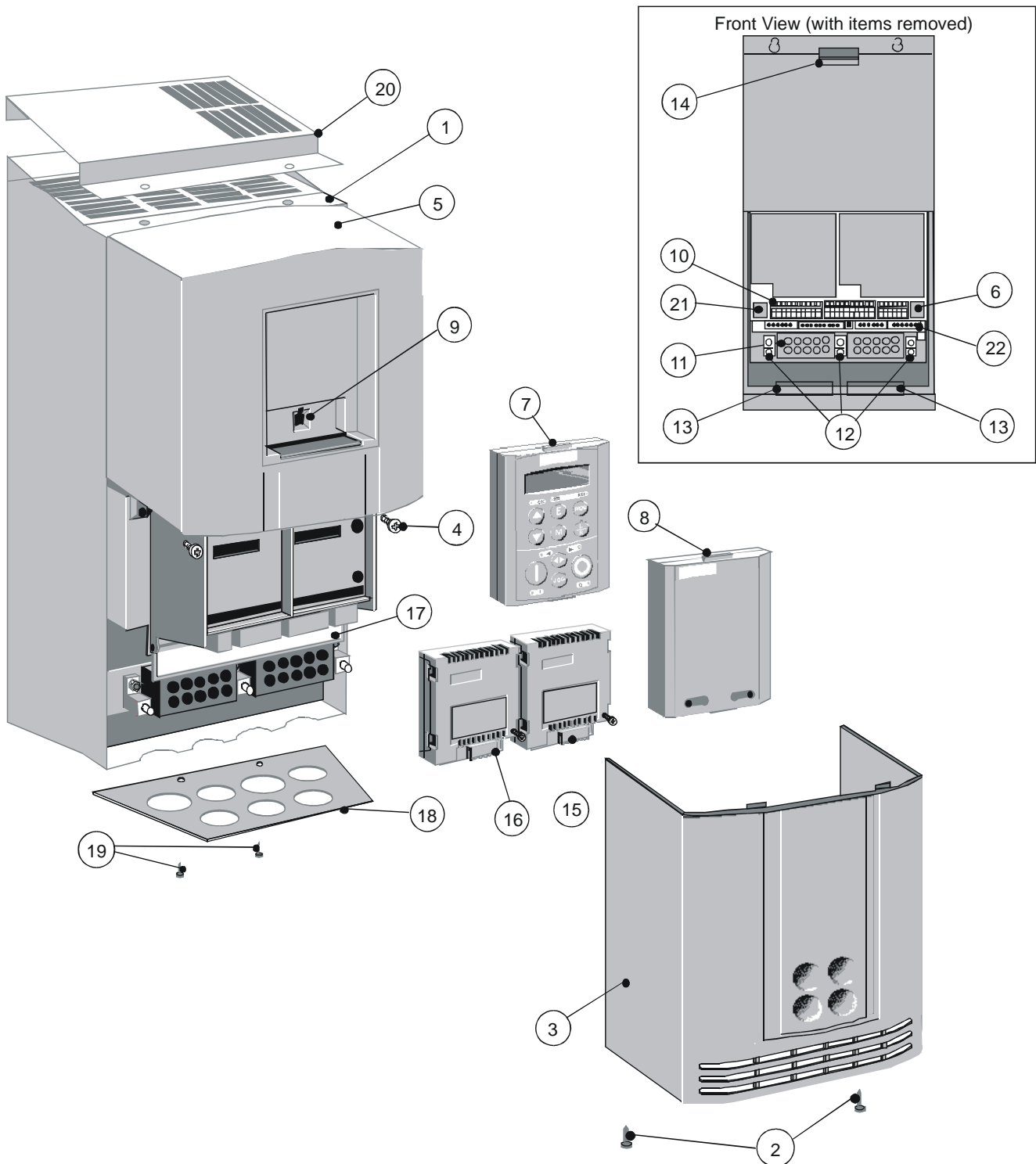
**Figure 2-3  690+ AC Drive, Frame D  15 - 22kW**

| | | | |
|---|---|---|---|
| **1** | Main drive assembly | **12** | Earthing points |
| **2** | Lower front cover retaining screw | **13** | Chassis fan |
| **3** | Lower front cover | **14** | Power board fan |
| **4** | Upper front cover retaining screw | **15** | Comms technology box (optional) |
| **5** | Upper front cover | **16** | Speed feedback technology box (optional) |
| **6** | RS232 programming port (P3) | **17** | Power terminal shield |
| **7** | 6901 Keypad | **18** | Gland plate |
| **8** | Blank cover (Part Number: LA389836U001) | **19** | Gland plate retaining screw |
| **9** | Keypad port (P3) | **20** | Top cover (optional) |
| **10** | Control terminals | **21** | Future communications option (P8) |
| **11** | Power terminals | **22** | System Board (optional) |
| | | | *Through-panel fixing plate and screws not illustrated* |
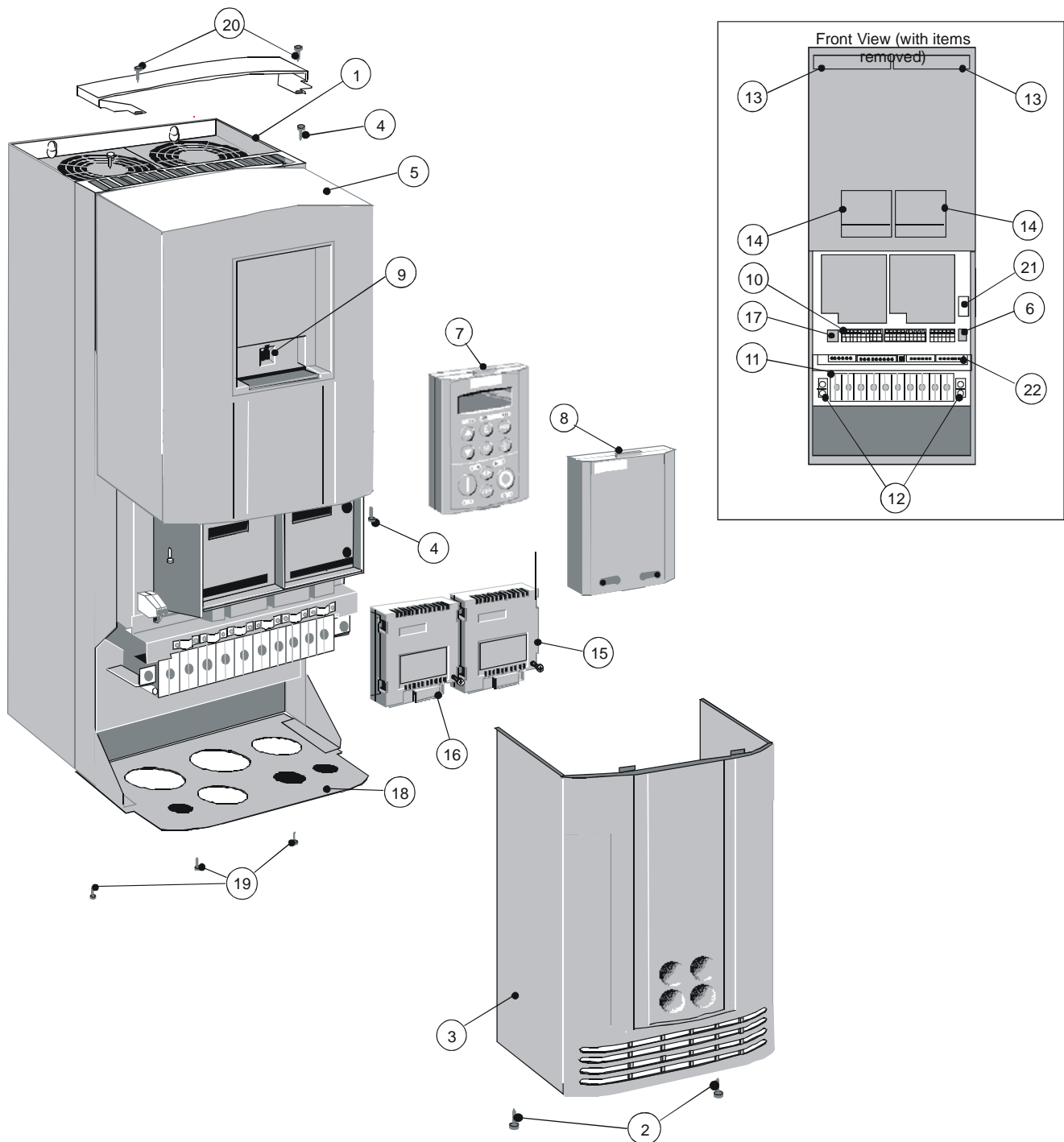
**Figure 2-4  690+ AC Drive, Frame E  30 - 45kW**

| | | | |
|---|---|---|---|
| **1** | Main drive assembly | **13** | Chassis fan |
| **2** | Lower front cover retaining screw | **14** | Power board fan |
| **3** | Lower front cover | **15** | Comms technology box (optional) |
| **4** | Upper front cover retaining screw | **16** | Speed feedback technology box (optional) |
| **5** | Upper front cover | **17** | Future communications option (P8) |
| **6** | RS232 programming port (P3) | **18** | Gland plate |
| **7** | 6901 Keypad | **19** | Gland plate retaining screw |
| **8** | Blank cover (Part Number: LA389836U001) | **20** | Top cover (optional) |
| **9** | Keypad port (P3) | **21** | Motor thermistor terminals |
| **10** | Control terminals | **22** | System Board (optional) |
| **11** | Power terminals | | |
| **12** | Earthing points | | *Through-panel fixing plate and screws not illustrated* |
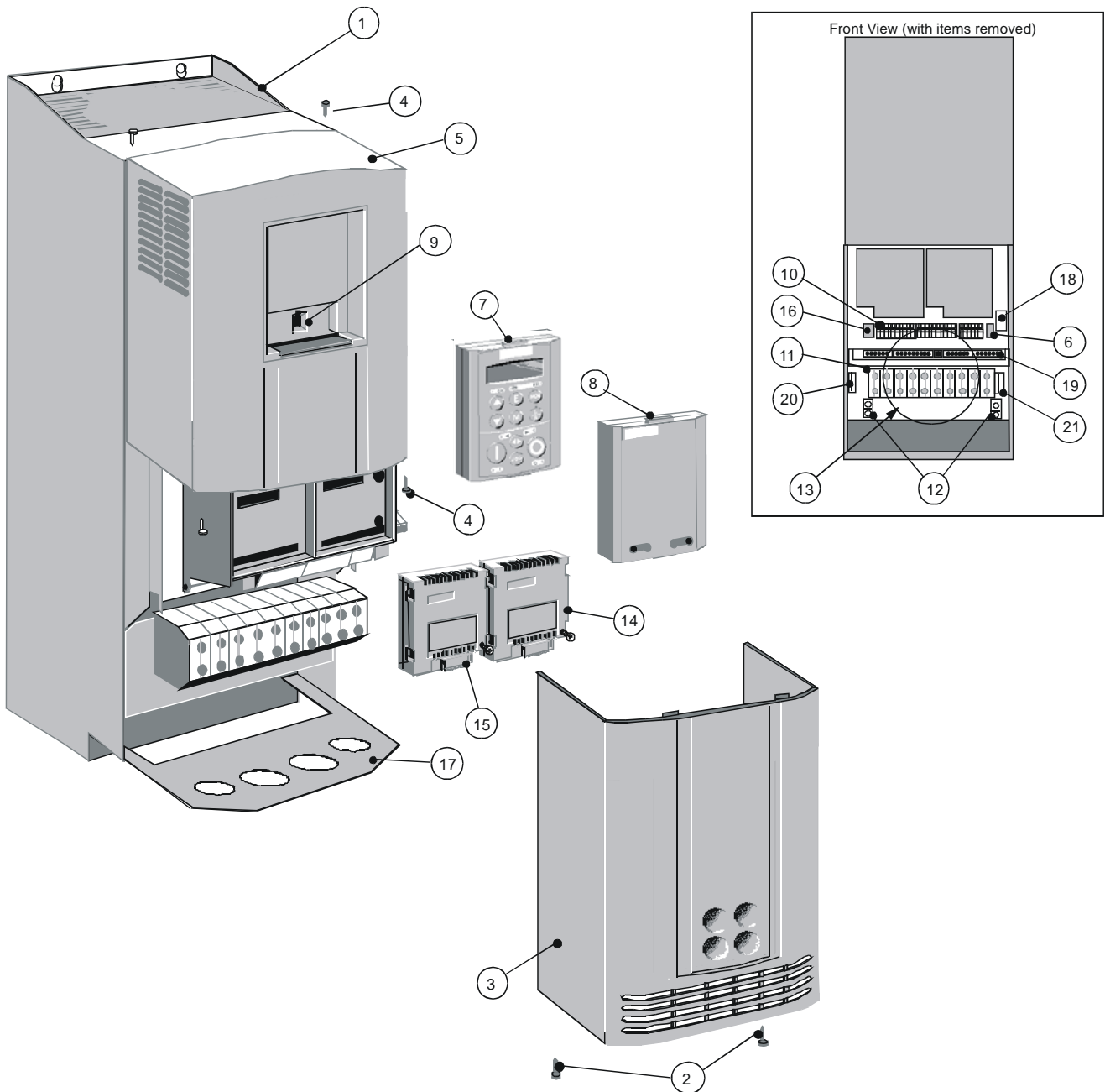
**Figure 2-5  690+ AC Drive, Frame F  55 - 90kW**

| | | | |
|---|---|---|---|
| **1** | Main drive assembly | **11** | Power terminals |
| **2** | Lower front cover retaining screw | **12** | Earthing points |
| **3** | Lower front cover | **13** | Chassis fan |
| **4** | Upper front cover retaining screw | **14** | Comms technology box (optional) |
| **5** | Upper front cover | **15** | Speed feedback technology box (optional) |
| **6** | RS232 programming port (P3) | **16** | Future communications option (P8) |
| **7** | 6901 Keypad | **17** | Gland plate |
| **8** | Blank cover (Part Number: LA389836U001) | **18** | Motor thermistor terminals |
| **9** | Keypad port (P3) | **19** | System Board (optional) |
| **10** | Control terminals | **20** | Auxiliary supply terminals (fan) |
| | | **21** | Brake terminals |

# Control Features

The drive is fully-featured when controlled using the optional Keypad (or a suitable PC programming tool).

DEFAULT

*The `General' control features below are not user-selectable when the unit is controlled using the analog and digital inputs and outputs.*

| General | Output Frequency | Selectable 0-500Hz, or 0-1000Hz ≥6kHz (V/Hz mode)<br>Selectable 0-350Hz (closed loop vector mode)<br>Selectable 0-120Hz (sensorless vector mode) |
|---|---|---|
| | Switching Frequency | *Constant Torque* : selectable 3kHz, 6kHz or 9kHz depending on power rating<br>*Quadratic Torque* : 3kHz for all units |
| | Voltage Boost | 0-25% (Fixed or Auto Boost) |
| | Flux Control | 1. V/F control with linear or fan law profile<br>2. Sensorless vector with automatic flux control and slip compensation<br>3. Closed loop vector<br>   (with speed feedback Technology Box) |
| | Skip Frequencies | 4 skip frequencies with adjustable skip band width |
| | Preset Speeds | 8 presets with programmable ramp rates |
| | Stopping Modes | Ramp, ramp with hold, coast, dc injection, fast stop |
| | Ramps | Symmetric or asymmetric ramp up and down rates |
| | Raise/Lower | Programmable MOP function |
| | Jog | Programmable jog speed |
| | Logic Functions | 10 programmable 3 input logic function blocks performing NOT, AND, NAND, OR, NOR and XOR functions |
| | Value Functions | 10 programmable 3 input value function blocks performing IF, ABS, SWITCH, RATIO, ADD, SUB, RATIO, TRACK/HOLD, and BINARY DECODE functions |
| | Diagnostics | Full diagnostic and monitoring facilities |
| Protection | Trip Conditions | Output short line to line, and line to earth<br>Overcurrent > 220%<br>I*t overload 50-105% (adjustable)<br>Heatsink overtemperature<br>Motor Thermistor overtemperature<br>Overvoltage and undervoltage |
| | Current Limit | Adjustable 50%-150%<br>180% shock load limit |
| | Voltage/ Frequency Profile | Linear Law<br>Fan Law<br>User Defined (v5.1 onwards) |
| Inputs/ Outputs | Analog Inputs | 4 configurable inputs - voltage or current |
| | Analog Outputs | 3 configurable outputs - voltage or current |
| | Digital Inputs | 7 configurable 24V dc inputs, 1 fixed 24V dc inputs |
| | Relay Outputs | 3 relay contacts (volt-free) |

**Table 2-1  Control Features**

# Functional Overview

SYSTEM BOARD
INTERFACE
CONNECTOR

SYSTEM BOARD
INTERFACE

TECHNOLOGY OPTION
INTERFACE

TECHNOLOGY OPTION 1
INTERFACE
CONNECTOR

RS232
PROGRAMMING
PORT

6901
OPERATOR
STATION
INTERFACE

TECHNOLOGY OPTION
INTERFACE

TECHNOLOGY OPTION 2
INTERFACE
CONNECTOR

26
25
24
23
22
21

RELAY

L1  L2/N  L3

FILTER

20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

CONTROL
TERMINALS

PROCESSOR

PE

POWER

Diode Bridge

DC+

DC-

DBR

CONTROL

M1  M2  M3
U   V   W

**Figure 2-6  Functional Block Diagram (Frame B)**

SYSTEM BOARD
INTERFACE
CONNECTOR

SYSTEM BOARD
INTERFACE

TECHNOLOGY OPTION
INTERFACE

TECHNOLOGY OPTION 1
INTERFACE
CONNECTOR

RS232
PROGRAMMING
PORT

6901
OPERATOR
STATION
INTERFACE

TECHNOLOGY OPTION
INTERFACE

TECHNOLOGY OPTION 2
INTERFACE
CONNECTOR

26
25
24
23
22
21

RELAY

MOTOR
THERMISTOR
TERMINALS

*(LOCATION VARIES
WITH FRAME SIZE)*

20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

CONTROL
TERMINALS

PROCESSOR

Diode Bridge

L1

L2

L3

DC Link
Choke
Frames
C & D

AC Line Choke
Frames E & F

Charging
Circuit

DC+

DC-

DBR+

DBR-

CONTROL

POWER

M1  M2  M3
U   V   W

**Figure 2-7  Functional Block Diagram (Frames C, D, E, F)**

## Filter Board (Frame B only)

This two-stage filter consists of common and differential mode elements. It attenuates the drive noise produced on to the mains supply. Mains supply is applied to terminals L1, L2 (N) and L3.

## Power Board/Stack

DC link capacitors smooth the dc voltage output prior to the drive power stage. The IGBT (Insulated Gate Bi-polar Transistor) output stage converts the dc input to a three phase output used to drive the motor.

## Control Board

### Processor

The processor provides for a range of analog and digital inputs and outputs, together with their reference supplies. For further details refer to Chapter 8: "Technical Specifications" - Control Terminals.

### Technology Options

### Comms Technology Box

This is a multi-way connector and processor bus interface with control signals allowing various Technology Box protocol options to be fitted to the drive.

### Speed Feedback Technology Box/Board

Provides speed feedback for HTTL encoders. The option takes the form of a Technology Board in the case of the 690+ Frame B.

### Keypad Interface

This is a non-isolated RS232 serial link for communication with the Keypad. Alternatively, a PC running SSD Drives' "ConfigEd Lite" Windows-based configuration software (or some other suitable PC programming tool) can be used to graphically program and configure the drive.

### System Board Interface

The System Board interface hosts the factory-fitted System Board which enhances the 690+ product in to a fully featured systems drive.

# INSTALLING THE DRIVE

**IMPORTANT:** Read Chapter 9: "Certification for the Drive" before installing this unit.

## Mechanical Installation

*Top Cover increased height shown by H2*



If wall-mounted, the unit must be fitted with the Top Cover firmly screwed into position.
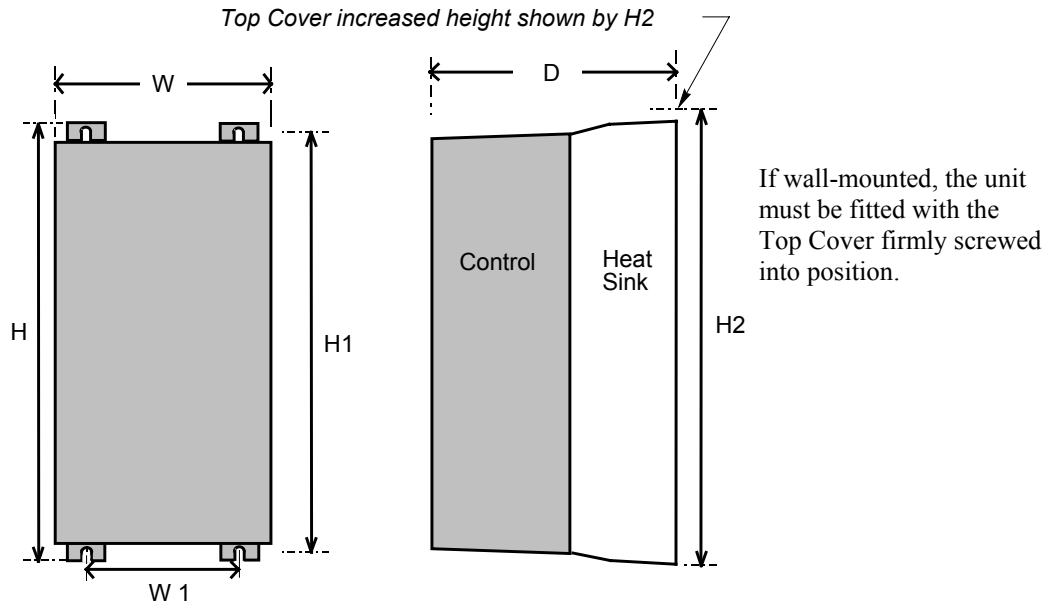
*Approximate Frame C shown for illustration purposes*

**Figure 3-1 Mechanical Dimensions for 690+ Series**

| Models | Max. Weight kg/lbs | H | H1 | H2 | W | W1 | D | Fixings |
|--------|--------------------|----|-----|-----|----|-----|----|---------|
| Frame B | 4.3/9.5 | 233.0 (9.17) | 223.0 (8.78) | 234.0 (9.20) | 176.5 (6.95) | 129.5 (5.10) | 181.0* (7.15) | Slot 4.8mm wide Use M4 fixings |
| Frame C | 9.3/20.5 | 348.0 (13.70) | 335.0 (13.19) | 365.0 (14.37) | 201.0 (7.91) | 150 (5.90) | 208.0 (8.19) | Slot 7mm wide Use M5 or M6 fixings. |
| Frame D | 18.4/40.6 | 453.0 (17.8) | 440.0 (17.3) | 471.0 (18.5) | 252.0 (9.92) | 150 (5.90) | 245.0 (9.65) | Slot 7mm wide Use M5 or M6 fixings. |
| Frame E | 32.5/72 | 668.6 (26.3) | 630.0 (24.8) | 676.0 (26.6) | 257.0 (10.1) | 150.0 (5.9) | 312 (12.3) | Use M6 fixings |
| Frame F | 41/90.4 | 720.0 (28.3) | 700.0 (27.6) | Not applicable | 257.0 (10.1) | 150.0 (5.9) | 355.0 (14.0) | Use M6 fixings |
| | *\* 197.0 (8.04) when unit fitted with System Board* | | | | | | | |
| | All dimensions are in millimetres (inches) | | | | | | | |

**Note:** *For details of a through-panel mounting option for Frames D & E refer to pages 3-6 and 3-8 respectively.*

### Mounting the Drive

The unit must be mounted vertically on a solid, flat, vertical surface. It can be wall-mounted, or mounted inside a suitable cubicle, depending upon the required level of EMC compliance - refer to Chapter 8: "Technical Specifications".

### Ventilation

The drive gives off heat in normal operation and must therefore be mounted to allow the free flow of air through the ventilation slots and heatsink. Maintain minimum clearances for ventilation as given in the tables below to ensure adequate cooling of the drive, and that heat

generated by other adjacent equipment is not transmitted to the drive. Be aware that other equipment may have its own clearance requirements. When mounting two or more 690+ units together, these clearances are additive. Ensure that the mounting surface is normally cool.

## Minimum Air Clearance (Frame B)

### Cubicle-Mount Product/Application (Frame B)
(Europe: IP2x, USA/Canada: Open Type)

The drive, without the top cover fitted, must be mounted in a suitable cubicle.
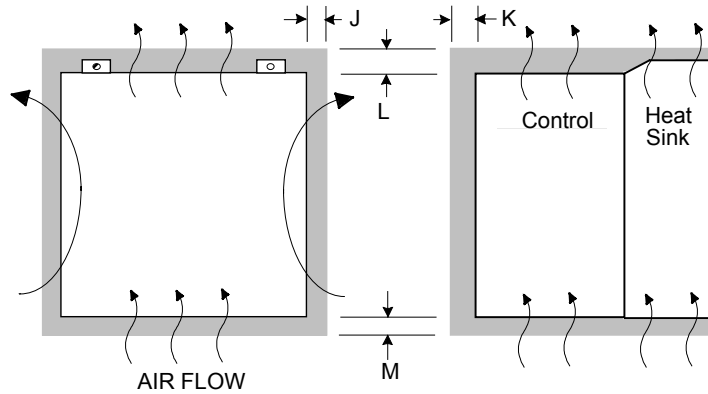


**Figure 3-2  Air Clearance for a Cubicle-Mount Product/Application**

| Model Recognition | Clearances for Standard Product without Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame B | 15 | 15 | 70 | 80 |

### Wall-Mount Product/Application (Frame B)
(Europe: IP2x plus IP4x top surface protection, USA/Canada: Type 1)

Wall-mounted 690+ units **must** have the top cover correctly fitted. The top cover fixing screw has a maximum tightening torque of 1.5Nm (1.2Nm recommended). Refer to Chapter 9: "Certification for the Drive" - Direct Wall-Mountable Models.
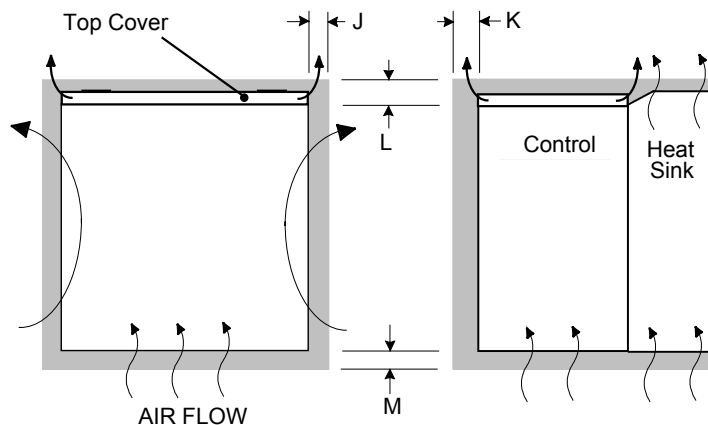


**Figure 3-3  Air Clearance for a Wall-Mount Product/Application**

| Model Recognition | Clearances for Standard Product fitted with Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame B | 15 | 15 | 70 | 80 |

# Minimum Air Clearance (Frame C)

## Cubicle-Mount Product/Application (Frame C)

(Europe: IP2x, USA/Canada: Open Type).

The drive, without the top cover fitted, must be mounted in a suitable cubicle.



**Figure 3-4  Air Clearance for a Cubicle-Mount Product/Application**

| Model Recognition | Clearances for Standard Product without Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame C | 15 | 15 | 70 | 70 |

## Wall-Mount Product/Application (Frame C)

(Europe: IP2x plus IP4x top surface protection, USA/Canada: Type 1).

Wall-mounted 690+ units **must** have the top cover correctly fitted. The top cover fixing screw has a maximum tightening torque of 1.5Nm (1.2Nm recommended).
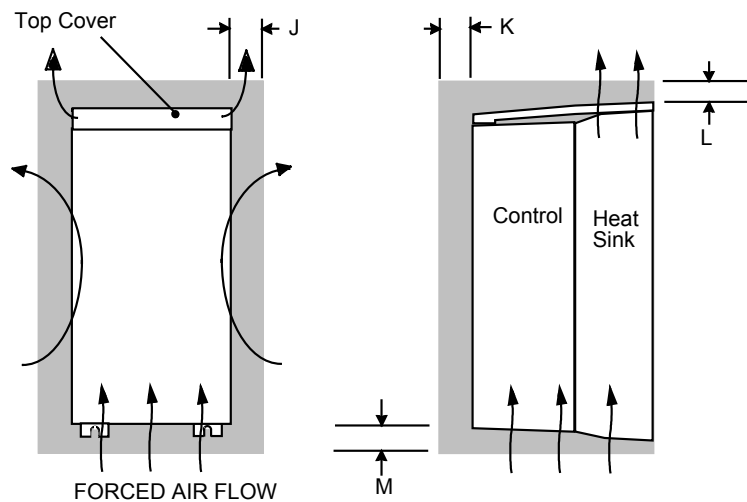


**Figure 3-5  Air Clearance for a Wall-Mount Product/Application**

| Model Recognition | Clearances for Standard Product fitted with Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame C | 20 | 15 | 70 | 70 |

# 3-4 Installing the Drive

## Through-Panel Mount Product/Application (Frame C)

(Europe: IP2x, USA/Canada: Open Type).

The drive, without the top cover fitted, can be mounted in a suitable cubicle.



**Figure 3-6  Air Clearance for a Through-Panel Mount Product/Application**

| Model Recognition | Clearances for Through-Panel Mount Standard Product (mm) | | | | Through-Panel Dimensions | |
|---|---|---|---|---|---|---|
| | J | K | L | M | N | P |
| Frame C | 20 | 15 | 70 | 70 | 125 | 82 |
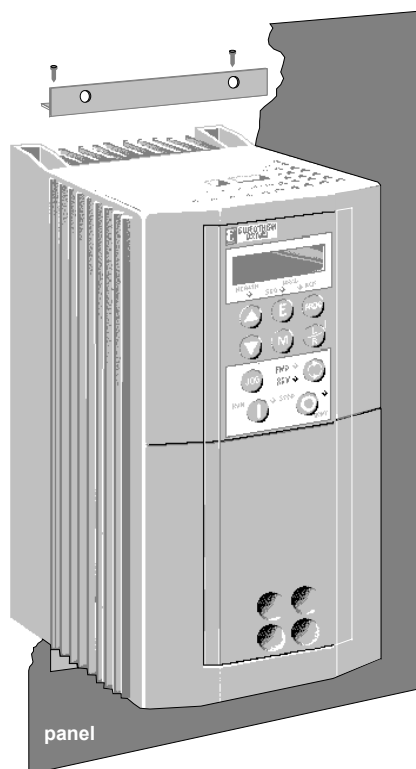


## Through-Panel Mount Bracket Assembly (Frame C)

The through-panel kit is available as a separate item, part number LA465034U003.

Through-panel mounting a drive in a cubicle allows you to use a smaller cubicle because much of the heat generated by the drive is dissipated outside the cubicle.

- Cut the panel aperture to the dimensions given in the drawing at the end of this chapter.

- Screw the top and bottom brackets to the drive as shown, torque to 3Nm. When in position, these complete a mating face for the panel around the drive.

- Fit the top and bottom self-adhesive gasket material to the brackets making sure that the gasket covers the gap between the bracket and heatsink along the top and bottom edge of the drive.

- Fit a gasket to each side of the drive to complete the gasket seal. Ensure a complete seal is made; 2 extra side gaskets are provided.

- Offer up the drive to the panel and secure.

Refer to Through-Panel Cutout Details, page 3-9.

# Minimum Air Clearance (Frame D)

## Cubicle-Mount Product/Application (Frame D)

(Europe: IP2x, USA/Canada: Open Type).

The drive, without the top cover fitted, must be mounted in a suitable cubicle.



ISOLATED FORCED AIR FLOWS
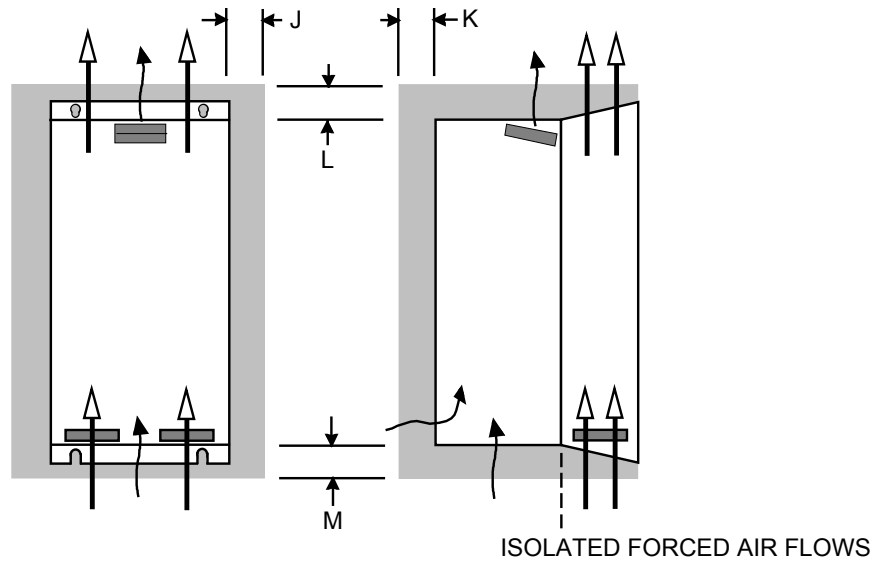
**Figure 3-7  Air Clearance for a Cubicle-Mount Product/Application**

| Model Recognition | Clearances for Standard Product without Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame D | 15 LHS, 5 RHS | 25 | 70 | 70 |

## Wall-Mount Product/Application (Frame D)

(Europe: IP2x plus IP4x top surface protection, USA/Canada: Type 1).

Wall-mounted 690+ units **must** have the top cover correctly fitted. The top cover fixing screw has a maximum tightening torque of 1.5Nm (1.2Nm recommended).



Top Cover

ISOLATED FORCED AIR FLOWS
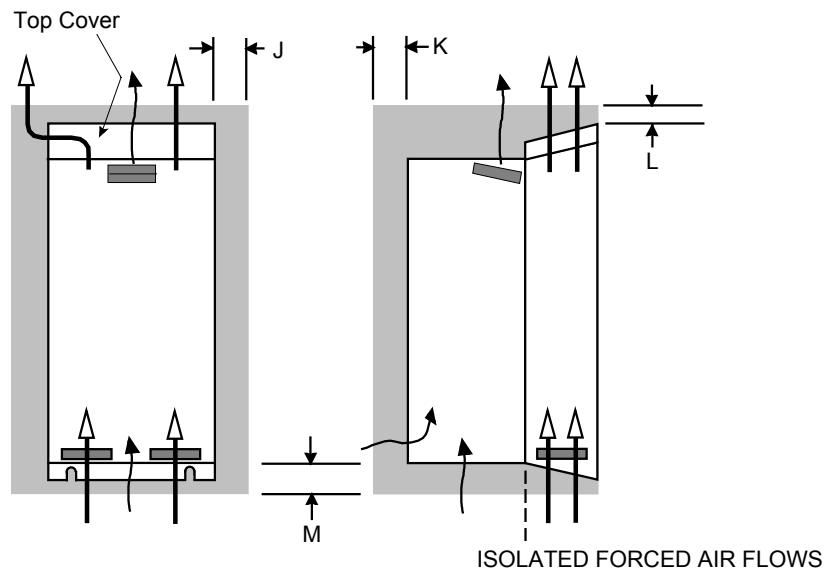
**Figure 3-8  Air Clearance for a Wall-Mount Product/Application**

| Model Recognition | Clearances for Standard Product fitted with Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame D | 15 LHS, 5 RHS | 25 | 70 | 70 |

## Through-Panel Mount Product/Application (Frame D)

(Europe: IP2x, USA/Canada: Open Type).

The drive, without the top cover fitted, can be mounted in a suitable cubicle.



ISOLATED FORCED AIR FLOWS

**Figure 3-9  Air Clearance for a Through-Panel Mount Product/Application**

| Model Recognition | Clearances for Through-Panel Mount Standard Product (mm) | | | | Through-Panel Dimensions | |
|---|---|---|---|---|---|---|
| | J | K | L | M | N | P |
| Frame D | 15 LHS, 5 RHS | 25 | 100 | 100 | 141 | 104 |
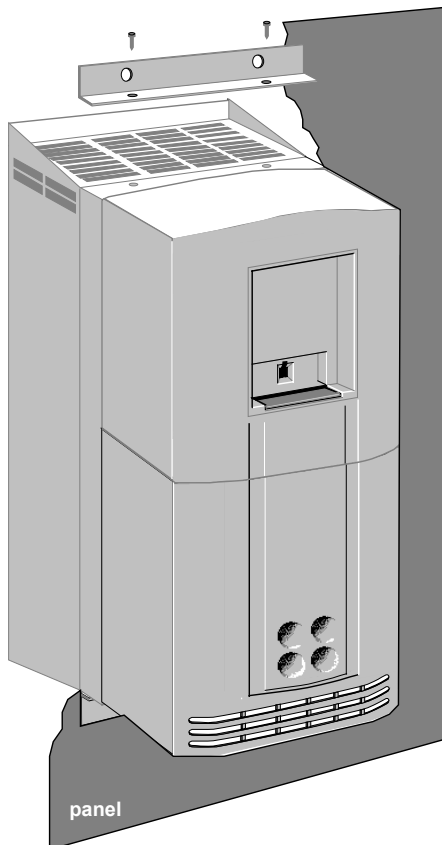


## Through-Panel Mount Bracket Assembly (Frame D)

The through-panel kit is available as a separate item, part number LA465048U003.

Through-panel mounting a drive in a cubicle allows you to use a smaller cubicle because much of the heat generated by the drive is dissipated outside the cubicle.

- Cut the panel aperture to the dimensions given in the drawing at the end of this chapter.

- Screw the top and bottom brackets to the drive as shown, torque to 4Nm. When in position, these complete a mating face for the panel around the drive.

- Fit the top and bottom gaskets to the panel, aligning the gasket holes with the holes in the panel for fixing the drive. Fit two side gaskets around the panel aperture so that an air-tight seal will be made between the drive and the panel; 2 extra side gaskets are provided.

- Offer up the drive to the panel and secure.

Refer to Through-Panel Cutout Details, page 3-9.

# Minimum Air Clearance (Frame E)

## Cubicle-Mount Product/Application (Frame E)

(Europe: IP2x, USA/Canada: Open Type).

The drive, without the top cover fitted, must be mounted in a suitable cubicle.



ISOLATED FORCED AIR FLOWS
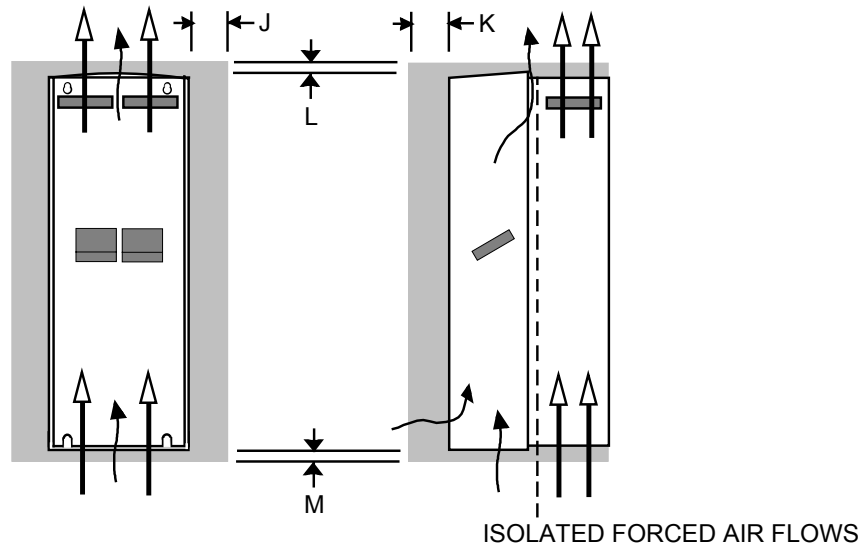
**Figure 3-10  Air Clearance for a Cubicle-Mount Product/Application**

| Model Recognition | Clearances for Standard Product without Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame E | 0 (zero) | 25 | 70 | 70 |

## Wall-Mount Product/Application (Frame E)

(Europe: IP2x plus IP4x top surface protection, USA/Canada: Type 1).

Wall-mounted 690+ units **must** have the top cover correctly fitted. The top cover fixing screw has a maximum tightening torque of 1.5Nm (1.2Nm recommended).



Top Cover

ISOLATED FORCED AIR FLOWS
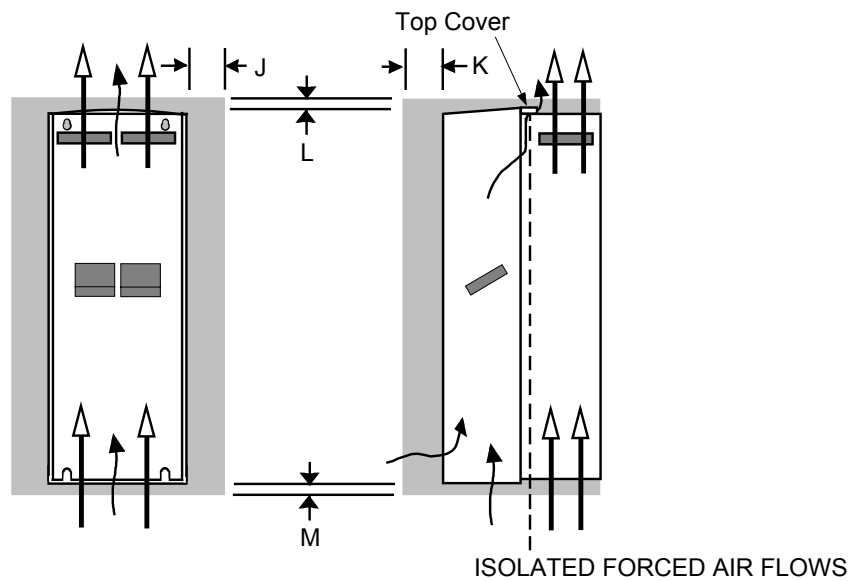
**Figure 3-11  Air Clearance for a Wall-Mount Product/Application**

| Model Recognition | Clearances for Standard Product fitted with Top Cover  (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame E | 0 (zero) | 25 | 70 | 70 |

### Through-Panel Mount Product/Application (Frame E)

(Europe: IP2x, USA/Canada: Open Type).
The drive, without the top cover fitted, can be through-panel mounted in a suitable cubicle.



ISOLATED FORCED AIR FLOWS
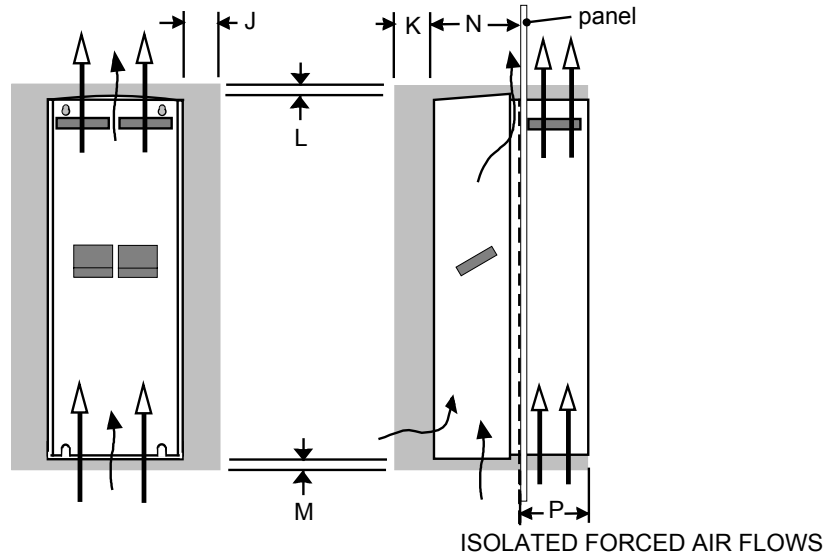
**Figure 3-12  Air Clearance for a Through-Panel Mount Product/Application**

| Model Recognition | Clearances for Through-Panel Mount Standard Product (mm) | | | | Through-Panel Dimensions | |
|---|---|---|---|---|---|---|
| | J | K | L | M | N | P |
| Frame E | 0 (zero) | 25 | 70 | 70 | 180 | 129 (panel thickness not included, max. thickness 5mm |
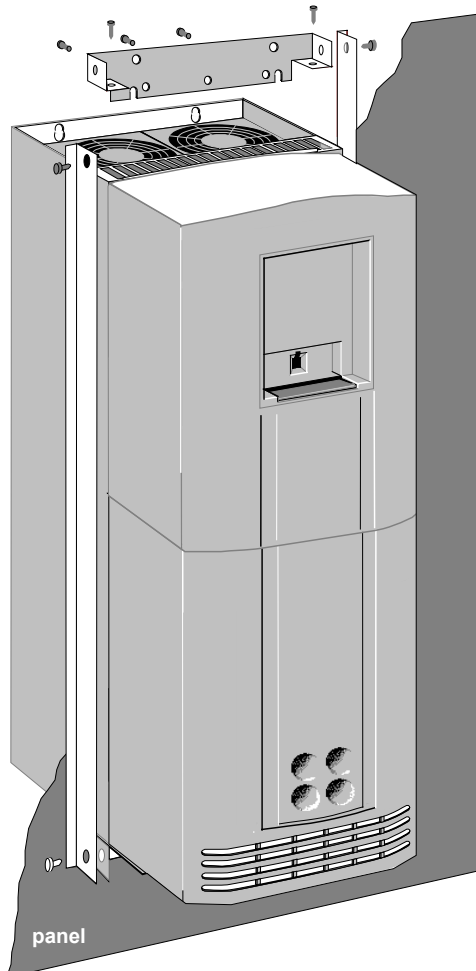


### Through-Panel Mount Bracket Assembly (Frame E)

The through-panel kit is available as a separate item, part number LA465058U003.

Through-panel mounting a drive in a cubicle allows you to use a smaller cubicle because much of the heat generated by the drive is dissipated outside the cubicle.

- Cut the panel aperture to the dimensions given in the drawing at the end of this chapter.

- Lay the drive on its back.

- Lightly screw the top and bottom brackets to the drive as shown.

- Fit the two side brackets to complete the frame and tighten all screws securely.

- Fit the self-adhesive gasket material to the mating face of the drive to produce an air-tight seal between the drive and the panel.

- Offer up the drive to the panel and secure.

Refer to Through-Panel Cutout Details, page 3-9.

## Through-Panel Cutout Details
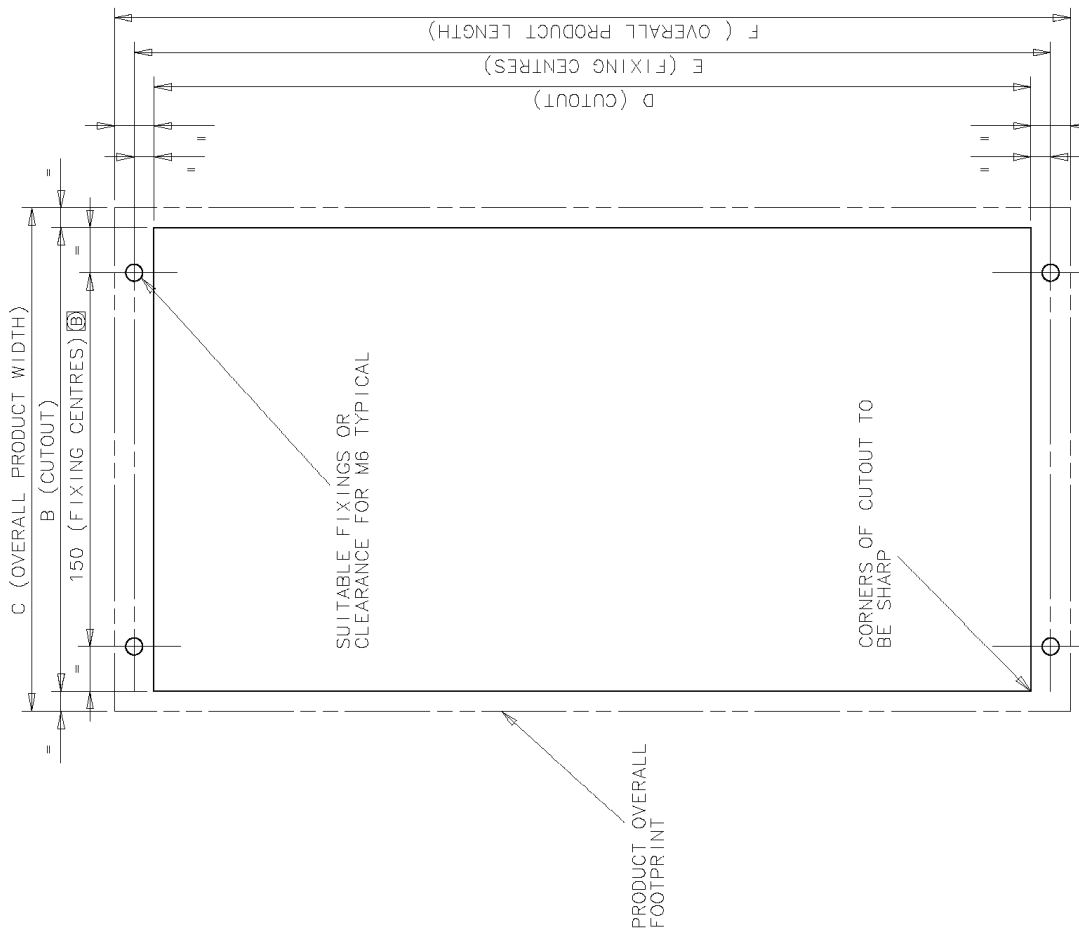
| PRODUCT | DIM "B" | DIM "C" | DIM "D" | DIM "E" | DIM "F" |
|---------|---------|---------|---------|---------|---------|
| FRAME C | 186 | 196 | 354 | 370 | 390 |
| FRAME D | 236 | 252 | 453 | 470 | 485 |
| FRAME E | 255 | 290 | 649 | 667.5 | 687 |

F ( OVERALL PRODUCT LENGTH )

E (FIXING CENTRES)

D (CUTOUT)

C (OVERALL PRODUCT WIDTH)

B (CUTOUT)

150 (FIXING CENTRES) [B]

SUITABLE FIXINGS OR
CLEARANCE FOR M6 TYPICAL

CORNERS OF CUTOUT TO
BE SHARP

PRODUCT OVERALL
FOOTPRINT

## Minimum Air Clearance (Frame F)

*Note:*   *There is no through panel-mount capability for the 690F.*

### Cubicle-Mount Product/Application (Frame F)
(Europe: IP2x, USA/Canada: Open Type).

The drive must be mounted in a suitable cubicle.



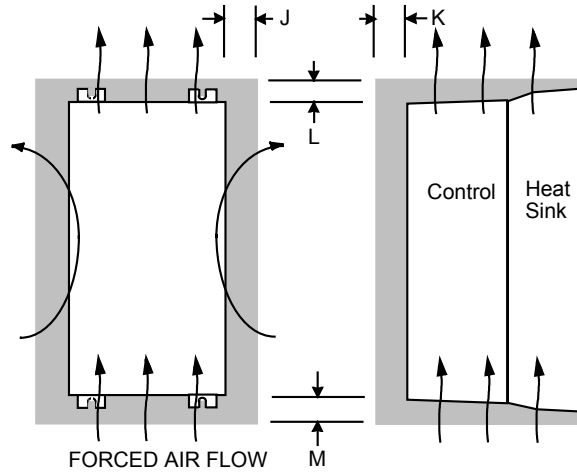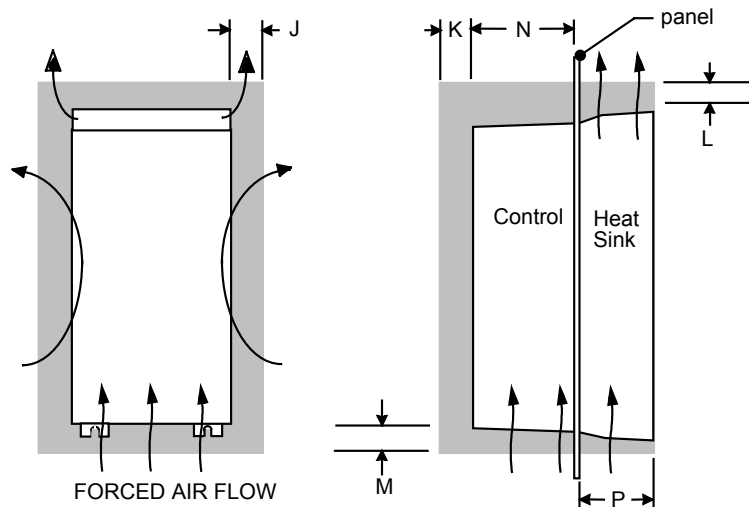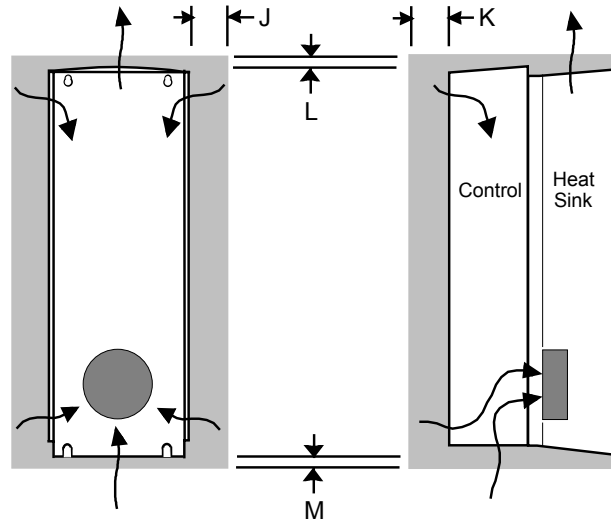**Figure 3-13  Air Clearance for a Cubicle-Mount Product/Application**

| Model Recognition | Clearances for Standard Product (mm) | | | |
|---|---|---|---|---|
| | J | K | L | M |
| Frame F | 0 (zero) | 25 | 70 | 70 |

### Duct Kit
A Duct kit, Part Number LA466717U003 is available for the 690+ Frame F drive.

The installation diagram is provided on the following page.

---

**Caution**
Protect any equipment in the cubicle from swarf etc.
Ensure all equipment is isolated.

---

♦   The duct length determines the vertical position of the drive in the cubicle. Drill the lower mounting panel hole centres for the drive at 976mm from the top of the cubicle. There is a generous tolerance of ±4mm.

♦   Cut-out the hole for the duct directly above where the drive sits. Project the position of the drive mounting surface inside the cubicle and mark it on the roof. From the drawing, you can calculate that the cut-out is made 8.5mm in front of the drive mounting surface (the centres for the cowling fixing holes will be 7.5mm behind the drive mounting surface). Draw the cut-out shape, check its position, and cut it out.

♦   Because of the weight of the drive, it may be better to secure the drive in the cubicle first, and lower the duct into the cubicle from above.

♦   Fix the duct to the drive using the M4 fasteners.

♦   Fit the gasket between the duct cowling and the top of the cubicle to provide a good seal. Drill through and secure all this with the M6 fasteners.

**Duct Kit Installation Diagram**
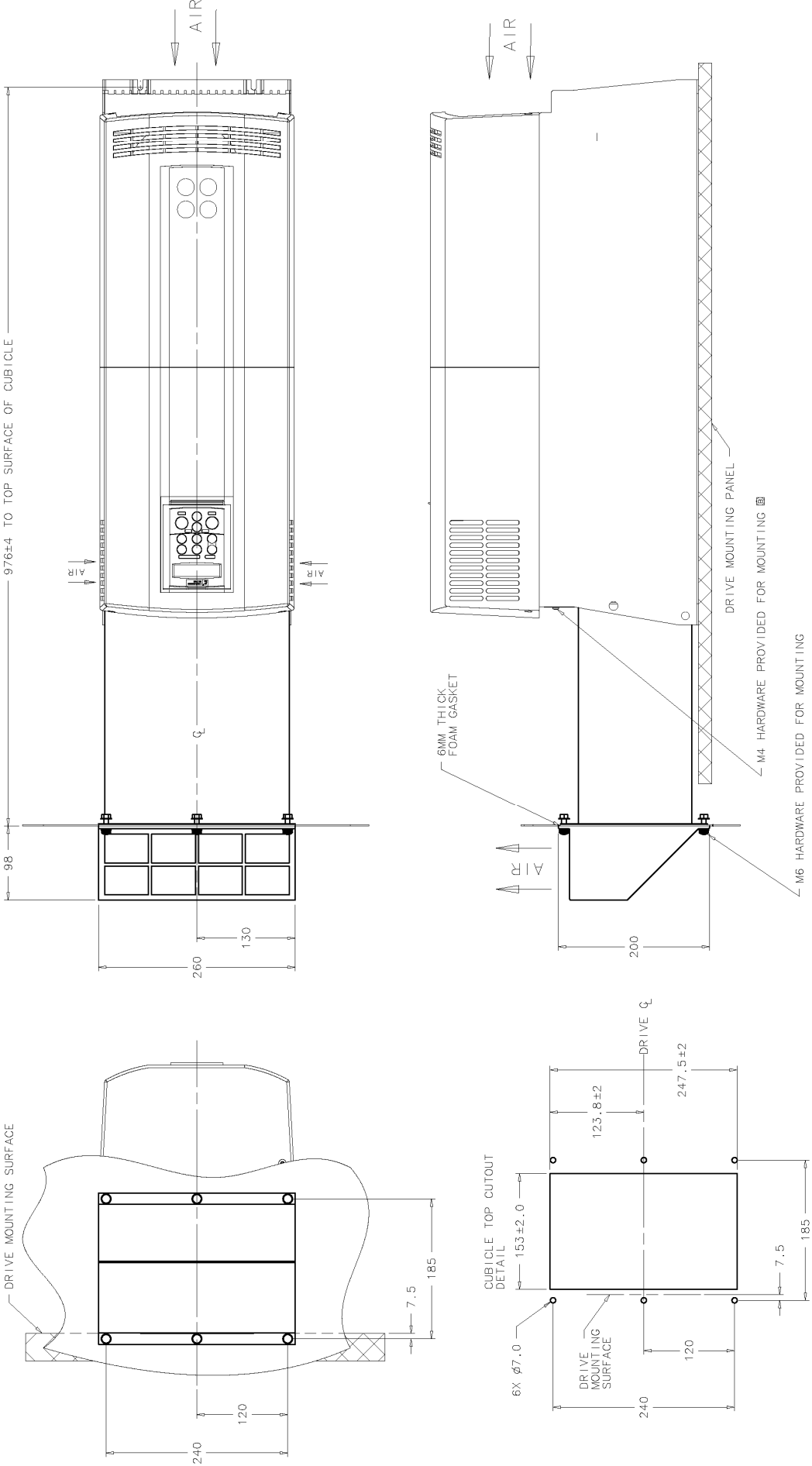
# Electrical Installation

**IMPORTANT:** Please read the Safety Information on page Cont. 3 & 4 before proceeding.

> **WARNING!**
> Ensure that all wiring is electrically isolated and cannot be made "live" unintentionally by other personnel.

*Note:* *Refer to Chapter 8: "Technical Specifications" for additional Cabling Requirements and Terminal Block Wire Sizes.*
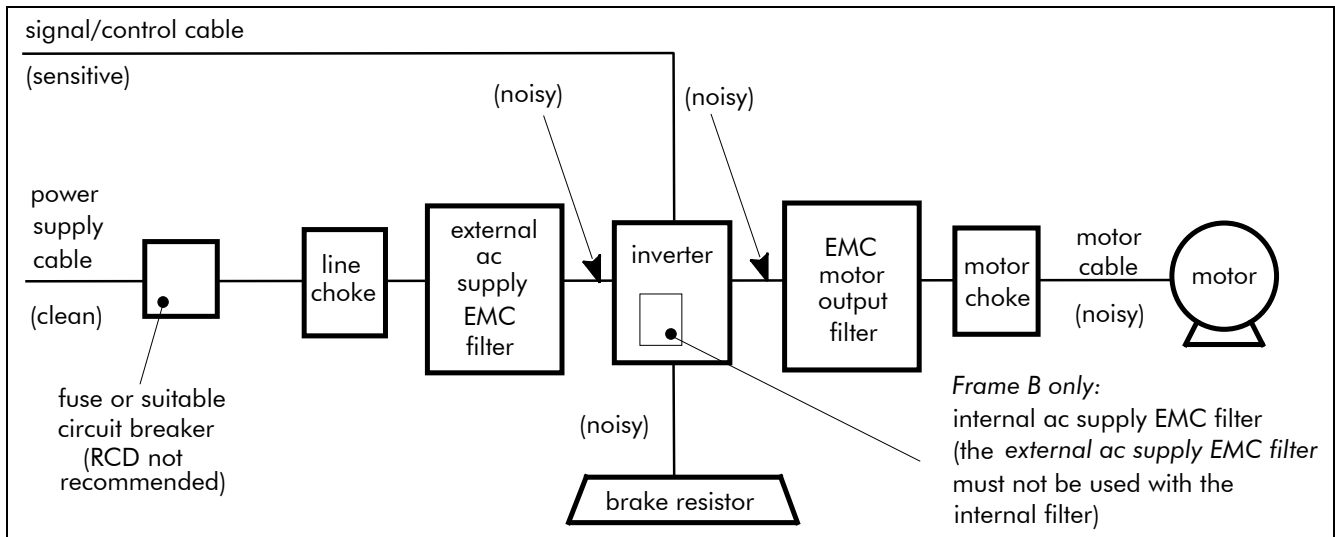


**Figure 3-14  Cabling Requirements**

Cables are considered to be electrically *sensitive*, *clean* or *noisy*. You should already have planned your cable routes with respect to segregating these cables for EMC compliance. If not, refer to Chapter 9: "Certification for the Drive".

## Gland Plate Details

**Frame B**  The gland plate is fitted with grommets. Alternatively, the supplied screen termination clamps may be fitted.

The gland plate holes accept the following gland sizes:

- metric M20, PG16 and American ½" NPT cable gland sizes.

**Frame C**  The gland plate holes accept the following gland sizes:

- 22.8mm to accept metric M20, PG16 and American ½" NPT cable gland sizes
- 28.6mm to accept M25, PG21 and American ¾" NPT cable gland sizes

**Frame D**  The gland plate holes accept the following gland sizes:

- 28.6mm to accept metric M20, PG16 and American ½" NPT cable gland sizes
- 37.3mm to accept  metric M32, PG29 and American 1" NPT

**Frame E**  The gland plate holes accept the following gland sizes:

- 22.8mm to accept metric M20, PG16 and American ½" NPT cable gland sizes
- 28.6mm to accept metric M25, PG21 and American ¾" NPT cable gland sizes
- 47.3mm to accept metric M40, PG36 and American 1¼" NPT cable gland sizes
- 54.3mm to accept metric M50, PG42 and American 1½" NPT cable gland sizes

**Frame F**  The gland plate holes accept the following gland sizes:

- 22.8mm to accept metric M20, PG16 and American ½" NPT cable gland sizes
- 28.6mm to accept M25, PG21 and American ¾" NPT cable gland sizes

# Cable Gland Requirements

Use a metal gland to connect to the internally earthed gland plate. It must be capable of securing a 360 degree screened connection to give EMC compliance. A 360 degree screened connection can be achieved as shown.
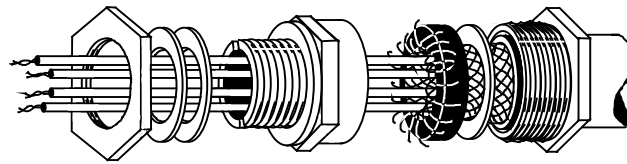


**Figure 3-15  360 Degree Screened Connection**

# Protective Earth (PE) Connections ⏚

The unit must be **permanently earthed** according to EN 50178 - see below. Protect the incoming mains supply using a suitable fuse or circuit breaker (circuit breaker types RCD, ELCB, GFCI are not recommended). Refer to "Earth Fault Monitoring Systems", page 3-30.

**IMPORTANT:** The drive is only suitable for earth referenced supplies (TN) when fitted with an internal filter. External filters are available for use on TN and IT (non-earth referenced) supplies.

For installations to EN 50178 in Europe:

*   for permanent earthing, two individual incoming protective earth conductors (<10mm² cross-section) or one conductor (>10mm² cross-section) are required. Each earth conductor must be suitable for the fault current according to EN 60204.

Refer to Chapter 9: "Certification for the Drive" - EMC Installation Options.

## Motor Connections

## Power Wiring Connections (Frame B)



**Single Phase Input**

power supply

motor
(maximum motor cable length 50m)

motor thermistor

*Brake resistor and cable must be screened if not fitted inside a control cubicle*



**Three Phase Input**

power supply

motor
(maximum motor cable length 50m)

motor thermistor

1.   Remove the terminal cover retaining screws and lift off the terminal cover.
2.   Feed the power supply and motor cables into the drive through the metal gland plate using the correct cable entries, and connect to the power terminals. Tighten all terminals to the correct tightening torque, refer to the Terminal Tightening Torques table.

## Power Wiring Connections (Frame C)



*Brake resistor and cable must be screened if not fitted inside a control cubicle*

*All screens terminated using a gland at the gland plate*

brake resistor

motor thermistor

1.   Remove the terminal cover retaining screws and lift off the terminal cover.
2.   Lift the internal power terminal shield.
3.   Feed the power supply and motor cables into the drive through the metal gland plate using the correct cable entries, and connect to the power terminals. Tighten all terminals to the correct tightening torque, refer to the Terminal Tightening Torques table.
4.   Lower the internal power terminal shield.

## Power Wiring Connections (Frame D)



*Brake resistor and cable must be screened
if not fitted inside a control cubicle*

*All screens terminated using a gland at the gland plate*

1. Remove the terminal cover retaining screws and lift off the terminal cover.
2. Lift the internal power terminal shield.
3. Feed the power supply and motor cables into the drive through the metal gland plate using the correct cable entries, and connect to the power terminals. Tighten all terminals to the correct tightening torque, refer to the Terminal Tightening Torques table.
4. Lower the internal power terminal shield.

## Power Wiring Connections (Frame E)



*Brake resistor and cable must be screened
if not fitted inside a control cubicle*

*All screens terminated using a gland at the gland plate*

***Note:*** *The standard Frame E terminals are not intended for flat busbar. A Power Terminal adaptor is available to enable wiring with flat busbar, part number BE465483.*

1. Remove the terminal cover retaining screws and lift off the terminal cover.
2. Feed the power supply and motor cables into the drive through the metal gland plate using the correct cable entries, and connect to the power terminals. Tighten all terminals to the correct tightening torque, refer to the Terminal Tightening Torques table.

## Power Wiring Connections (Frame F)
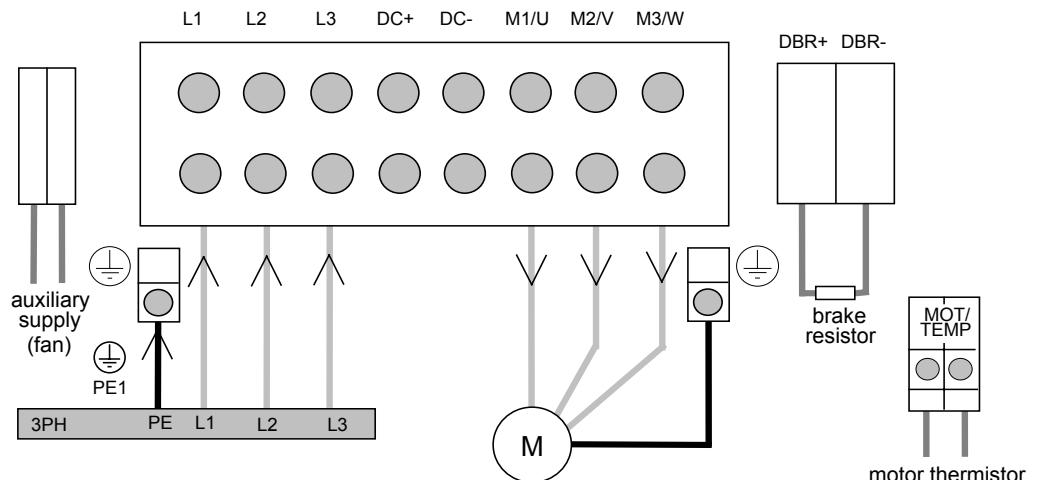


*Terminate all control cable screens using a gland at the gland plate*

*Bond the motor cable screen to the drive and motor, as close as possible to both terminals*

***Note:*** *For cooling fan details, refer to Chapter 8: "Technical Specifications" - Cooling Fan (Frame F).*

***Note:*** *The standard Frame F terminals are not intended for flat busbar. A Power Terminal adaptor is available to enable wiring with flat busbar, part number BE465483.*

1. Remove the terminal cover retaining screws and lift off the terminal cover.
2. Feed the motor cables into the cubicle using the correct cable entry glands ensuring the screen is connected (see Figure 3-14  Cabling Requirements, page 3-12).
3. Feed the power supply and motor cables into the drive through the large aperture in the metal gland plate and connect to the power terminals. Tighten all terminals to the correct tightening torque, refer to the Terminal Tightening Torques table.

## Motor Thermistor Connections

This input is provided to detect over-temperature in motors fitted with an internal thermistor. There is no polarity to the thermistor connections.

***MMI Menu Map***

**1** SETUP

**2** TRIPS

**3** I/O TRIPS

    └ INVERT THERMIST

**IMPORTANT:** This input provides "Basic" insulation only to the SELV control circuits and assumes the motor has "Basic" insulation to the windings/mains circuits.

The thermistor type supported is PTC `Type A' as defined in IEC 34-11 Part 2. The drive uses the following resistance thresholds:

| | |
|---|---|
| Rising temperature trip resistance: | 1650 to 4000Ω |
| Falling temperature trip reset resistance: | 750 to 1650Ω |

If the motor is not fitted with an internal thermistor, you should disable the thermistor trip function either by setting INVERT THERMIST to be TRUE, or by linking the thermistor terminals.
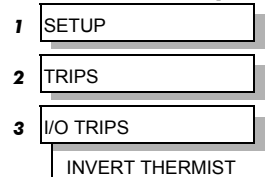
# Control Wiring Connections

All 690+ Series AC Drives have the same control wiring connections.

***Note:*** *Use screened control cables to comply with EMC requirements. All screens terminated using a gland at the gland plate.*

1. Feed the control cables into the drive through the metal gland plate and connect to the control terminals. The diagram below shows the typical control connections required for operation as a simple speed controller.

    Each bank of cables (1-10, 11-20 and 21-26) **must** be secured together with a cable tie as close to the terminals as possible.

2. Refit and secure the terminal cover using the retaining screws.

**IMPORTANT:** The control board 0V must be connected to protective earth outside of the product to meet EMC and safety requirements.

***Note:*** *Refer to Chapter 8: "Technical Specifications" for Control Terminal information*
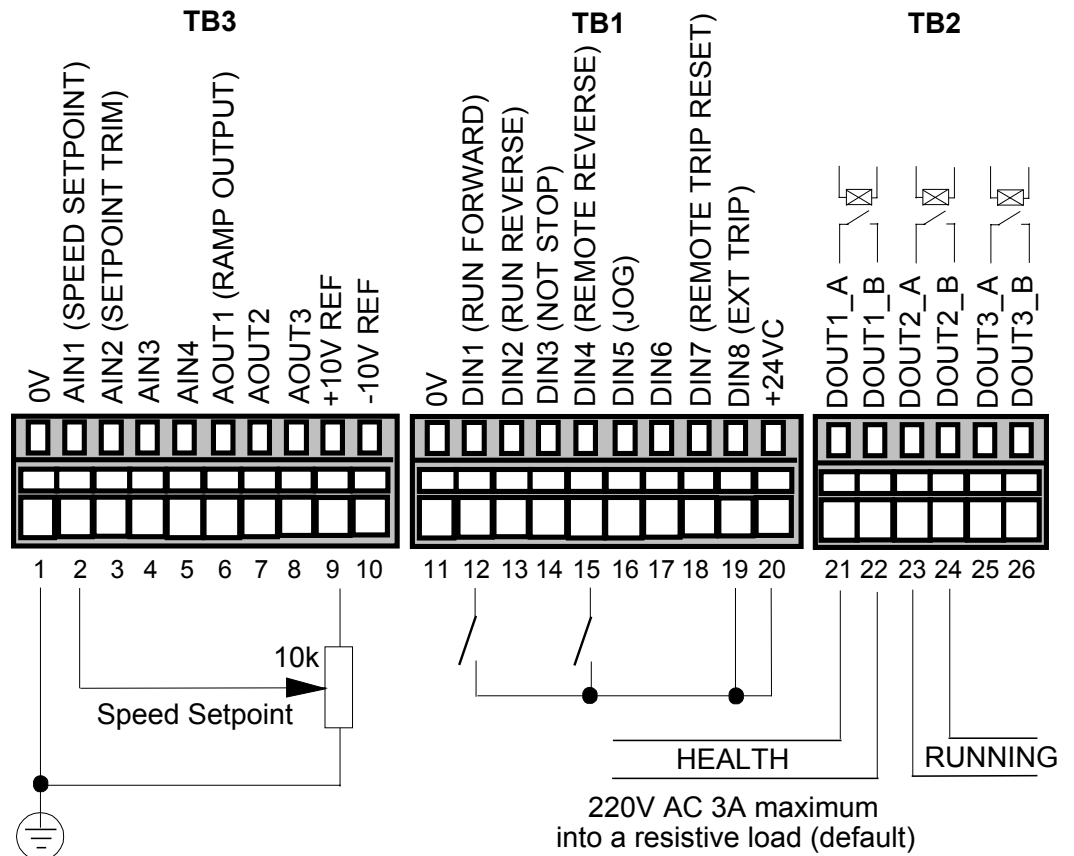


**Figure 3-16  Typical Connection to the Control Terminals**
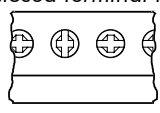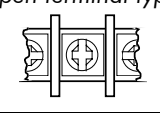
## Terminal Block Acceptance Sizes

Wire sizes for Europe should be chosen with respect to the operating conditions and your local National Electrical Safety Installation Requirements. Local wiring regulations always take precedence. For North American UL wire sizes refer to Chapter 9: "Certification for the Drive" - Requirements for UL Compliance.

| Product Code | Power Terminals (minimum/maximum acceptance for aperture) | | Control Terminals including Thermistor Terminals | System Board Terminals (option) |
|---|---|---|---|---|
| 690PB/... | 0.75 / 6mm$^2$ | | 2.5 mm$^2$ | 2.5 mm$^2$ |
| 690PC/... | 0.75 / 10mm$^2$ (*16mm$^2$) | | 2.5 mm$^2$ | 2.5 mm$^2$ |
| 690PD/0150/... 690PD/0180/... 690PD/0220/... | 2.5 / 16mm$^2$ (* 25mm$^2$) | | 2.5 mm$^2$ | 2.5 mm$^2$ |
| 690PD/0300/... | 2.5 / 25mm$^2$ (* 35mm$^2$) | | 2.5 mm$^2$ | 2.5 mm$^2$ |
| | **Solid** | **Stranded** | | |
| 690PE/... | 16 / 50mm$^2$ | 25 / 50mm$^2$ (* 70mm$^2$) | 2.5 mm$^2$ | 2.5 mm$^2$ |
| 690PF/... | 25/120mm$^2$ | 35 / 95mm$^2$ (*120mm$^2$) | 2.5 mm$^2$ | 2.5 mm$^2$ |

*Note*: The standard Frame E and Frame F terminals are not intended for flat busbar. A Power Terminal adaptor is available to enable wiring with flat busbar, part number BE465483.

*\* The larger wire sizes can be used provided a crimp is fitted to the wire*

## Terminal Tightening Torques

| Frame Size | Model Recognition | | Thermistor & fan supply | Power Terminals | Brake Terminals | Ground Terminals |
|---|---|---|---|---|---|---|
| | Product Code (Block 2 & 3) | Catalog Code (Block 2 & 3) | | | | |
| Frame B | All | All | N/A | 1.04Nm (9.2lb-in) | 1.04Nm (9.2lb-in) | 1.5Nm (13.3 lb-in) |
| Frame C 230V | 0055/230 0075/230 | 0007/230 0010/230 | N/A | 1.35Nm (12 lb-in) | 1.35Nm (12 lb-in) | 2.5Nm (22 lb-in) |
| Frame C 400/500V | 0055/400 0055/500 | 0007/460 | N/A | 1.35Nm (12 lb-in) | 1.35Nm (12 lb-in) | 2.5Nm (22 lb-in) |
| Frame C 400/500V | 0075/400 0110/400 0150/400 0075/500 0110/500 0150/500 | 0010/460 0015/460 0020C/460 | N/A | 1.35Nm (12 lb-in) *enclosed terminal type*  1.8Nm (16 lb-in) *open terminal type* | 1.35Nm (12 lb-in) | 2.5Nm (22 lb-in) |
| Frame D | All | All | N/A | 4Nm (35 lb-in) | 4Nm (35 lb-in) | 4.5Nm (40 lb-in) |
| Frame E | All | All | 0.7Nm (6.1 lb-in) | 6-8Nm (53-70 lb-in) | 6-8Nm (53-70 lb-in) | 6-8Nm (53-70 lb-in) |
| Frame F | All | All | 0.7Nm (6.1 lb-in) | 15-20Nm (132-177 lb-in) | 0.7Nm (6.1 lb-in) | 42Nm (375 lb-in) |

# Optional Equipment

## System Board

With this factory-fitted expansion board, the 690+ drive is suitable for high-end web processing and mini PLC replacement applications.

The following features are provided:

- Converts AIN1-4 in to high resolution (12-bit plus sign) non-isolated analog inputs
- 5 configurable fully-isolated digital inputs/outputs (for PLC applications), individually selectable to input or output
- Supplies variable voltage, isolated encoder power supply
- Decoding logic to interface the encoder to the microprocessor
- Master Encoder Input (isolated HTTL), A, B and Z
- Slave Encoder Input (isolated HTTL), A, B and Z
- Encoder Re-Transmit (isolated HTTL), A, B and Z

Front View (with items removed)



system board
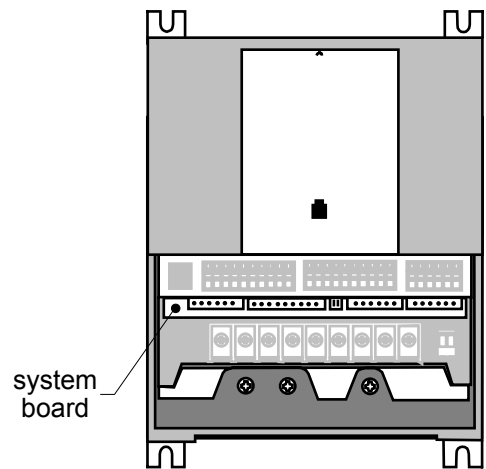
*Frame B illustrated*

## External Power Supply

An external 0V and 24V dc (±10%) 1A power supply is required for the board to operate and supply the digital I/O and encoder power supply at maximum loading.

## Encoder Input Specification

| Maximum Pulse Rate | 250kHz |
|---|---|
| Receiver Current | ≤10mA per channel |
| Input Format | Two differential channels in quadrature |
| Differential Input Threshold | 3V ±1 |
| Encoder Supply | Maximum load = 200mA. Voltage adjustable 12-24V by switches SW1 & SW2 |
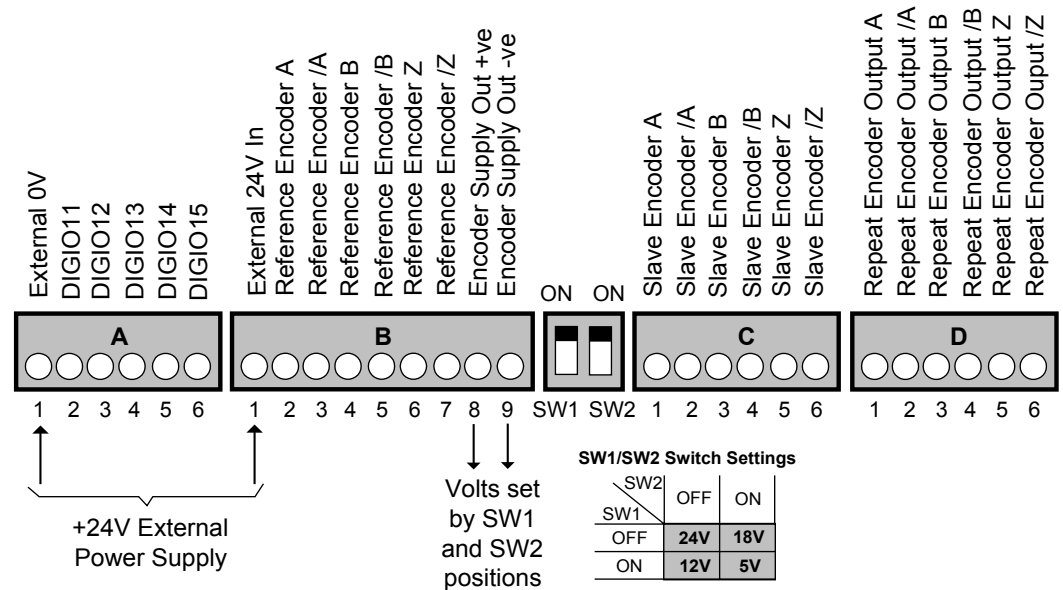


**Figure 3-17 System Board Terminals**

## Encoder Connections

Take special care wiring the encoders to the system board due to the low level of the signals.

All wiring to the system board should be made in screened cable. Use cable with an overall screen and a screen over each individual pair. To ensure compliance with the EMC Directive the overall cable screen should be connected to the encoder body and to the drive chassis.

*Recommended cable (pairs individually screened):*
    Belden equivalent 8777
    SSD Drives Part Number CM052666

## Differential Encoders

*System Board Terminal B*

| | | MASTER | | | | | Encoder supply | | |
|---|---|---|---|---|---|---|---|---|---|
| External +24V In | A | /A | B | /B | Z | /Z | + | - | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

| A | /A | B | /B | Z | /Z | + | -/0V supply |
|---|---|---|---|---|---|---|---|

REFERENCE ENCODER

*System Board Terminal C*

| | SLAVE | | | | | | |
|---|---|---|---|---|---|---|---|
| A | /A | B | /B | Z | /Z | | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | | |

Encoder supply

| + | -/0V supply | A | /A | B | /B | Z | /Z |

SLAVE ENCODER

*System Board Terminal D*

| | REPEAT OUT | | | | | |
|---|---|---|---|---|---|---|
| A | /A | B | /B | Z | /Z | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | |

| 2 | 3 | 4 | 5 | 6 | 7 | |
| A | /A | B | /B | Z | /Z | Master drive chassis |

MASTER

## Single-Ended Encoders

*System Board Terminal B*

| | | MASTER | | | | | Encoder supply | | |
|---|---|---|---|---|---|---|---|---|---|
| External +24V In | A | /A | B | /B | Z | /Z | + | - | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |

| A | B | Z | + | -/0V supply | -/0V |

REFERENCE ENCODER

*System Board Terminal C*

| | SLAVE | | | | | | |
|---|---|---|---|---|---|---|---|
| A | /A | B | /B | Z | /Z | | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | | |

Encoder supply

| + | -/0V supply | A | B | Z | -/0V |

SLAVE ENCODER

*System Board Terminal D*

| | REPEAT OUT | | | | | |
|---|---|---|---|---|---|---|
| A | /A | B | /B | Z | /Z | Drive chassis |
| 1 | 2 | 3 | 4 | 5 | 6 | |

| 2 | 3 | 4 | 5 | 6 | 7 | |
| A | /A | B | /B | Z | /Z | Master drive chassis |

MASTER

## SSD Drives Approved Encoders

Operation with 5V encoders is not recommended. We recommend using 10-24V differential encoders, as shown below.

| Recommended Encoder (12mm bore) | Hengstler: | RI 58TD//2048ED.37IF |
|---|---|---|
| | SSD Drives Part Number: | DD464475U012 |
| Alternative Encoders (20mm bore) | Hengstler: | RI 76TD/2048ED-4N20IF |
| | SSD Drives Part Number: | DD464475U020 |

Encoders are available from Hengstler in other accuracy's such as 500 lines/rev or 2000 lines/rev to suit the application.

## Technology Options

***Note:*** *Optional equipment is fitted to Frames C, D, E and F in very similar ways, but because of its compact size, Frame B is a special case.*

Speed Feedback Option

Remote
Operator
Station
or
Comms
Option

cable tie loop
for restraining
speed feedback
board cables

*Frame B illustrated*

Top Cover

Remote
Operator
Station

Comms
Option

Speed
Feedback
Option

Remote
Operator
Station
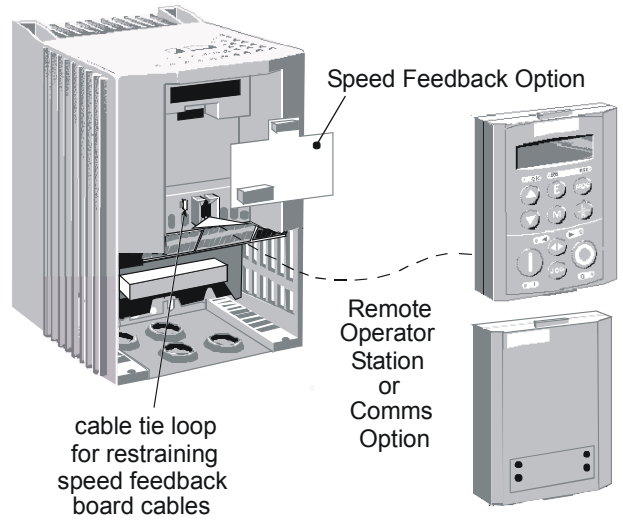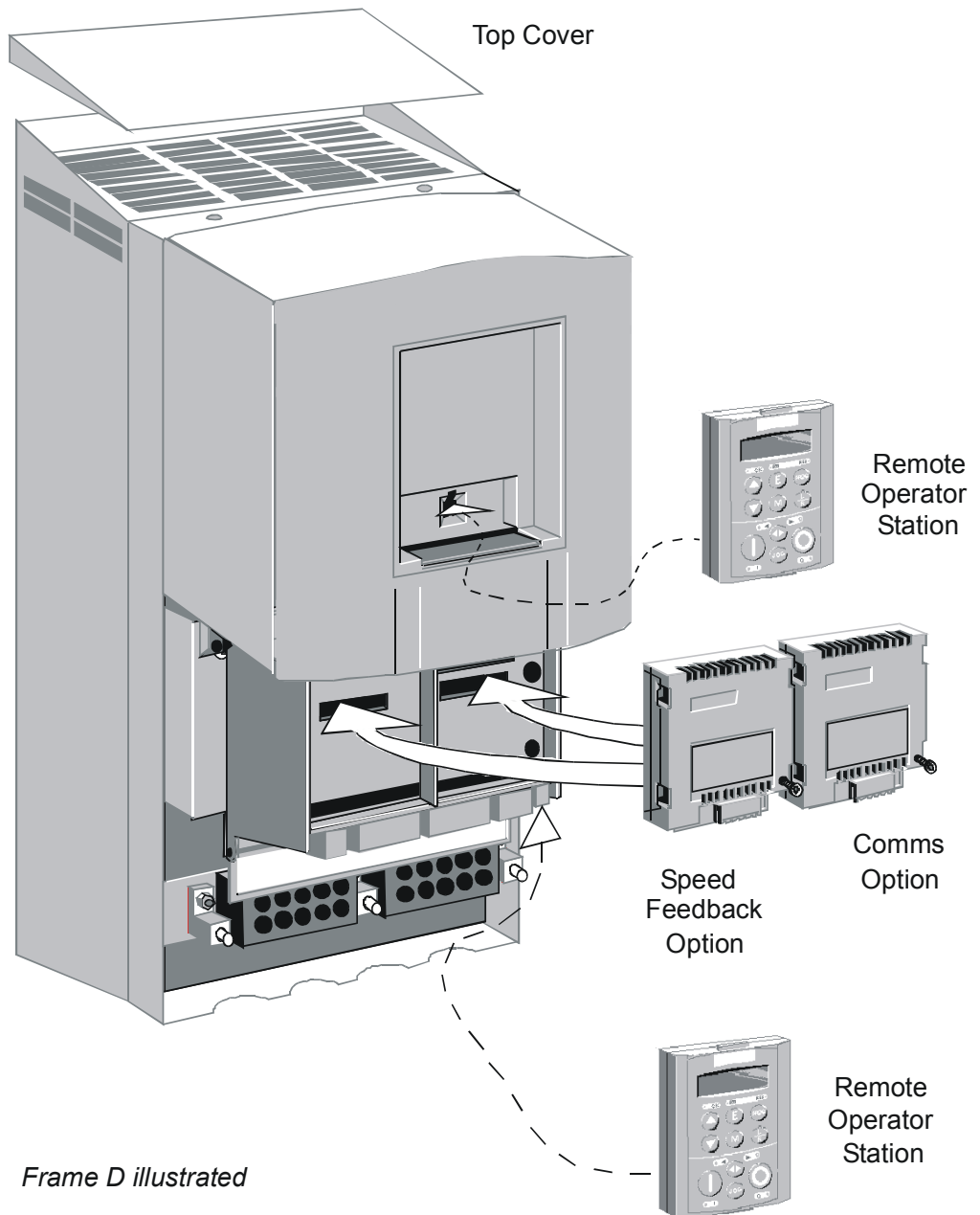
*Frame D illustrated*

> ## WARNING!
> Isolate the drive before fitting or removing the option.

There are two Technology Options:

1. Speed Feedback
2. Communications

These are plugged into the two positions, as illustrated on the previous page.

All Technology Options are designed as plug-in technology boxes, except for the Frame B Speed Feedback option which is a plug-in board.

You can operate the drive with the Speed Feedback and/or Communications Technology Options, but you **cannot** use two options of the same kind.

*Note:* *Refer to the appropriate Technology Option Technical Manual for further information.*

## Technology Box

Remove a technology box option by carefully pushing a long screwdriver (for instance) under the option and gently prising it out. The pins are protected by the option moulding.
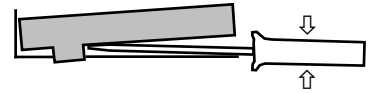
## Speed Feedback Technology Board (Frame B)

### Caution
Observe static control precautions when handling and installing the board.

Fit the technology option by pushing into location until the catches click in position.

Remove the Speed Feedback Board by pushing in the catches and pulling the board away from the drive using the finger holds shown to grip.
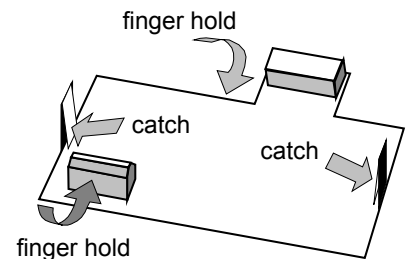
| Item | Part No: Frame B | Part No: Frames C to F |
|---|---|---|
| **TB1 Comms Technology Option** | | |
| *Plug-in field bus communications interface options.* | | |
| Profibus | 6053/PROF | 6055/PROF |
| Profibus Technology Option manual | HA463561U001 | HA463561U001 |
| RS485/RS422/Modbus/EI Bisynch | 6053/EI00 | 6055/EI00 |
| RS485 Technology Option manual | HA463560U001 | HA463560U001 |
| Link | 6053/LINK | 6055/LINK |
| Link Technology Option manual | HA470237 | HA470237 |
| Device Net | 6053/DNET | 6055/DNET |
| Device Net Technology Option Manual | HA463575U001 | HA463575U001 |
| **TB2 Speed Feedback Technology Option** | | |
| *Plug-in speed feedback HTTL Encoder option.* | | |
| • Technology Board (Frame B) | LA467461 | |
| • Technology Box (Frames C, D, E & F) | | 6054/HTTL |
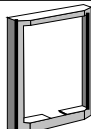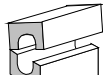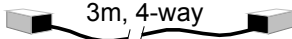
## Fitting the Remote 6901 Keypad

The 6052 Mounting Kit is required to remote-mount a 6901 Keypad. It is possible to:

- Remote-mount the drive-mounted Keypad using the port(s) illustrated
- Remote-mount an additional Keypad in the lower port (not Frame B) - in this case, both Keypads are fully functional
- Remote-mount both Keypads as illustrated (not Frame B) - in this case, both Keypads are fully functional

You can also replace any Keypad for a PC running ConfigEd Lite (or other suitable PC programming tool) in all of the options above. Refer to the Software Product Manual: "Serial Communications".

### 6052 Mounting Kit Parts for the Remote Keypad

| 6052 Mounting Kit Tools required : No. 2 Posidrive screwdriver | | | | | |
|---|---|---|---|---|---|
| 1 | | 1 | | 1 | Steward 28A2025-OAO |
| 4 | No. 6 x 12mm | 1 | 3m, 4-way | | |

### Assembly Procedure

Remove the factory-fitted P3 lead from the P3 port under the terminal cover which connects the fitted keypad. Fit the ferrite to one end of the 3m connector lead, passing the cable through the ferrite twice as shown below. Plug the 3m connector lead from the remote-mounted keypad into the P3 port (see the diagram on the previous page) ensuring that the ferrite is at the drive end of the lead and is as close to the drive as
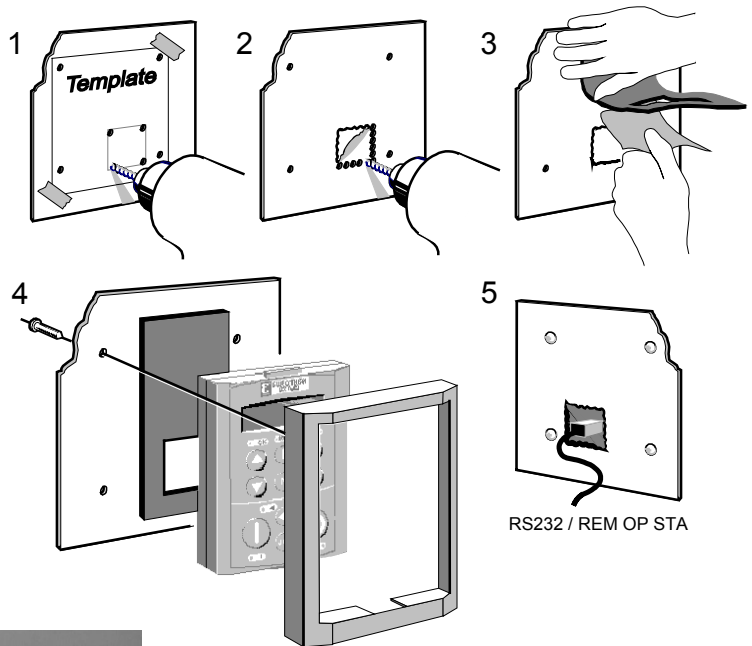


possible.

### Cutout Dimensions

An actual size template is provided with Keypad/6052 Mounting Kit.

**Figure 3-18  Mounting Dimensions for the Remote-Mounted Keypad 6901**
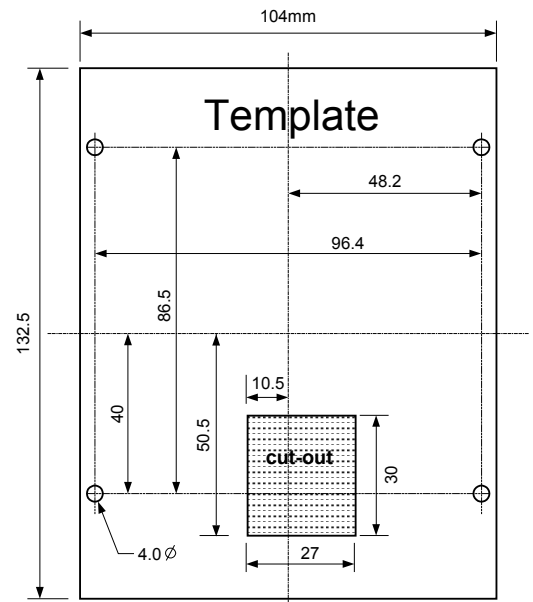
## Top Cover

This can be fitted to wall-mounted 690+ units to give improved compliance ratings. Refer to Chapter 8: "Technical Specifications" - Environmental Details.

The top cover must be correctly fitted and secured with screw(s).

***Note:*** *The maximum operating temperature of the drive is reduced by fitting the top cover. Refer to Chapter 8: "Technical Specifications" - Environmental Details.*

| Item | Part Number |
|---|---|
| Top Cover Kit (UL Type 1 / IP4x), including screws<br>*A protective cover fitted to wall-mounted units to give improved compliance ratings* | |
| • Frame B | LA467452 |
| • Frame C | LA465034U002 |
| • Frame D | LA465048U002 |
| • Frame E | LA465058U002 |

## External Brake Resistor

Three standard power resistors are available from SSD Drives. These resistors should be mounted on a heatsink (back panel) and covered to prevent injury from burning.
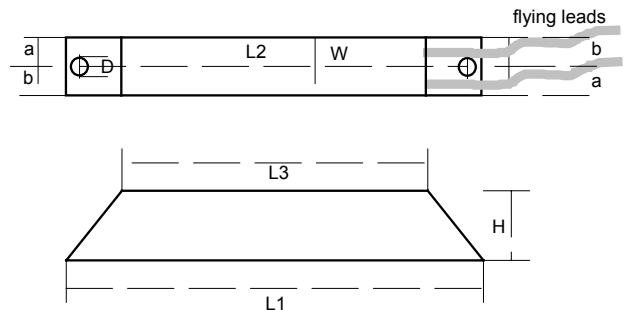


| Part Number | CZ389853 | CZ463068 | CZ388396 |
|---|---|---|---|
| Models used on | Frame B | Frames B, C, D, E, F | Frames C, D, E, F |
| Resistance | 100Ω | 56Ω | 36Ω |
| Maximum Wattage | 100W | 200W | 500W |
| 5 second rating | 500% | 500% | 500% |
| 3 second rating | 833% | 833% | 833% |
| 1 second rating | 2500% | 2500% | 2500% |
| Dimensions L1 (mm) | 165 | 165 | 335 |
| L2 (mm) | 152 | 146 | 316 |
| L3 (mm) | 125 | 125 | 295 |
| W (mm) | 22 | 30 | 30 |
| H (mm) | 41 | 60 | 60 |
| D (mm) | 4.3 | 5.3 | 5.3 |
| a (mm) | 10 | 13 | 13 |
| b (mm) | 12 | 17 | 17 |
| Flying lead length (mm) | 500 | 500 | 500 |
| Electrical Connection | M4 spade | M5 spade | M5 ring |

## North American Standard Dynamic Braking Resistor Kits

The Dynamic Braking Resistor kits were designed for stopping a motor at full load current from base speed with two times motor inertia, three times in rapid succession in accordance with NEMA ICS 3-302.62 Dynamic Braking Stop option.

| 230Vac dynamic braking resistor kit with cover CONSTANT & VARIABLE TORQUE | | | |
|---|---|---|---|
| Hp | Ohms | kW | Catalog No. |
| 3 | 45 | 0.28 | CZ470637 |
| 5 | 27 | 0.35 | CZ353192 |

| | 460 VAC Dynamic Braking Resistor Kit with Cover CONSTANT TORQUE | | | 460 VAC Dynamic Braking Resistor Kit with Cover VARIABLE TORQUE | | |
|---|---|---|---|---|---|---|
| Hp | Ohms | kW | Catalog No. | Ohms | kW | Catalog No. |
| 3 | 100 | 0.1 | CZ389853 | 100 | 0.1 | CZ389853 |
| 5 | 100 | 0.26 | CZ353179 | 100 | 0.26 | CZ353179 |
| 7.5 | 100 | 0.2 | CZ353179 | 100 | 0.2 | CZ353179 |
| 10 | 54 | 0.7 | CZ353181 | 100 | 0.7 | CZ353179 |
| 15 | 54 | 0.84 | CZ353181 | 54 | 0.84 | CZ353181 |
| 20 | 30 | 1.26 | CZ353182 | 54 | 1.26 | CZ353181 |
| 25 | 30 | 1.17 | CZ353182 | 30 | 1.17 | CZ353182 |
| 30 | 30 | 1.56 | CZ353182 | 30 | 1.56 | CZ353182 |
| 40 | 26 | 2.03 | CZ353183 | 30 | 2.03 | CZ353182 |
| 50 | 18.4 | 2.36 | CZ353185 | 26 | 2.36 | CZ353183 |
| 60 | 12 | 2.0 | CZ353186 | 18.4 | 2.92 | CZ353185 |
| 75 | 9 | 3.39 | CZ353188 | 12 | 3.39 | CZ353186 |
| 100 | 7 | 3.39 | CZ353189 | 9 | 3.39 | CZ353188 |
| 125 | 5.5 | 3.39 | CZ353190 | 7 | 3.39 | CZ353189 |
| 150 | 5.5 | 3.39 | CZ353190 | 5.5 | 3.39 | CZ353190 |

## Brake Resistor Selection

*Note:* *SSD Drives can supply suitable brake resistors.*

Brake resistor assemblies must be rated to absorb both peak braking power during deceleration and the average power over the complete cycle.

$$\text{Peak braking power } P_{pk} = \frac{0.0055 \times J \times (n_1{}^2 - n_2{}^2)}{t_b} \quad \textbf{(W)}$$

$$\text{Average braking power } P_{av} = \frac{P_{pk}}{t_c} \times t_b$$

| | |
|---|---|
| J | - total inertia (kgm$^2$) |
| $n_1$ | - initial speed (rpm) |
| $n_2$ | - final speed (rpm) |
| $t_b$ | - braking time (s) |
| $t_c$ | - cycle time (s) |

Obtain information on the peak power rating and the average power rating of the resistors from the resistor manufacturer. If this information is not available, a large safety margin must be incorporated to ensure that the resistors are not overloaded.

By connecting these resistors in series and in parallel the braking capacity can be selected for the application.

**IMPORTANT:** The minimum resistance of the combination and maximum dc link voltage must be as specified in Chapter 8: "Technical Specifications" - Internal Dynamic Brake Switch.
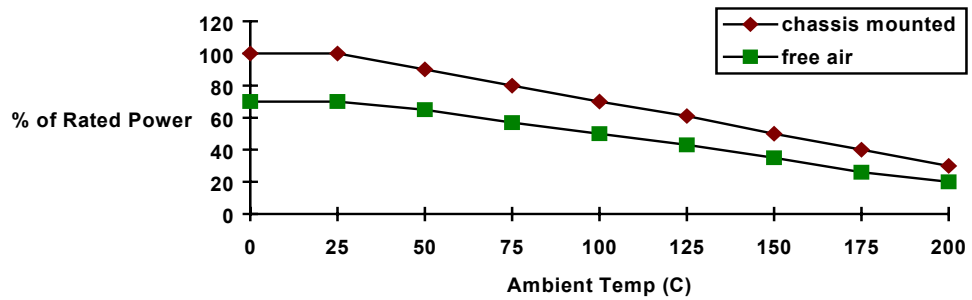
**Figure 3-19  Brake Resistor Derating Graph**

## External AC Supply EMC Filter

```
                            WARNING!
    Do not use an internal ac supply EMC filter with supplies that are not balanced
                    with respect to earth (IT). They must only be used with
                            earth referenced supplies (TN).
    External filters are available for use with TN and IT supplies. Please check for
    suitability in Chapter 8: "Technical Specifications" - External AC Supply (RFI) Filters.
        Do not touch filter terminals or cabling for at least 3 minutes
                        after removing the ac supply.
        Only use the ac supply filter with a permanent earth connection.
```

**IMPORTANT:**  Do not use an external filter on a drive supplied with an internal ac supply EMC filter.

Mount the filter as close as possible to the drive.

*Note:*  *Follow the cabling requirements given in Chapter 8: "Technical Specifications"*
*Refer to Chapter 8: "External  AC Supply (RFI) Filters" for further information.*

## Footprint/Bookcase Mounting Filters for Frame C, D, E & F

These filters can be both footprint and bookcase mounted. They are suitable for wall or cubicle mount, but the filter must be fitted with the appropriate gland box when wall mounted.

The filters for Frames C, D and E  look similar. The Frame D filter drawing is given in the following pages. Size variations for the frames are given in the table below.

The Frame F drawing and sizes are also supplied.

| Filter Description | Filter Part Number | Terminal Block | Earth Terminal | Gland Mounting | Dimensions | Fixing Centres | Weight |
|---|---|---|---|---|---|---|---|
| Frame B | | | | | | | |
| 460V TN | CO467841U020 | $10mm^2$ | 4mm | 4 x 4mm | 283 x 168x 45mm | 272 x 143mm | 1.7kg |
| 500V IT/TN | CO467842U020 | $10mm^2$ | 4mm | 4 x 4mm | 283 x 168x 45mm | 272 x 143mm | 1.7kg |
| | | | | | | *Gland Plate : BA467840U020* | |
| Frame C | | | | | | | |
| 460V TN | CO467841U044 | $10mm^2$ | 5mm | 4 x 4mm | 400 x 178x 55mm | 384 x 150mm | 2.1kg |
| 500V IT/TN | CO467842U044 | $10mm^2$ | 5mm | 4 x 4mm | 400 x 178x 55mm | 384 x 150mm | 2.1kg |
| | | | | | | *Gland Plate : BA467840U044* | |
| Frame D | | | | | | | |
| 460V TN | CO467841U084 | $25mm^2$ | 6mm | 4 x 4mm | 513 x 233 x 70mm | 495 x 208mm | 4.2kg |
| 500V IT/TN | CO467842U084 | $25mm^2$ | 6mm | 4 x 4mm | 513 x 233 x 70mm | 495 x 208mm | 4.2kg |
| | | | | | | *Gland Plate : BA467840U084* | |
| Frame E | | | | | | | |
| 460V TN | CO467841U105 | $50mm^2$ | 8mm | 4 x 4mm | 698 x 250 x 80mm | 680 x 216mm | 6.2kg |
| 500V IT/TN | CO467842U105 | $50mm^2$ | 8mm | 4 x 4mm | 698 x 250 x 80mm | 680 x 216mm | 6.2kg |
| | | | | | | *Gland Plate : BA467840U105* | |
| Frame F | | | | | | | |
| 460V TN | CO467841U215 | $95mm^2$ | 8mm | not applicable | 825 x 250 x 115mm | 795 x 216mm | |
| 500V IT/TN | CO467842U215 | $95mm^2$ | 8mm | not applicable | 825 x 250 x 115mm | 795 x 216mm | |
| | | | | | | *Gland Plate : Not applicable* | |
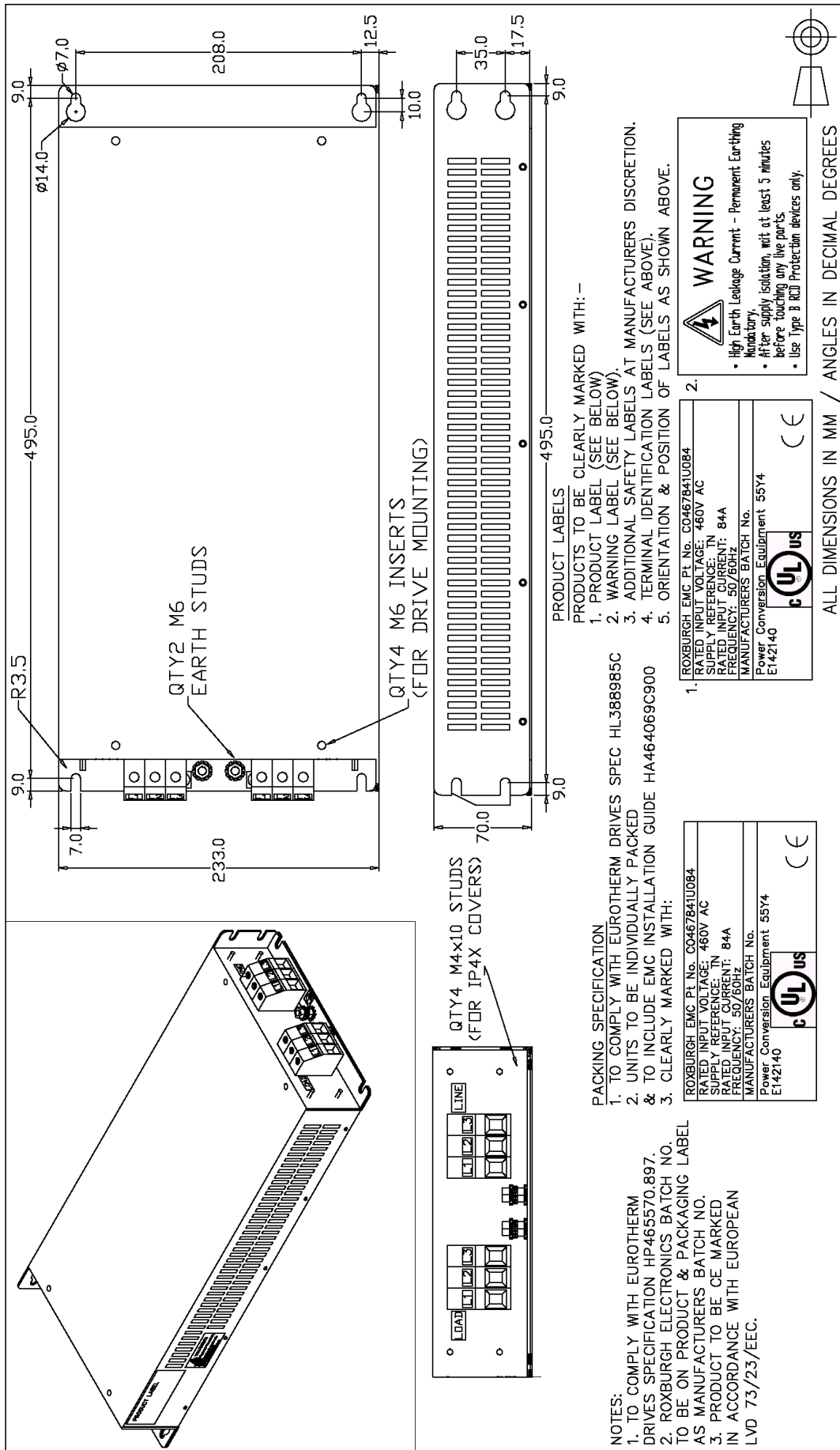
**Figure 3-20  Footprint/Bookcase Mounting Filters (generic drawing)**
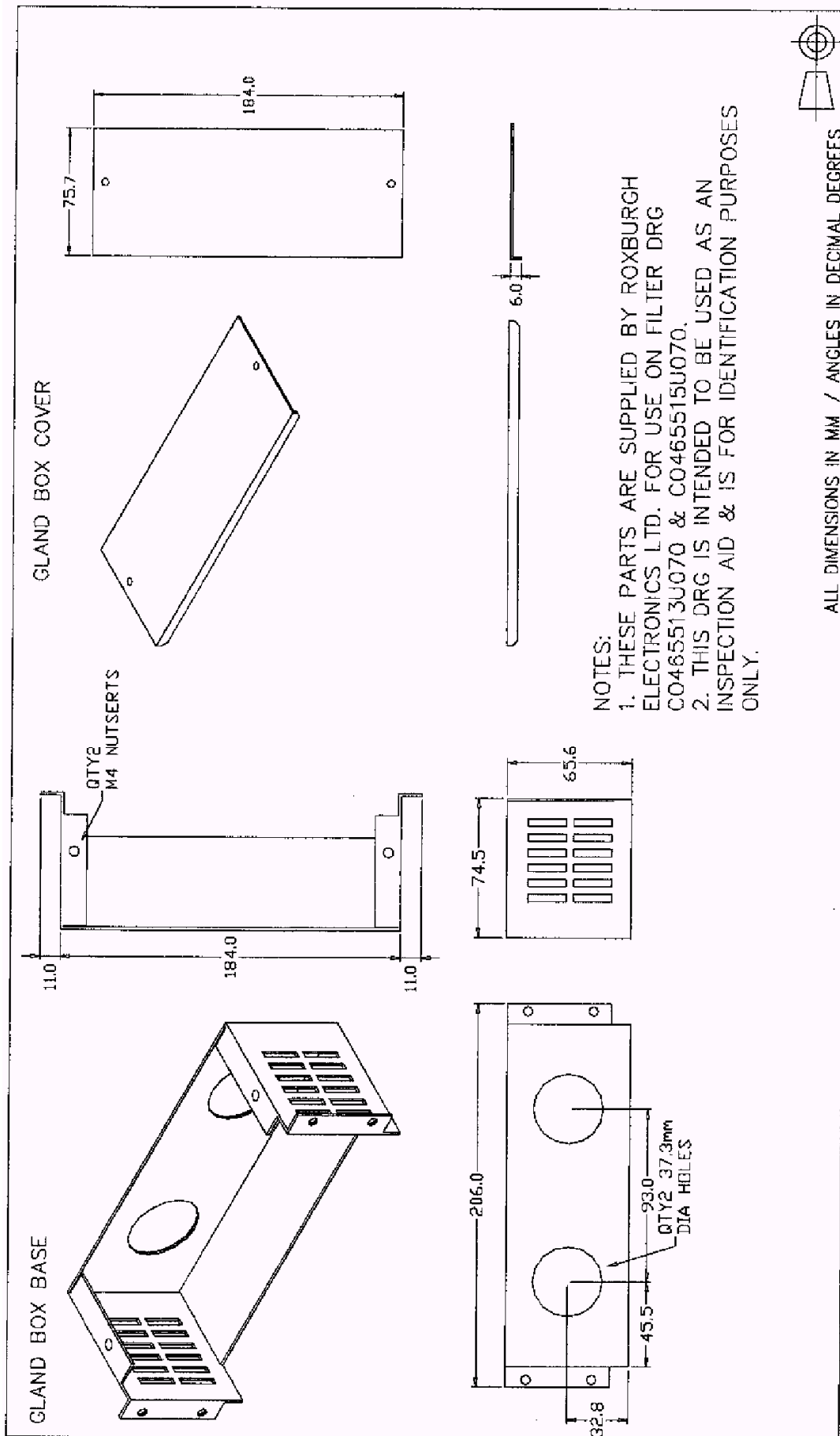
**Figure 3-21  Gland Box for Footprint/Bookcase Mounting Filters (generic drawing)**

## EMC Motor Output Filter

This can help the drive achieve EMC and filter thermal conformance. It also ensures longer motor life by reducing the high voltage slew rate and overvoltage stresses. Mount the filter as close to the VSD as possible. Please refer to SSD Drives for the selection of a suitable filter.

## Output Contactors

Output contactors can be used, although we recommend that this type of operation is limited to emergency use only, or in a system where the drive can be inhibited before closing or opening this contactor.

## Earth Fault Monitoring Systems

We do not recommend the use of circuit breakers (e.g. RCD, ELCB, GFCI), but where their use is mandatory, they should:

- Operate correctly with dc and ac protective earth currents (i.e. type B RCDs as in Amendment 2 of IEC755).
- Have adjustable trip amplitude and time characteristics to prevent nuisance tripping on switch-on.

When the ac supply is switched on, a pulse of current flows to earth to charge the internal/external ac supply EMC filter's internal capacitors which are connected between phase and earth. This has been minimised in SSD Drives' filters, but may still trip out any circuit breaker in the earth system. In addition, high frequency and dc components of earth leakage currents will flow under normal operating conditions. Under certain fault conditions larger dc protective earth currents may flow. The protective function of some circuit breakers cannot be guaranteed under such operating conditions.

> **WARNING!**
> Circuit breakers used with VSDs and other similar equipment are not suitable for personnel protection. Use another means to provide personal safety. Refer to EN50178 (1997) / VDE0160 (1994) / EN60204-1 (1994)

## Line Chokes (input)

Line chokes may be used to reduce the harmonic content of the supply current where this a particular requirement of the application or where greater protection from mains borne transients is required. Line chokes are fitted internally to Frames E and F. Please refer to SSD Drives for the selection of a suitable line choke for Frames B, C and D.

## AC Motor Choke (output)

Maximum Motor dv/dt = 10,000V/µs. This can be reduced by adding a motor choke in series with the motor.

Installations with long cable runs may suffer from nuisance overcurrent trips, refer to Chapter 8: "Technical Specifications" - Cabling Requirements for maximum cable lengths. A choke may be fitted in the drive output to limit capacitive current. Screened cable has a higher capacitance and may cause problems in shorter runs. Contact SSD Drives for recommended choke values.

## 5703/1 Speed Repeater Support

The 5703/1 unit provides the facility to run a line of drives in speed-lock. For accurate speed holding, encoder feedback is required. Ratioed speed-locking is supported.

A 16-bit signal is passed between the drives using a fibre optic link connected to the P3 port on each drive. The P3 port operates RS232 compatible signal levels. The 5703/1 unit converts these signals into a fibre optic signal for transmission, and from the converted optical signal to RS232 for reception.

Refer to the manual supplied with the 5703/1 Speed Repeater.

*Note:* *The P3 port is configured for 5703/1 support using the MMI. Refer to the Software Product Manual, Chapter 1: "Programming Your Application"*

# OPERATING THE DRIVE

**DEFAULT**

*By default, the drive will operate in Remote Start/Stop and Remote Speed Control. Analog and digital inputs and outputs are selected to control the unit.*

*The drive will operate as an open-loop drive. No set-up or tuning is required. It is programmed to control an induction motor of equivalent power, current and voltage rating to the drive.*

*In this chapter, refer to Control Philosophy, Initial Start-up Routine, (Routine 1: Remote Control using* Control Terminals*) and The Start/Stop Mode Explained.*

## Pre-Operation Checks

---

### WARNING!
Wait for 5 minutes after disconnecting power before working on any part of the system or removing the terminal cover from the drive.

---

**Initial checks before applying power:**
- Mains power supply voltage is correct.

- Motor is of correct voltage rating and is connected in either star or delta, as appropriate.

- Check all external wiring circuits - power, control, motor and earth connections.

*Note:* *Completely disconnect the drive before point to point checking with a buzzer, or when checking insulation with a Meggar.*

- Check for damage to equipment.

- Check for loose ends, clippings, drilling swarf etc. lodged in the drive and system.

- If possible check that the motor can be turned freely, and that any cooling fans are intact and free from obstruction.

**Ensure the safety of the complete system before the drive is energised:**
- Ensure that rotation of the motor in either direction will not cause damage.

- Ensure that nobody else is working on another part of the system which will be affected by powering up.

- Ensure that other equipment will not be adversely affected by powering up.

**Prepare to energise the drive and system as follows:**
- Remove the supply fuses, or isolate using the supply circuit breaker.

- Disconnect the load from the motor shaft, if possible.

- If any of the drive's control terminals are not being used, check whether these unused terminals need to be tied high or low. Refer to Chapter 8: Technical Specifications - Control Terminals.

- Check external run contacts are open.

- Check external speed setpoints are all zero.

**Re-apply power to the drive and system**
The drive has Macro 1 installed as the factory default. If you are controlling the drive in Remote control, refer to the Software Product Manual : "Application Macros" for details of other macros.

# Control Philosophy

There are four ways to control the drive using Remote and Local control:
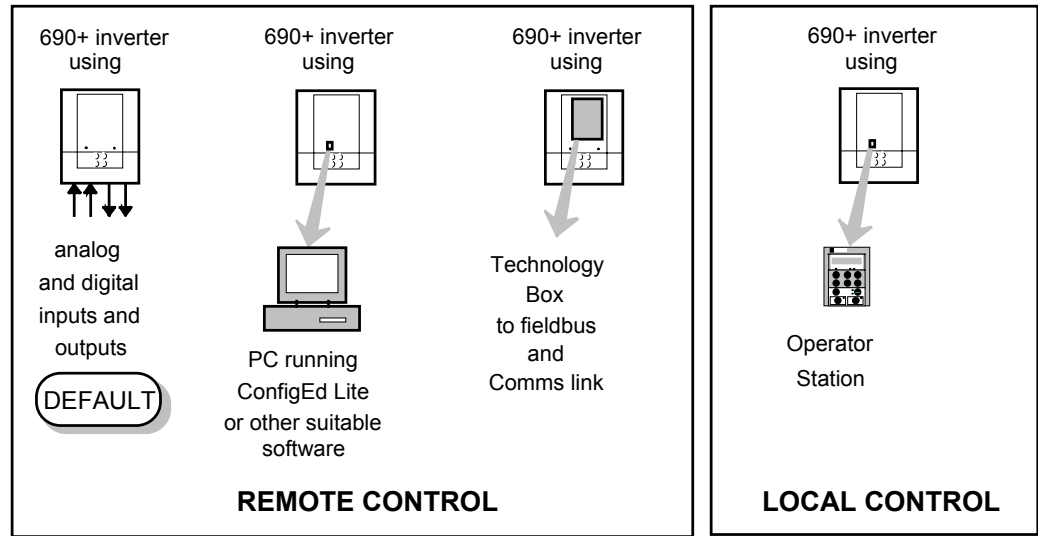


*Frame B illustrated*

**Figure 4-1  Remote and Local Control Modes**

# Start/Stop and Speed Control

There are two forms of control in operation at any time: *Start/Stop* and *Speed Control*. Each can be individually selected to be under either Local or Remote Control.

- **Local or Remote Start/Stop** decides how you will start and stop the drive.
- **Local or Remote Speed Control** determines how you will control the motor speed.

In each case, Local and Remote control are offered by using the following:

**Local:** The Keypad
**Remote:** Analog and digital inputs and outputs, RS232 Port or the 6053 Technology Box

Thus the drive can operate in one of four combinations of local and remote modes:
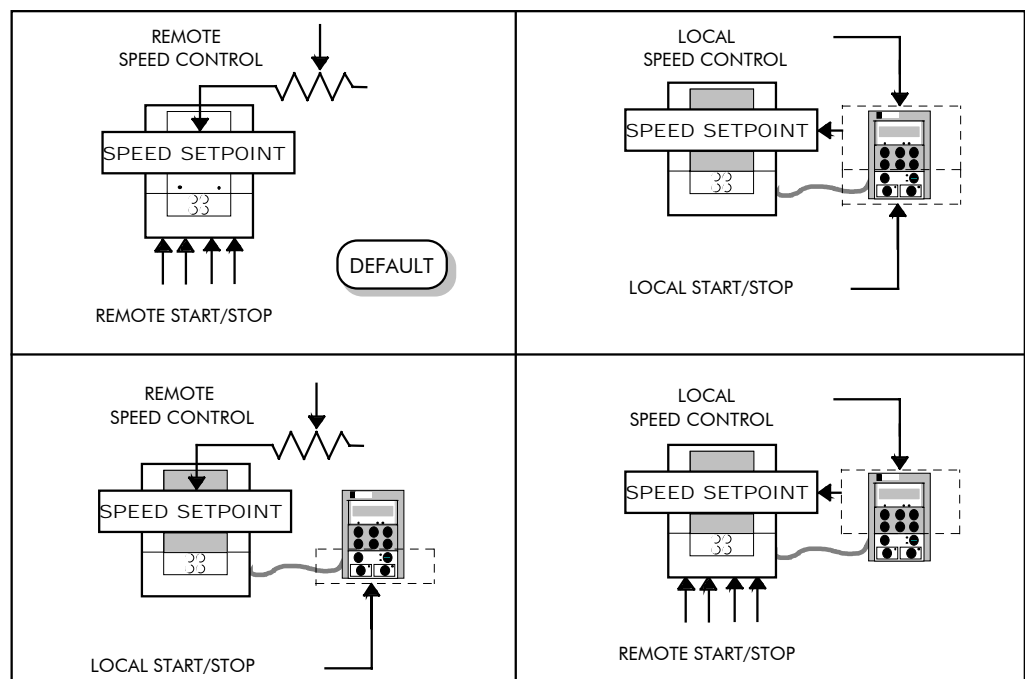


*Frame B illustrated*

**Figure 4-2  The Four Combinations of Local and Remote Control**

*Note:* *Start/Stop is also known as "Sequencing".*
*Speed Control is also known as "Reference Generation".*

## Selecting Local or Remote Control

If the default combination of remote Start/Stop and Speed Control is not suitable for your application, follow the instructions below using the Keypad or a suitable PC programming tool to select suitable combinations of local or remote control.

*Note:* *You can only change between Local and Remote control when the drive is "stopped".*

*To change a combination the Keypad must have  FULL VIEW selected; allowing you to view enough of the menu structure to make the change. Refer to Chapter 5: "The Keypad" - Menu Viewing Levels.*

The **L/R** key on the Keypad toggles between **Local** and **Remote** control, changing both Start/Stop and Speed Control modes at the same time.

However, you can "fix" either or both modes in software to be either Local or Remote control. This makes the **L/R** key inoperative for that mode. In this way, you can select a combination where both Local and Remote modes are present.

To do this, go to the LOCAL CONTROL menu at level 4 and select either:

LOCAL ONLY          Sets Local control

REMOTE ONLY         Sets Remote control

LOCAL/REMOTE        Gives selection powers back to the **L/R** key.
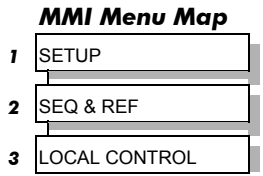
Fixing only one of the modes will mean that the **L/R** key will still toggle the other mode between Local and Remote control.

**MMI Menu Map**

| | |
|---|---|
| *1* | SETUP |
| *2* | SEQ & REF |
| *3* | LOCAL CONTROL |

### LED Indications

The mode of control is indicated by the "LOCAL" LEDs on the Keypad:

> SEQ = Start/Stop
> REF = Speed Control

If the LED is illuminated ( ● ), then LOCAL mode is in force.

```
SEQ MODES
              LOCAL ONLY
 HEALTH        LOCAL
   ●        SEQ ●   ○ REF
```
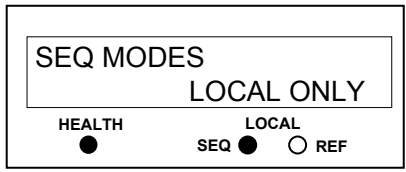
**Figure 4-3  Control Mode LED Indications**

*Note:* *The default is for the L/R key to be operative for both Sequencing and Reference Generation, and to be set for Remote control, i.e. both LEDs will be off.*

# Initial Start-up Routines

---

> **WARNING!**
>
> Unpredictable motion, especially if motor parameters are incorrect.
>
> Ensure no personnel are in the vicinity of the motor or any connected machinery.
>
> Ensure that no machinery connected to the motor will be damaged by unpredictable motion.
>
> Ensure that the emergency stop circuits function correctly before running the motor for the first time.

**Replace the supply fuses or circuit breaker and apply power to the drive.**

The routine below will run the drive in the default V/F fluxing control mode (VOLTS / HZ) to begin with using either the Control Terminals, or the Keypad (if supplied).

## Routine 1: Remote Control using Control Terminals

DEFAULT   *This is the simplest method of operating the drive. No Set-up or tuning is required. The drive can only operate in V/F Fluxing control mode (VOLTS / HZ).*

This routine assumes that the drive's control terminals are wired as shown in Figure 3-15 "Typical Connection to the Control Terminals".

**IMPORTANT:**   Ensure that the speed potentiometer is set to zero.

*1.*   Power-up the unit. The HEALTH LED will light (the RUN LED remains off).
*If the HEALTH LED flashes, the drive has tripped. Refer to Chapter 6: "Trips and Fault Finding" to investigate and remove the cause of the trip. Reset the unit by momentarily closing either the RESET switch or the RUN switch. The HEALTH LED will now light.*

2.   Close the RUN switch. The RUN LED will flash if the setpoint is at zero. Turn the speed potentiometer up a little to apply a small speed setpoint. The RUN LED will light and the motor will rotate slowly.

Reverse the motor's direction of rotation either by pressing the DIR key, or by swapping two of the motor phases (**WARNING: Disconnect the mains supply first**).

### Reading the Status LEDs

The HEALTH and RUN LEDs indicate status. The LEDs are considered to operate in five different ways:



OFF

SHORT FLASH

EQUAL FLASH

LONG FLASH

ON
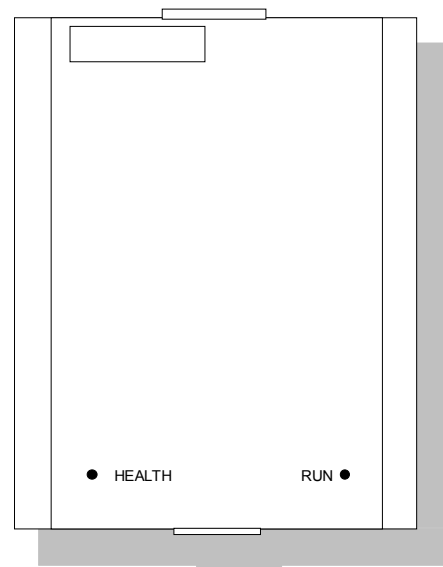


● HEALTH                    RUN ●

**Figure 4-4  Blank Cover showing LED Operation**

| HEALTH | RUN | Drive State |
|---|---|---|
| ⬭● | ⬭● | Re-configuration, or corrupted non-volatile memory at power-up |
| ⬭◼ | ⬭ | Tripped |
| ⬭◼ | ⬭● | Auto Restarting, waiting for trip cause to clear |
| ⬭◼ | ⬭◼ | Auto Restarting, timing |
| ◼ | ⬭ | Stopped |
| ◼ | ◼○ | Running with zero reference, enable false or contactor feedback false |
| ◼ | ◼ | Running |
| ◼ | ⬭◼ | Stopping |
| ◼○ | ◼○ | Braking and running with zero speed demand |
| ◼○ | ◼ | Braking and running |
| ◼○ | ⬭◼ | Braking and stopping |

**Table 4-1  Status indications given by the Blank Cover Health and Run LEDs**

## Routine 2: Local Control using the Keypad

***Note:*** *Refer to Chapter 5: "The Keypad" to familiarise yourself with the Keypad's LED indications, and how to use the keys and menu structure.*

This routine assumes that the drive's control terminals are wired as shown in Figure 3-15 "Typical Connection to the Control Terminals" and the Keypad is fitted.

1.  Power-up the unit. The display will show the power-up screen, "AC MOTOR DRIVE". After a few seconds, SETPOINT(REMOTE) will appear on the display. The HEALTH, STOP, and FWD LEDs will light.

    *If the HEALTH LED flashes, the drive has tripped. The display will indicate the reason for the trip. Refer to Chapter 6: "Trips and Fault Finding" to investigate and remove the cause of the trip. Reset the trip condition by pressing the **Stop/Reset** key on the keypad. The HEALTH LED will now light.*

2.  Press the **L/R** (Local/Remote) key to enable Local control. Both the LOCAL SEQ and LOCAL REF LEDs will light when Local control in enabled.

3.  Press the **RUN** key. The RUN LED will light and the motor will rotate slowly. (The RUN LED would flash if the setpoint was at zero.)

4.  Reverse the motor's direction of rotation by pressing either the **DIR** key, or by swapping two of the motor phases **(WARNING: Disconnect the mains supply first)**.


Using the Keypad (or other suitable programming tool) the drive must now be set-up:

•   as a simple Open-loop Drive (V/F fluxing)

•   in Sensorless Vector Fluxing mode

•   in Closed-Loop Vector mode

## Set-up as an Open-loop Drive (V/F Fluxing)

The parameters from the QUICK SETUP menu most likely to require attention in this control mode (VOLTS / HZ) are shown below.

**MMI Menu Map**

1   QUICK SETUP

| Tag | QUICK SET-UP Parameters | Default | Brief Description |
|---|---|---|---|
| 1105 | CONTROL MODE | VOLTS / HZ | Selects the control mode for the drive |
| 106 | BASE FREQUENCY | * 50.0 Hz | Frequency at which maximum output volts is generated |
| 1032 | MAX SPEED | * 1500 RPM | Max speed clamp and scale factor for other speed parameters |
| 337 | MIN SPEED | -100.00 % | Min speed clamp |
| 258 | RAMP ACCEL TIME | 10.0 s | Acceleration time from 0Hz to max speed |
| 259 | RAMP DECEL TIME | 10.0 s | Deceleration time from max speed to 0Hz |
| 104 | V/F SHAPE | LINEAR LAW | Constant torque V to F characteristic |
| 50 | QUADRATIC TORQUE | FALSE | Selects between Constant or Quadratic mode of operation |
| 64 | MOTOR CURRENT | ** 11.3 A | Calibrates drive to motor full load current |
| 365 | CURRENT LIMIT | 100.00% | Level of motor current as % of FULL LOAD CALIB |
| 107 | FIXED BOOST | ** 0.00 % | Boosts starting torque by adding volts at low speed |
| 279 | RUN STOP MODE | RAMPED | Ramp to standstill when RUN signal removed |
| 246 | JOG SETPOINT | 10.0 % | Drive speed setpoint whilst jogging |
| 13 | ANALOG INPUT 1 | 0..+10 V | Input range and type |
| 22 | ANALOG INPUT 2 | 0..+10 V | Input range and type |
| 712 | ANALOG INPUT 3 | 0..+10 V | Input range and type |
| 719 | ANALOG INPUT 4 | 0..+10 V | Input range and type |
| 231 | DISABLED TRIPS | 0000 >> | Sub-menu to set disabled trips |
| 742 | DISABLED TRIPS + | 0040 >> | Sub-menu to set disabled trips |
| 1083 | MOTOR BASE FREQ | ** 50.0 Hz | Frequency at which drive gives maximum output volts |
| 1084 | MOTOR VOLTAGE | ** 400.0 V | Maximum motor output voltage |
| 65 | MAG CURRENT | ** 3.39 A | Calibrates drive to motor no load current |
| 83 | NAMEPLATE RPM | ** 1445 RPM | Motor nameplate speed |
| 84 | MOTOR POLES | ** 4 | Number of motor poles |

## Set-up using the Sensorless Vector Fluxing Mode

The drive must be tuned to the motor in use by matching the motor parameters in the drive to those of the motor being controlled.

**MMI Menu Map**

1   QUICK SETUP

**IMPORTANT:**   You **MUST** use the Autotune feature.

Enter values for the following parameters in the QUICK SETUP menu.

| Tag | QUICK SET-UP Parameters | Default | Brief Description |
|---|---|---|---|
| 1105 | CONTROL MODE | SENSORLESS VEC | Selects the control mode for the drive |
| 1032 | MAX SPEED | * 1500 RPM | Max speed clamp and scale factor for other speed parameters |
| 64 | MOTOR CURRENT | ** 11.3 A | Calibrates drive to motor full load current |
| 365 | CURRENT LIMIT | 100.00% | Level of motor current as % of FULL LOAD CALIB |
| 1083 | MOTOR BASE FREQ | ** 50.0 Hz | Frequency at which drive gives maximum output volts |
| 1084 | MOTOR VOLTAGE | ** 400.0 V | Maximum motor output voltage |
| 83 | NAMEPLATE RPM | ** 1445 RPM | Motor nameplate speed (motor synchronous speed (rpm) minus full load slip) |
| 84 | MOTOR POLES | ** 4 | Number of motor poles |
| 124 | MOTOR CONNECTION | ** STAR | Type of motor connection |
| 603 | AUTOTUNE ENABLE | FALSE | Enables the Autotune feature |
| For more information refer to Chapter 5: "The Keypad" - The QUICK SETUP Menu. | | | |

## Set-up using the Closed-loop Vector Mode

> ### WARNING!
> When the drive is run for the first time the direction of rotation will be unknown, the drive may run inconsistently, and the speed control may not operate.

In this mode, speed feedback signals from the motor shaft encoder are processed to determine the rotational speed of the shaft. A PI algorithm within the software uses this information to produce varying gate drive signals to the drive circuits. These signals cause the drive to output the required voltage and frequency for a particular motor speed.

If the encoder is to be fitted to the System Board option rather than the Speed Feedback option, set SPD LOOP SPD FBK to SLAVE ENCODER.

*MMI Menu Map*

*1* SETUP

*2* SYSTEM BOARD

*3* PHASE CONFIGURE
  └ SPD LOOP SPD FBK

**IMPORTANT:** You **MUST** use the Autotune feature.

Enter values for the following parameters in the QUICK SETUP menu.

*MMI Menu Map*

*1* QUICK SETUP

| Tag | QUICK SET-UP Parameters | Default | Brief Description |
|-----|-------------------------|---------|-------------------|
| 1105 | CONTROL MODE | CLOSED-LOOP VEC | Selects the control mode for the drive |
| 1032 | MAX SPEED | * 1500 RPM | Max speed clamp and scale factor for other speed parameters |
| 64 | MOTOR CURRENT | ** 11.3 A | Calibrates drive to motor full load current |
| 365 | CURRENT LIMIT | 100.00% | Level of motor current as % of FULL LOAD CALIB |
| 566 | ENCODER LINES | ** 2048 | Set to the number of lines used by the encoder |
| 1083 | MOTOR BASE FREQ | ** 50.0 Hz | Frequency at which drive gives maximum output volts |
| 1084 | MOTOR VOLTAGE | ** 400.0 V | Maximum motor output voltage |
| 83 | NAMEPLATE RPM | ** 1445 RPM | Motor nameplate speed (motor synchronous speed (rpm) minus full load slip) |
| 84 | MOTOR POLES | ** 4 | Number of motor poles |
| 124 | MOTOR CONNECTION | ** STAR | Type of motor connection |
| 567 | ENCODER INVERT | FALSE | Encoder direction |
| 603 | AUTOTUNE ENABLE | FALSE | Enables the Autotune feature |
| For more information refer to Chapter 5: "The Keypad" - The QUICK SETUP Menu. | | | |

## The Autotune Feature

**IMPORTANT:** You **MUST** carry out an Autotune if you intend to use the drive in either of the two vector control modes. If you are using it in Volts/Hz control an Autotune is not necessary.

The Autotune feature identifies motor characteristics to allow the drive to control the motor. It loads the values into the parameters below, which are in the QUICK SETUP menu.

| Parameter | Description | Note |
|-----------|-------------|------|
| ENCODER INVERT | Encoder direction | Parameter is only set up if drive is configured to run as Closed-loop Vector<br>Not measured by Stationary Autotune |
| MAG CURRENT | Magnetising current | Not measured by Stationary Autotune |
| STATOR RES | Per phase stator resistance | |

| Parameter | Description | Note |
|---|---|---|
| LEAKAGE INDUC | Per phase stator leakage inductance | |
| MUTUAL INDUC | Per phase mutual inductance | |
| ROTOR TIME CONST | Rotor time constant | This is identified from magnetising current and motor nameplate rpm |

For further information on the functions of all parameters, refer to the Product Manual, Chapter 1: "Programming your Application".

## Stationary or Rotating Autotune?

Will the motor spin freely, i.e. not connected to a load, during the Autotune?

- If it can spin freely, use a Rotating Autotune (preferred)
- If it cannot spin freely, use a Stationary Autotune

| | Action | Requirements |
|---|---|---|
| **Rotating Autotune** *Preferred method* | Spins the motor up to the maximum speed set by the user to identify all necessary motor characteristics | Motor must spin freely during Autotune |
| **Stationary Autotune** *Only used when the motor cannot spin freely during the Autotune feature* | Motor does not spin during Autotune. A limited set of motor characteristics are identified | You must enter the correct value of magnetising current  Do not subsequently operate the drive above base speed  In Closed-loop Vector Mode set up the encoder direction parameter |

## Necessary Data

You **MUST** enter values for the following parameters, found in the QUICK SETUP menu, before an Autotune can be carried out:

*MMI Menu Map*
1 QUICK SETUP

MOTOR CURRENT
MOTOR BASE FREQ
MOTOR VOLTAGE        (maximum motor output voltage)
NAMEPLATE RPM        (motor nameplate speed)
MOTOR POLES          (the number of motor poles)
ENCODER LINES        (if an encoder is fitted, enter the number of lines used by the encoder)

## Performing a Rotating Autotune

Check that the motor can rotate freely in the forward direction. Ensure also that the motor is unloaded. Ideally, the motor shaft should be disconnected completely. This includes disconnection from a gearbox, where fitted.

1. In the QUICK SETUP menu, set MAX SPEED to the maximum speed at which you will operate the drive in normal operation. The Autotune will characterise the motor up to 30% above this speed. If you later wish to run faster than this, you will need to carry out another Autotune.

*MMI Menu Map*
1 QUICK SETUP

2. Set AUTOTUNE ENABLE to TRUE, and start the drive. The drive will carry out a Rotating Autotune, indicated by the Run and Stop led's flashing. This may take several minutes, during which the motor will be accelerated to maximum speed and then brought to a stop. When complete, the drive is returned to the stopped condition and the AUTOTUNE ENABLE parameter is reset to FALSE. In Closed-loop Vector mode (with an encoder) the encoder sign has been adjusted by the Autotune feature.

**IMPORTANT:** Now perform a SAVE CONFIG to save your new settings. Refer to Chapter 5: "The Keypad" - SAVE CONFIG.

## Performing a Stationary Autotune

Before starting the stationary Autotune, you **MUST** enter the value of magnetising current for the motor. This may be available on the motor nameplate. If not, you may need to contact the motor supplier.

1.  In the AUTOTUNE menu, set the MODE parameter to STATIONARY.

2.  Set ENABLE to TRUE, and start the drive. The drive will carry out a stationary Autotune, injecting current into the motor but not turning the shaft.  The Run and Stop led's will flash. When complete, the drive is returned to the stopped condition and the AUTOTUNE ENABLE parameter is reset to FALSE.

*MMI Menu Map*

*1* SETUP

*2* MOTOR CONTROL

*3* AUTOTUNE
     ⌐ ENABLE
     ⌐ MODE
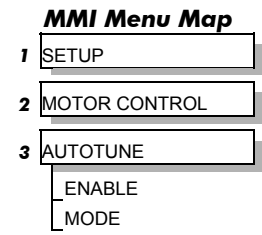
**IMPORTANT:** Now perform a SAVE CONFIG to save your new settings. Refer to Chapter 5: "The Keypad" - SAVE CONFIG.

•   If the drive is configured to run in Sensorless Vector mode, set-up is complete.

•   If the drive is configured to run in Closed-loop Vector mode, i.e. using an encoder, then the encoder direction must be set up. Refer to "Setting the Encoder Sign" below.

## Setting the Encoder Sign

If you have performed a Stationary Autotune in Closed-loop Vector mode, you should check the encoder directon as follows:

Look and listen to the motion of the motor when the drive is running at a speed demand of between 5 - 10%.

As a test, use the **Up (▲)** control key to increase the speed to about double the original figure. Change the direction of rotation using the **FWD/REV** control key.

If ENCODER INVERT is correct, the motor will rotate smoothly and will respond to the changes in speed demand and direction.

---

If ENCODER INVERT is incorrect, the motor will rotate in a jerky and/or noisy manner. Alternatively, it may rotate smoothly at a very low speed but not respond to changes in speed demand or direction.

•   Change the setting of ENCODER INVERT to change the encoder sign.
•   Change the direction of rotation back to the original direction. Re-set the speed demand.

The encoder sign is now correct for the original motor direction.

---

If however the direction of the motor is incorrect at this point, then power down the entire drive, wait for 3 minutes (for the dc link capacitors to discharge) and then swap the motor drive cables M1/U and M2/V. Change the setting of ENCODER INVERT.

The encoder sign is now correct for the new motor direction.

# The Start/Stop Mode Explained

The default configuration below shows the drive in Remote control, (using the analog and digital inputs and outputs). This example will be referred to in the following explanations.
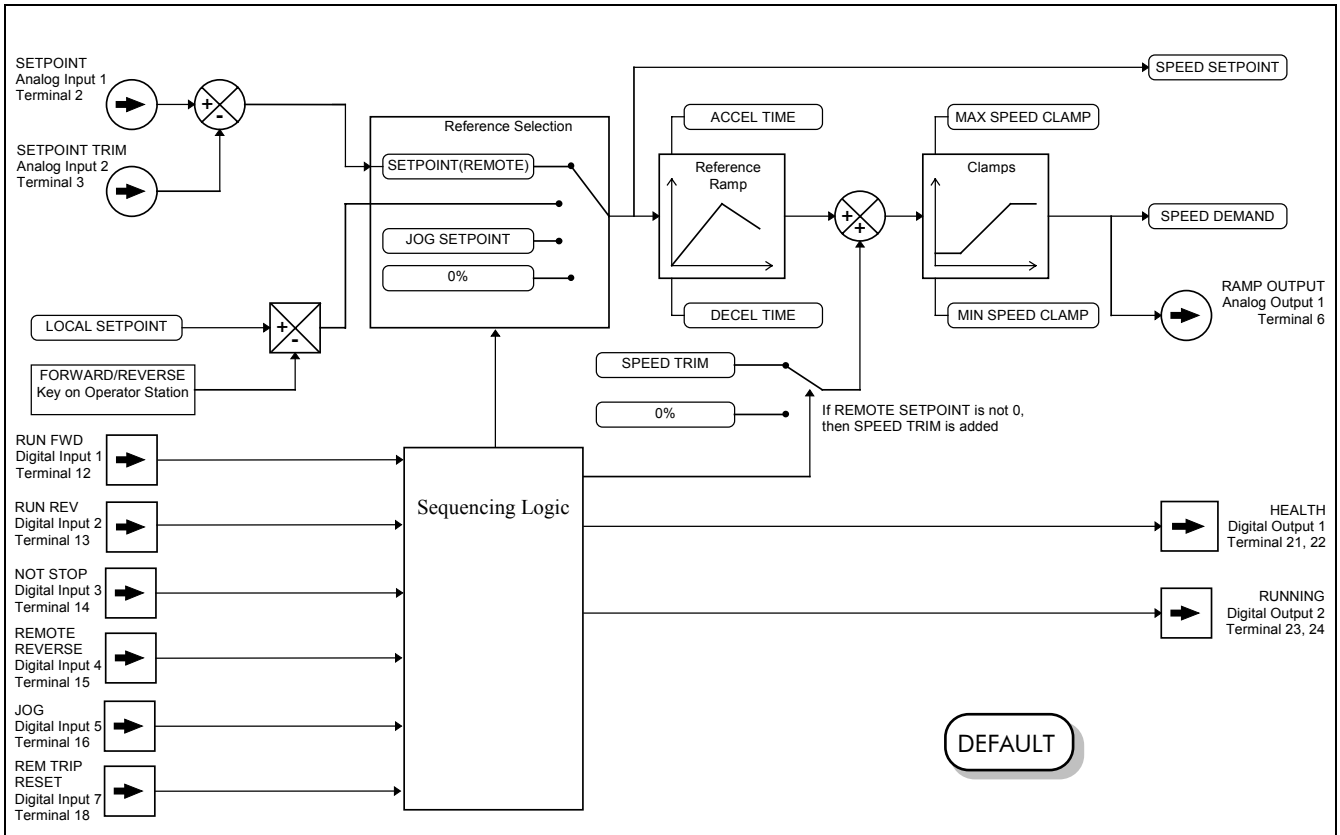


**Figure 4-5  Portion of the Default Configuration**

### Start/Stop Controlled Remotely

DEFAULT

In the configuration shown, the reference value is obtained by summing ANALOG INPUT 1 and ANALOG INPUT 2. The direction of rotation is controlled by DIGITAL INPUT 4. When the RUN input (DIGITAL INPUT 1) is TRUE, the SPEED DEMAND ramps up to the reference value at a rate controlled by ACCEL TIME. The drive will continue to run at the reference value while the RUN input remains TRUE.

Similarly when the JOG input (DIGITAL INPUT 5) is TRUE, the SPEED DEMAND ramps up to the JOG SETPOINT at a ramp rate set by JOG ACCEL TIME (not shown in the diagram). The drive will continue to run at the JOG SETPOINT while the JOG input remains TRUE.

### Start/Stop Controlled Locally

The reference value is set by the SETPOINT (LOCAL) parameter. The direction of rotation is controlled by the DIR key (forward/reverse) on the Keypad. When the RUN key is pressed the SPEED DEMAND ramps up to the reference value at a rate controlled by ACCEL TIME. The drive will continue to run at the reference value even when the RUN key is released. Press the STOP key to "stop" the drive.

When the JOG key is pressed and held, the SPEED DEMAND ramps up to the JOG SETPOINT at a ramp rate set by JOG ACCEL TIME (not shown in the diagram). Release the JOG key to "stop" the drive.

### Interaction between RUN and JOG

Only one of these signals can be in effect at any one time; the other signal is ignored. The drive must be "stopped" to change from running to jogging, or vice versa.

### Start/Stop Mode Diagnostics

In the configuration shown, Start/Stop mode provides two DIGITAL OUTPUT signals (RUNNING and HEALTH).

The RUNNING signal is TRUE from the time a start command is processed until a stop sequence is completed. This normally means the time between the drive starting until the power stack is quenched. Refer to the Software Product Manual, Chapter : "Sequencing Logic States" for a more detailed description.

The HEALTH output is TRUE when the drive is not tripped.

Additional diagnostic parameters are available when using the Keypad. These are described in the Software Product Manual, Chapter 4: "Programming Your Application" and "Sequencing Logic States".

# Starting and Stopping Methods

| | *MMI Menu Map* | | *MMI Menu Map* | | *MMI Menu Map* | | *MMI Menu Map* |
|---|---|---|---|---|---|---|---|
| *1* | SETUP | *1* | SETUP | *1* | SETUP | *1* | SETUP |
| *2* | SEQ & REF | *2* | SEQ & REF | *2* | SEQ & REF | *2* | SEQ & REF |
| *3* | REFERENCE | *3* | SEQUENCING LOGIC | *3* | REFERENCE STOP | *3* | REFERENCE RAMP |
| | SPEED TRIM | | NOT STOP | | STOP TIME | | DECEL TIME |
| | REMOTE REVERSE | | NOT FAST STOP | | STOP DELAY | | HOLD |
| | SPEED DEMAND | | NOT COAST STOP | | FAST STOP TIME | | |
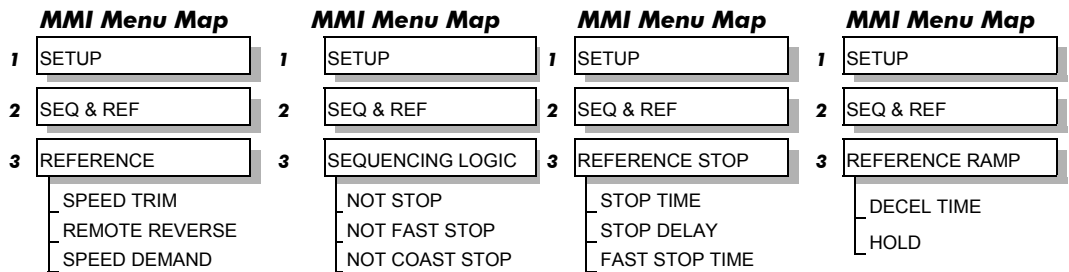
***Note:*** *Refer to the Software Product Manual, Chapter 1: "Programming Your Application" - REFERENCE, SEQUENCING LOGIC, REFERENCE STOP and REFERENCE RAMP, for explanations of parameters.*

## Normal Stopping Methods

DEFAULT   Macro 1 is set to "Ramp to Stop" (at STOP TIME, set to 10.0s).

- To "stop" the locally controlled drive press the STOP key on the Keypad

- To "stop" the remotely controlled drive remove the 24V from the RUN FWD input, terminal 12

With the Keypad, or suitable programming tool, the drive can be selected to "Ramp to Stop", or to "Coast to Stop" at one of two rates (STOP TIME or FAST STOP TIME).

## Ramp to Stop

When a stop command is received, the drive decelerates from its actual speed towards zero for the programmed DECEL TIME time. When this time has elapsed, SPEED TRIM is ramped to 0% in the programmed STOP TIME time.

***Note:*** *If SPEED TRIM does not operate, SPEED DEMAND is reduced to 0% in DECEL TIME.*

The power stack remains energised until the STOP DELAY period has elapsed.
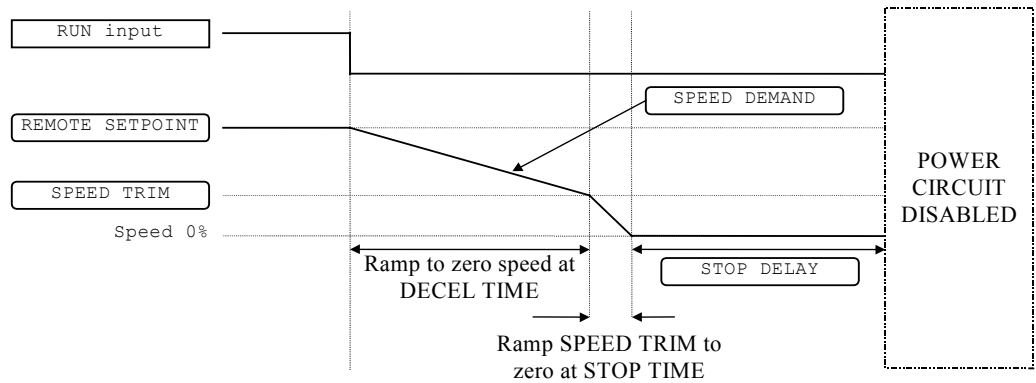


**Figure 4-6  Ramp to Stop with a Remote Reference**

A special case exists when the DECEL TIME is set to 0.0 seconds, or when the HOLD parameter is TRUE. In both these situations the SPEED DEMAND will ramp down to zero at the STOP TIME.
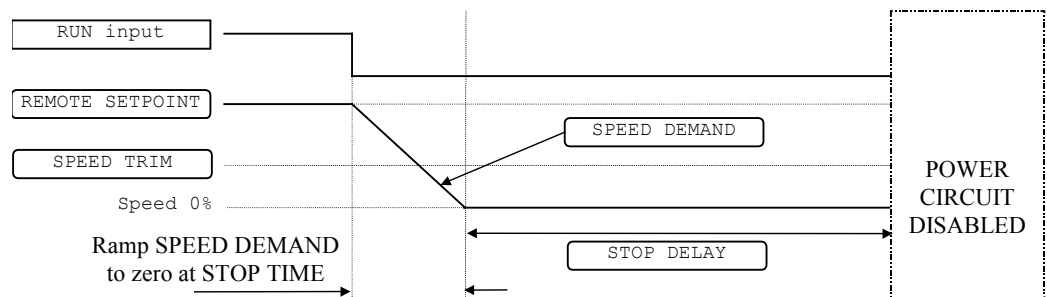


**Figure 4-7  Remote to Stop with a Remote Reference: no DECEL TIME**

## Coast to Stop

In this mode the DECEL TIME ramp and the STOP TIME ramp are both ignored. Thus the SPEED DEMAND changes immediately to 0% as soon as the Stop command is given. The power stack is also immediately disabled at this time, causing the load to coast.
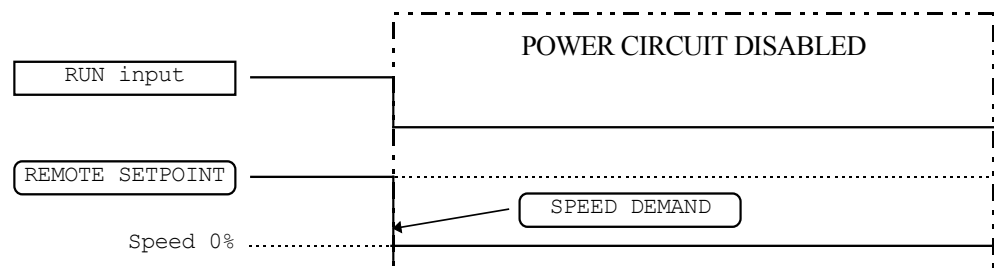


**Figure 4-8  Coast to Stop with a Remote Reference**

## Advanced Stopping Methods

The drive can be selected to NOT FAST STOP or to NOT COAST STOP. The stopping procedure is unaffected by Local or Remote Sequencing options.

### Forced Fast Stop

The Not Fast Stop mode overrides the RUN FWD, RUN REV and JOG inputs in Remote mode, and the RUN and JOG Keypad keys in Local mode. It is selected by setting NOT FAST STOP to TRUE.

The Fast Stop mode can be set to either RAMP or COAST. The stopping sequence starts when the NOT FAST STOP input goes FALSE, regardless of the state of the RUN input.
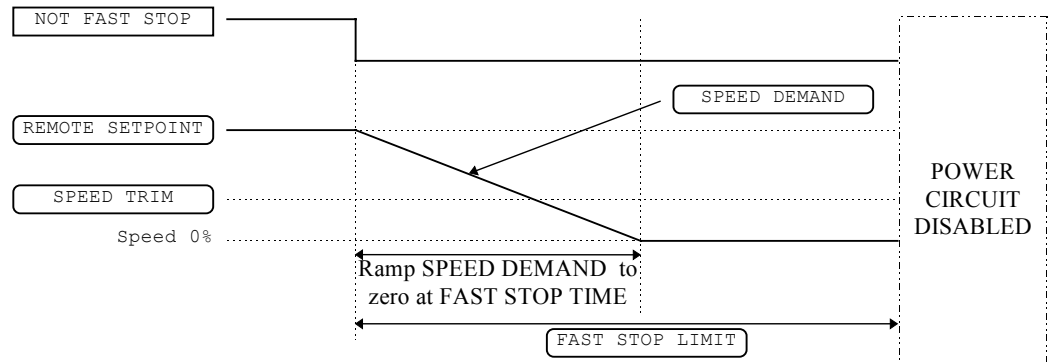


**Figure 4-9  Forced Fast Stop RAMP Mode example**

### Forced Coast Stop

Using the Not Coast Stop mode immediately disables the power stack, causing the load to coast to a stop. The drive gives priority to the NOT COAST STOP signal. The NOT FAST STOP signal is therefore ignored while NOT COAST STOP is active.
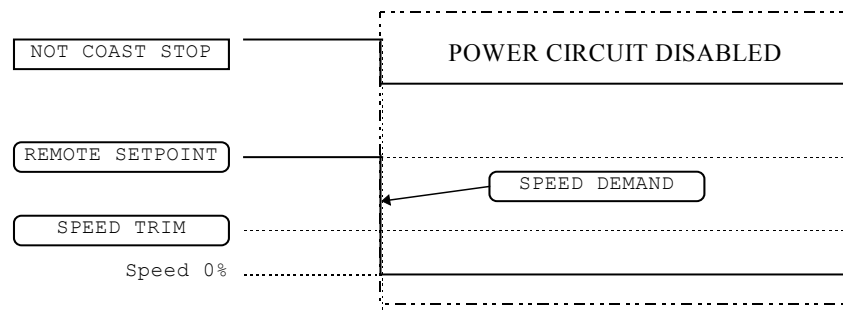


**Figure 4-10  Forced Coast Stop example**

### The Trip Condition

When a trip condition is detected, a similar stopping method to NOT COAST STOP is used. The power stack cannot be re-enabled until the trip condition has been cleared and successfully reset.
Refer to Chapter 6: "Trips and Fault Finding" for further details.

## Logic Stopping

The drive can be stopped by setting the NOT STOP to FALSE for a short time, (>100 ms). The stop sequence continues even if the NOT STOP signal goes inactive before the drive is stopped. Various combinations of stop logic are shown below.
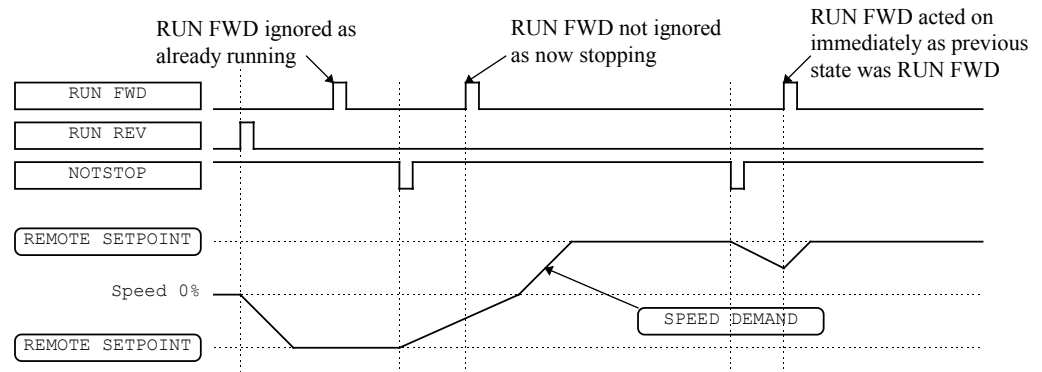


**Figure 4-11  Interaction between RUN FWD, RUN REV and NOT STOP Parameters**
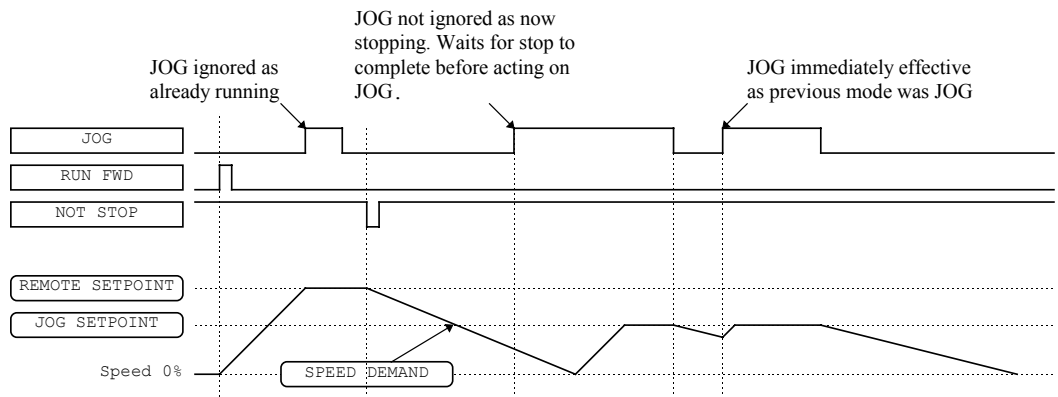


**Figure 4-12  Example of the Interaction between RUN and JOG Parameters**

## Starting Methods
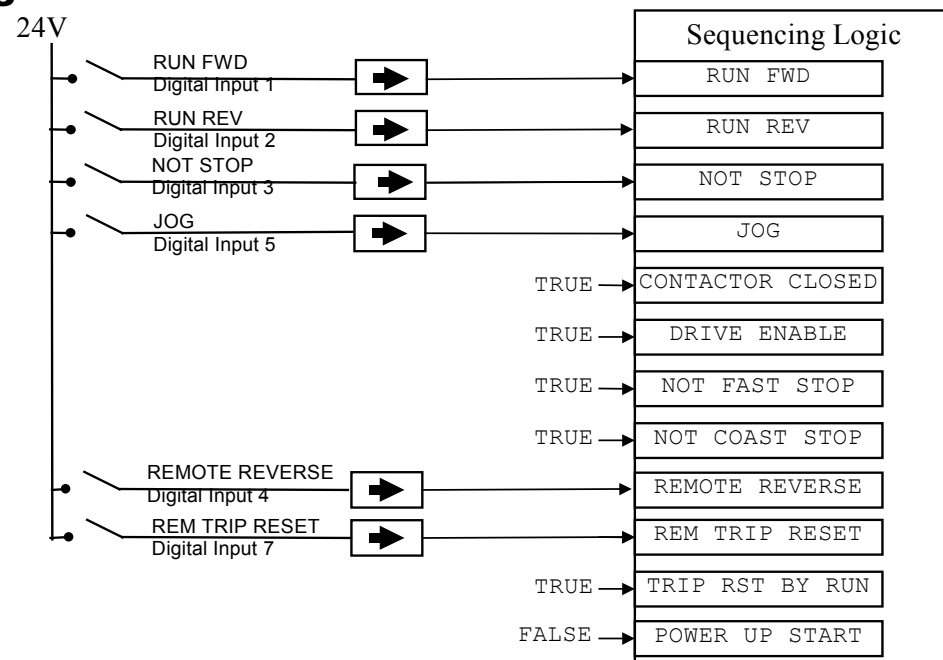


**Figure 4-13  Default Sequencing Wiring (Macro 1)**

The methods below can be used when the drive has Macro 1, 2, 3 or 4 installed.

**DEFAULT**

The default configuration view above caters for Single, Two, and Three Wire Logic Starting without rewiring. Note that the NOT STOP parameter is active (FALSE - not wired to), meaning that the drive will only run while the relevant RUN parameters are held TRUE.

## Starting Several Drives Simultaneously

**IMPORTANT:** We do not recommend that the DRIVE ENABLE signal is used to start an drive in "normal" use.

Use the DRIVE ENABLE parameter to control the output power stack. When this parameter is FALSE, the power stack is disabled regardless of the state of any other parameters. In conjunction with the HEALTH output parameter, DRIVE ENABLE can synchronise several drives on power-up.

## Single Wire Logic Starting

Use just DIGITAL INPUT 1 when the motor direction will always be the same. All other digital inputs are FALSE (0V). The motor will run while the RUN FWD switch is closed, and will stop when it is open.

## Two Wire Logic Starting

This uses two inputs; RUN FWD and RUN REV. The drive can operate in forward and reverse depending upon which switch is closed. If both RUN FWD and RUN REV are TRUE (24V) at the same time, both are ignored and the drive will stop.

## Three Wire Logic Starting
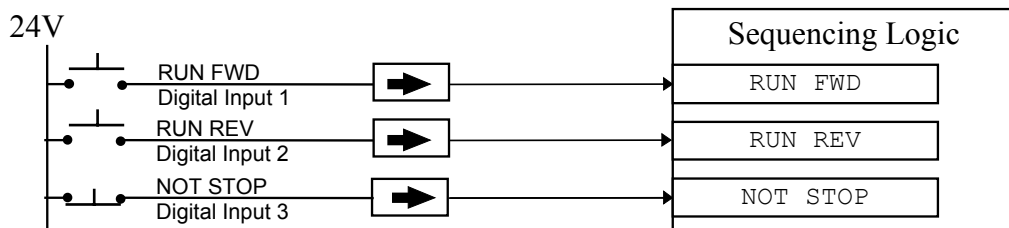
**Figure 4-14 Wiring for Three Wire Logic Starting**

This example uses three inputs; RUN FWD, RUN REV and NOT STOP.

- Fit normally-open push button switches to RUN FWD and RUN REV.

- Fit a normally-closed push button switch to NOT STOP, thus NOT STOP is held TRUE (24V). When TRUE, the action of NOT STOP is to latch the RUN FWD and RUN REV signals. When FALSE, these signals are not latched.

For example, operating the RUN FWD switch starts the drive running forward. Operating the RUN REV switch causes the drive to run in reverse. Operating the NOT STOP switch (making "NOT STOP" FALSE) at any time causes the drive to stop running.

*Note:* *The JOG parameter is never latched in this way. The drive only jogs while the JOG parameter is TRUE.*

# THE KEYPAD

## Connecting the Keypad

The Keypad is a plug-in MMI (Man-Machine Interface) option that allows full use of the drive's features.

It provides for local control of the drive, monitoring, and complete access for application programming.

Insert the Keypad into the front of the drive (replacing the blank cover and plugging into the RS232 programming port); or mount it up to 3 metres away using the optional panel mounting kit with connecting lead: refer to Chapter 3: "Installing the Drive" - Fitting the Remote 6901 Keypad.

Two Keypads (or one and a PC running suitable programming software) can be used simultaneously. In this case each Keypad runs independently.

**Figure 5-1  Keypad displaying Welcome screen**

The drive can operate in one of two modes:

**Remote Control Mode**: Allowing access for application programming using digital and analog inputs and outputs

**Local Control Mode**: Providing local control and monitoring of the drive using the Keypad, or PC running suitable programming software

Local control keys are inactive when Remote control mode is selected and vice versa, with one exception; the **L/R** key toggles Local or Remote control modes and so is always operative.

**HINT:** Customise the action of the Keypad to create an effective working tool.

### The Power-Up Condition

On power-up, a default Welcome screen is displayed for several seconds showing the product description; power rating, voltage and software version of the drive. After a few seconds the display changes to the SETPOINT (REMOTE) parameter.

*Note:* *By default the drive always initialises in Remote control mode, with the Local control keys inactive, making it unlikely that the motor could be started accidentally.*

# Controlling the Drive using the Keypad

## Control Key Definitions

**Note:**   *Refer to Chapter 4: "Operating the Drive" for more detail about Remote and Local modes.*

### Keys for Programming the Drive

**Note:**   *See "Navigating the Menu System", page 5-4 for a quick-start to using the menu.*

| Key | Description |
|---|---|
| **UP** ▲ | *Navigation* - Moves upwards through the list of parameters.<br>*Parameter* - Increments the value of the displayed parameter.<br>*Command Acknowledge* - Confirms action when in a command menu. |
| **DOWN** ▼ | *Navigation* - Moves downwards through the list of parameters.<br>*Parameter* - Decrements the value of the displayed parameter. |
| **ESCAPE** E | *Navigation* - Displays the previous level's Menu.<br>*Parameter* - Returns to the parameter list.<br>*Trip Acknowledge* - Acknowledges displayed Trip or Error message. |
| **MENU** M | *Navigation* - Displays the next Menu level, or the first parameter of the current Menu.<br>*Parameter* - Allows a writable parameter to be modified (this is indicated by → appearing on the left of the bottom line). |
| **PROG** | *Navigation* - Toggles between current locations within the Operator menu and any other menu. |
| **LOCAL/ REMOTE** L R | *Control* - Toggles between Remote and Local Control for both Start/Stop (Seq) and Speed Control (Ref). When toggling, the display automatically goes to the relevant SETPOINT screen, and the SETPOINT (LOCAL) screen will have the ▲ and ▼ keys enabled to alter the setpoint. |

### Keys for Operating the Drive Locally

| Key | Description |
|---|---|
| **FORWARD/ REVERSE** | *Control* - Changes the direction of motor rotation. Only operates when the drive is in Local Speed Control mode. |
| **JOG** | *Control* - Runs the motor at a speed determined by the JOG SETPOINT parameter. When the key is released, the drive returns to "stopped". Only operates when the drive is "stopped" and in Local Start/Stop mode. |
| **RUN** | *Control* - Runs the motor at a speed determined by the LOCAL SETPOINT or REMOTE SETPOINT parameter.<br>*Trip Reset* - Resets any trips and then runs the motor as above. Only operates when the drive is in Local Start/Stop (Seq) mode. |
| **STOP/RESET** | *Control* - Stops the motor. Only operates when the drive is in Local Sequence mode.<br>*Trip Reset* - Resets any trips and clears displayed message if trip is no longer active. |

# LED Indications

There are seven LEDs that indicate the status of the drive. Each LED is considered to operate in three different ways:

OFF

FLASH

ON

The LEDs are labelled HEALTH, LOCAL (as SEQ and REF), FWD, REV, RUN, and STOP. Combinations of these LEDs have the following meanings:

| HEALTH | RUN | STOP | Drive State |
|---|---|---|---|
| | | | Re-Configuration |
| | | | Tripped |
| | | | Stopped |
| | | | Stopping |
| | | | Running with zero speed demand or enable false or contactor feedback false |
| | | | Running |
| | | | Autotuning |
| | | | Auto Restarting, waiting for trip cause to clear |
| | | | Auto Restarting, timing |

| FWD | REV | Forward / Reverse State |
|---|---|---|
| | | Requested direction and actual direction are forward |
| | | Requested direction and actual direction are reverse |
| | | Requested direction is forward but actual direction is reverse |
| | | Requested direction is reverse but actual direction is forward |

| LOCAL SEQ | LOCAL REF | Local / Remote Mode |
|---|---|---|
| | | Start/Stop (Seq) and Speed Control (Ref) are controlled from the terminals |
| | | Start/Stop (Seq) is controlled using the RUN, STOP, JOG and FWD/REV keys. Speed Control (Ref) is controlled from the terminals |
| | | Start/Stop (Seq) is controlled from the terminals. Speed Control (Ref) is controlled using the up (▲) and down (▼) keys |
| | | Start/Stop (Seq) and Speed Control (Ref) are controlled using the Keypad keys |

*690+ Series AC Drive*

# The Menu System

The menu system is divided into a `tree' structure with 5 menu levels. Menu Level 1 is at the top of the tree.

The Keypad has selectable "viewing levels" which can restrict the view of the menu system.

Below is a simple description of the menus at Menu Level 1:

- OPERATOR: a customised view of selected parameters contained in the SETUP menu. You can create a working list of parameters for operating your drive.

- DIAGNOSTICS: a view of important diagnostic parameters contained in the SETUP menu.

- QUICK SETUP: contains all the parameters necessary for the drive to turn the motor.

- SETUP: contains all the function block parameters for programming your application.

- SYSTEM: Macro selection.
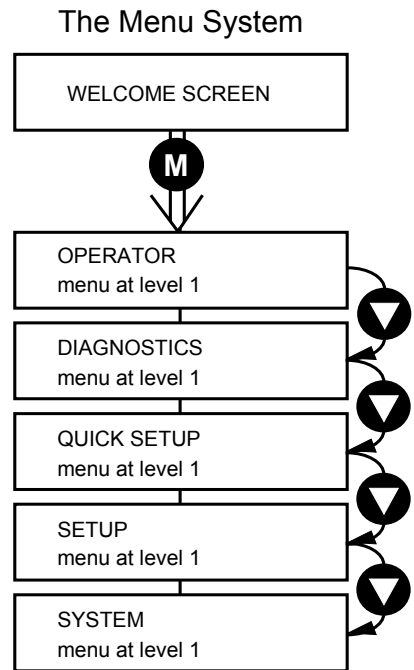


**Figure 5-2  The Menu System showing Menus at Level 1**

## Navigating the Menu System

On power-up, the Keypad defaults into the OPERATOR menu, timing out from the Welcome screen. You can skip the timeout by pressing the **M** key immediately after power-up which will take you directly to the OPERATOR menu.

The menu system can be thought of as map which is navigated using the four keys shown opposite.

*Keys **E** and **M** navigate through the menu levels. The up (▲) and down (▼) keys scroll through the Menu and Parameter lists.*

Refer to "The Menu System Map" to see how the full menu is mapped.



**HINT:** Remember that because the Menu and Parameter lists are looped, the ▲ key can quickly move you to the last Menu or Parameter in the loop.
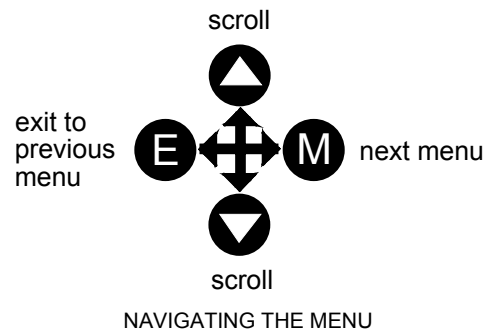
## Menu Viewing Levels

For ease of operation there are three `viewing levels' for the Keypad. The setting for the VIEW LEVEL parameter decides how much of the menu system will be displayed. The choice of menu for each has been designed around a type of user, hence we have the Operator, Basic and Advanced viewing levels.

*MMI Menu Map*

**1** QUICK SETUP

 VIEW LEVEL

In the QUICK SETUP menu, press the ⬤ key to quickly move to VIEW LEVEL, the last parameter in the menu.

*Note:*  *The contents of the OPERATOR menu remains unchanged for all view levels.*

Refer to "The Menu System Map", page 5-6 to see how VIEW LEVEL changes the menu.
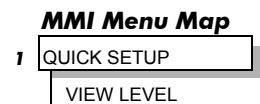
# Changing a Parameter Value

Refer to "The Menu System Map to see how the full menu is mapped.

Each menu contains parameters.

*With the Parameter you want on view, press **M** to begin editing.*

*The up (▲) and down (▼) keys will now change the parameter/function value.*

*Press **E** to finish editing.*

The four keys will once again navigate around the Menus. Refer back to "Navigating the Menu System", page 5-4.

increment

exit parameter change **E** ⬌ **M** enter parameter change

decrement

EDITING PARAMETERS
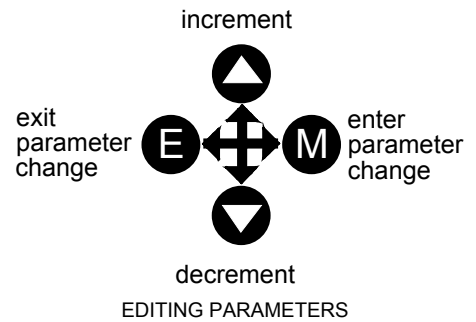
***Note:*** *When viewing a "number" value, i.e. 100.00%, pressing the M key moves the cursor along the number for editing of that character by the up (▲) and down (▼) keys. "Alphanumeric" values, i.e. PUMP 2, are produced and edited in a similar way.*

# What do the Symbols mean next to some Parameters?

## Parameter Status Information  →  ←  =

| → | Pressing **M** in a parameter displays → on the left of the bottom line to indicate that the up and down keys will now change parameter values. Pressing **E** removes the symbol and reverts the up and down keys to scrolling through the parameters. |
|---|---|
| ← | A writable parameter may be non-writable if it is the destination of a link. In this case it will be indicated by ← appearing on the left of the bottom line. |
| ← | A Feedback Link is indicated by ← appearing on the right of the bottom line. Refer to the Software Product Manual, Chapter 1: "Programming Your Application". |
| = | Non-writable parameters are identified by = appearing on the left of the bottom line. *Note that some parameters become non-writable when the drive is running.* |

## Expanded Menu Information  >>

The parameters listed below are followed by >> to the right of the bottom display line indicating that there is more information. Press the **M** key to display a further list of parameters.

*AUTO RESTART menu at level 4:*   AR TRIGGERS 1, AR TRIGGERS+ 1, AR TRIGGERS 2 AR TRIGGERS+ 2

*TRIPS STATUS menu at level 4*:   DISABLED TRIPS, DISABLED TRIPS+, ACTIVE TRIPS, ACTIVE TRIPS+, TRIP WARNINGS, TRIP WARNINGS+

*OP STATION menu at level 4:*   ENABLED KEYS

# Alert Message Displays

A message will be displayed on the Keypad when either:

- A requested operation is not allowed:
  *The top line details the illegal operation, while the bottom line gives the reason or cause. See example opposite.*

```
*  KEY INACTIVE  *
    REMOTE SEQ
```

- The drive has tripped:
  *The top line indicates a trip has occurred while the bottom line gives the reason for the trip. See example opposite.*

```
* * *  TRIPPED  * * *
   HEATSINK TEMP
```

Most messages are displayed for only a short period, or for as long as an illegal operation is tried, however, trip messages must be acknowledged by pressing the **E** key.

Experience will show how to avoid most messages. They are displayed in clear, concise language for easy interpretation. Refer to Chapter 6: "Trips and Fault Finding" for trip messages and reasons.

## The Menu System Map

| MENU LEVEL 1 | MENU LEVEL 2 | MENU LEVEL 3 | MENU LEVEL 4 |
|---|---|---|---|

OPERATOR
menu at level 1

DIAGNOSTICS
menu at level 1

QUICK SETUP
menu at level 1

SETUP
menu at level 1

SYSTEM
menu at level 1

COMMUNICATIONS
- 5703 INPUT
- 5703 OUTPUT
- SYSTEM PORT (P3)
- TEC OPTION

SYSTEM BOARD
- PHASE CONFIGURE
- PHASE CONTROL
- PHASE INCH
- PHASE MOVE
- PHASE OFFSET
- PHASE PID
- PHASE TUNING

HOIST/LIFT
- BRAKE CONTROL

INPUTS & OUTPUTS
- ANALOG INPUT
  - ANALOG INPUT 1
  - ANALOG INPUT 4
- ANALOG OUTPUT
  - ANALOG OUTPUT 1
  - ANALOG OUTPUT 3
- DIGITAL INPUT
  - DIGITAL INPUT 1
  - DIGITAL INPUT 15
- DIGITAL OUTPUT
  - DIGITAL OUTPUT 1
  - DIGITAL OUTPUT 15
- SYSTEM OPTION

LINKS
- LINK
  - LINK 1
  - LINK 80

MENUS
- ACCESS CONTROL
- DISPLAY SCALE
  - DISPLAY SCALE 1
  - DISPLAY SCALE 4
- OP STATION
  - OP STATION 1
  - OP STATION 2
- OPERATOR MENU
  - OPERATOR MENU 1
  - OPERATOR MENU 16

MISCELLANEOUS
- DEMULTIPLEXER
  - DEMULTIPLEXER 1
  - DEMULTIPLEXER 2
- HOME
- LOGIC FUNC
  - LOGIC FUNC 1
  - LOGIC FUNC 20
- MULTIPLEXER
  - MULTIPLEXER 1
  - MULTIPLEXER 2
- POSITION
- VALUE FUNC
  - VALUE FUNC 1
  - VALUE FUNC 20

**Effect of VIEW LEVEL**

OPERATOR / BASIC

BASIC

SELECTING ADVANCED WILL
DISPLAY ALL MENUS

**Note:** *When VIEW LEVEL is set to OPERATOR, the PROG key also toggles to the VIEW LEVEL parameter in the QUICK SETUP menu. This can be password protected.*

| MENU LEVEL 1 | MENU LEVEL 2 | MENU LEVEL 3 | MENU LEVEL 4 |
|---|---|---|---|
| | MOTOR CONTROL | AUTOTUNE | |
| | | CURRENT LIMIT | |
| | | DYNAMIC BRAKING | |
| | | FEEDBACKS | |
| | | FLUXING | |
| | | FLYCATCHING | |
| | | INJ BRAKING | |
| | | INVERSE TIME | |
| | | MOTOR DATA | |
| | | PATTERN GEN | |
| | | POWER LOSS CNTRL | |
| | | SETPOINT SCALE | |
| | | SLEW RATE LIMIT | |
| | | SLIP COMP | |
| | | SPEED LOOP | |
| | | STABILISATION | |
| | | TORQUE LIMIT | |
| | | VOLTAGE CONTROL | |
| | SEQ & REF | AUTO RESTART | |
| | | COMMS CONTROL | |
| | | LOCAL CONTROL | |
| | | REFERENCE | |
| | | REFERENCE JOG | |
| | | REFERENCE RAMP | |
| | | REFERENCE STOP | |
| | | SEQUENCING LOGIC | |
| | SETPOINT FUNCS | FILTER | FILTER 1 |
| | | | FILTER 2 |
| | | LINEAR RAMP | |
| | | MINIMUM SPEED | |
| | | PID | |
| | | PID (TYPE 2) | |
| | | PRESET | PRESET 1 |
| | | | PRESET 8 |
| | | RAISE/LOWER | |
| | | SKIP FREQUENCIES | |
| | | S-RAMP | |
| | | ZERO SPEED | |
| | TRIPS | I/O TRIPS | |
| | | STALL TRIP | |
| | | TRIPS HISTORY | |
| | | TRIPS STATUS | |
| | WINDER | COMPENSATION | |
| | | DIAMETER CALC | |
| | | SPEED CALC | |
| | | TAPER CALC | |
| | | TORQUE CALC | |

E ▲ M ▼ (keypad)

**Effect of VIEW LEVEL**

OPERATOR / BASIC

BASIC

SELECTING ADVANCED WILL
DISPLAY ALL MENUS

## The PROG Key

The **PROG** key toggles between the OPERATOR menu and any other menu, remembering and returning to previous positions in each menu. As you press the **PROG** key, the title of the menu you are about to enter is displayed, i.e. OPERATOR or for example DIAGNOSTICS. Releasing the key clears the display and releases you into that menu.
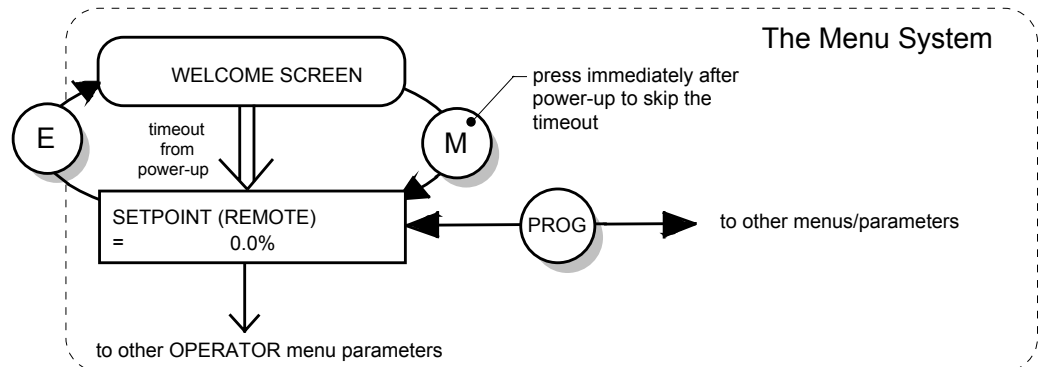


**Figure 5-3  The Menu System showing Operation of  the E, M and PROG Keys**

Holding the PROG key for approximately three seconds takes you to the SAVE CONFIG menu. Refer to "Quick Save Feature", page 5-18.

## The L/R Key

The **L/R** key (LOCAL/REMOTE) toggles between Remote and Local Control. In doing so, the view of the SETPOINT parameter in the OPERATOR menu toggles between SETPOINT (LOCAL) and SETPOINT (REMOTE. The default is for the SETPOINT (REMOTE) parameter to be displayed.

*Note:*   *A different naming convention is applied in the OPERATOR menu for these parameters when displayed as the first parameter entry:*

- *REMOTE SETPOINT is displayed as SETPOINT (REMOTE)*

- *LOCAL SETPOINT is displayed as SETPOINT (LOCAL)*

- *COMMS SETPOINT is displayed as SETPOINT (COMMS)*

- *JOG SETPOINT is displayed as SETPOINT (JOG)*

Pressing the L/R key when in Remote mode takes you directly to the SETPOINT (LOCAL) parameter with the Edit mode enabled. Press the PROG key to return to the previous display.

# The OPERATOR Menu

You can create 16 "custom screens" for display in the OPERATOR menu at level 1.

Each screen contains:

- a top line of sixteen characters
- user-definable units
- user-selectable scaling factor
- user selectable limits
- user selectable coefficients

This feature may be used to re-display the setpoint, for example, in more convenient units.

To add an item to the Operator Menu select a parameter (as shown below) in an OPERATOR MENU function block. You can also give the parameter a new name, and set the scaling and units to be displayed.
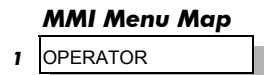
*Note:* *If  PARAMETER is set to NULL, the Operator Menu item is not included in the Operator Menu.*

## Parameter Selection
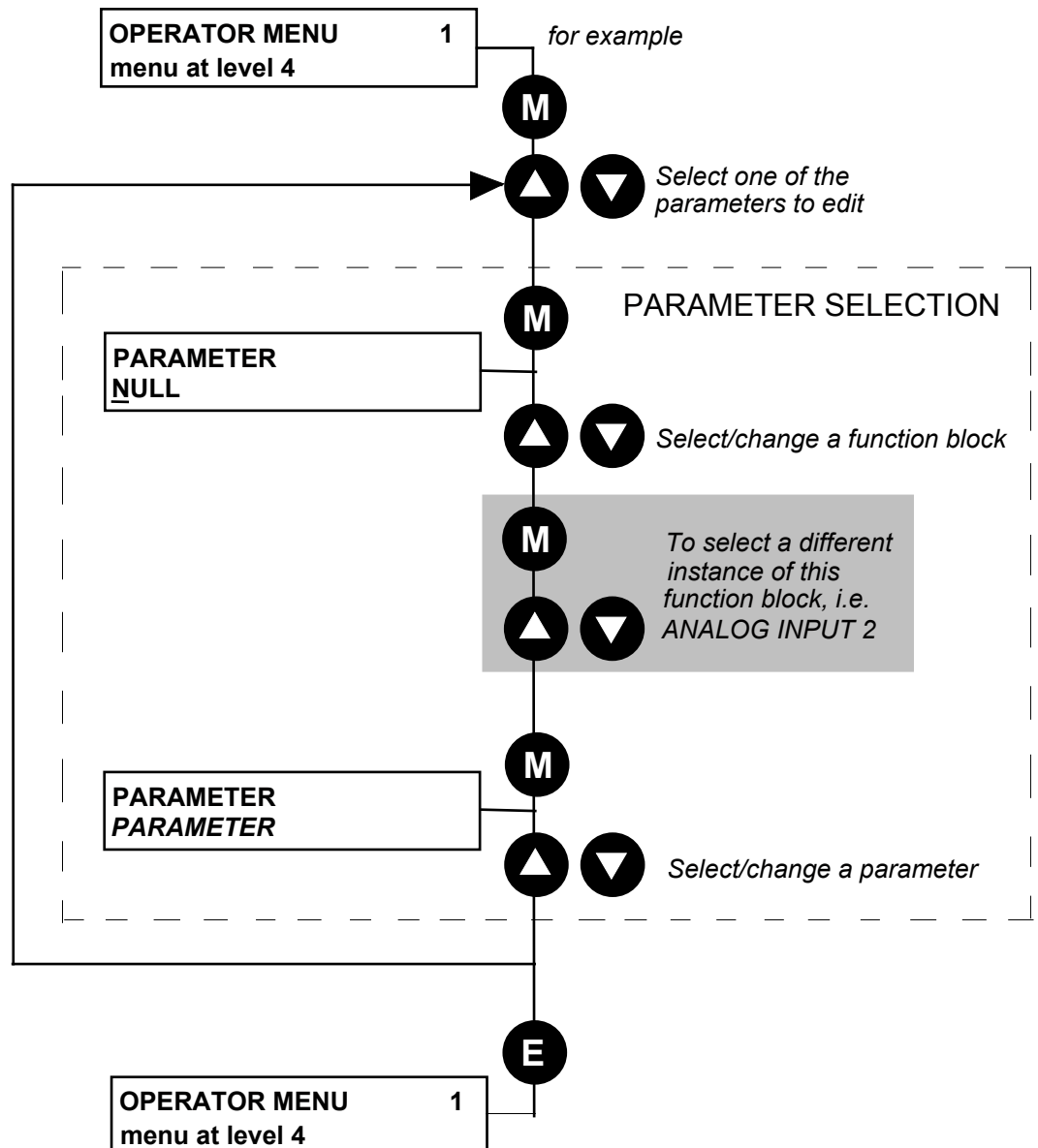


**Figure 5-4  Parameter Selection**

## String Entry

### Customising the Parameter Name

To enter a string:

- Press the **M** key to begin entering a character.

- Use the (▲) and down (▼) keys to scroll through the character set for each of the character spaces. If a key is not pressed within 2 seconds, the cursor will progressively move to the left of the screen.

- Press the **M** key to move to the next character within 2 seconds.

- Press the **E** key to exit parameter editing.

```
OPERATOR MENU          1
NAME
```

**M**

```
NAME
■
```

STRING ENTRY

To input another character        **M**
(2 second timout)

▲   ▼    Scroll through
         the characters
         (2 second timout)

```
NAME
a■
```

**E**

```
NAME
another name■
```
for example

**E**

```
OPERATOR MENU          1
NAME
```
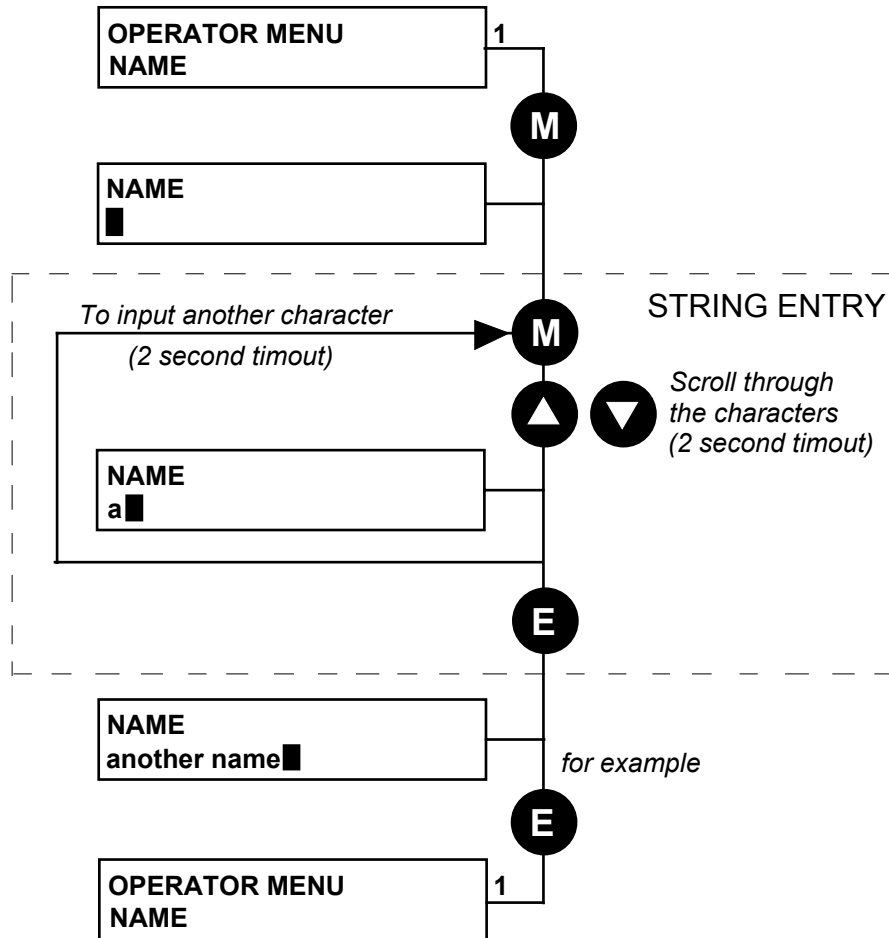
**Figure 5-5  String Entry**

***Note:*** *For details about user-definable units, scaling factors, limits and coefficients refer to the Software Product Manual, Chapter 1: Programming Your Application - OPERATOR MENU and DISPLAY SCALE function blocks.*

# The DIAGNOSTICS Menu

Diagnostics are used to monitor the status of the drive, internal variables, and its inputs and outputs.

The table below describes the parameters contained in the DIAGNOSTICS menu at level 1.

Ranges are given as "—.xx %", for example, indicating an indeterminate integer for the value.

*(Note the reference in brackets to the function block where each parameter is stored. Refer to the Software Product Manual).*

## The DIAGNOSTICS Menu

| SPEED DEMAND | Tag No. 255 | *Range: —.xx %* |
|---|---|---|

Indicates actual speed demand. This is the input to the frequency controller.

*(Refer to the REFERENCE function block)*

| REMOTE SETPOINT | Tag No. 245 | *Range: —.xx %* |
|---|---|---|

This is the target reference that the drive will ramp to in remote reference mode (not including trim), direction is taken from REMOTE REVERSE and the sign of REMOTE SETPOINT.

*(Refer to the REFERENCE function block)*

| COMMS SETPOINT | Tag No. 770 | *Range: —.xx %* |
|---|---|---|

This setpoint is the target reference that the drive will ramp to in Remote Reference Comms mode (not including trim). The direction is always positive, i.e. forward.

*(Refer to the REFERENCE function block)*

| LOCAL SETPOINT | Tag No. 247 | *Range: —.xx %* |
|---|---|---|

Indicates the Keypad setpoint. It is always a positive quantity; saved on power down. Direction is taken from LOCAL REVERSE.

*(Refer to the REFERENCE function block)*

| JOG SETPOINT | Tag No. 246 | *Range: —.xx %* |
|---|---|---|

The setpoint is the target reference that the drive will ramp to.

*(Refer to the REFERENCE function block)*

| TOTAL SPD DMD RPM | Tag No. 1203 | *Range: —.xx rpm* |
|---|---|---|

The final value of speed demand obtained after summing all sources.

*(Refer to the SPEED LOOP function block)*

| TOTAL SPD DMD % | Tag No. 1206 | *Range: —.xx %* |
|---|---|---|

The final value of speed demand obtained after summing all sources.

*(Refer to the SPEED LOOP function block)*

| SPEED FBK RPM | Tag No. 569 | *Range: —.xx rpm* |
|---|---|---|

The mechanical speed of the motor shaft in revolutions per minute.

*(Refer to the FEEDBACKS function block)*

| SPEED FBK % | Tag No. 749 | *Range: —.xx %* |
|---|---|---|

Shows the mechanical speed of the motor shaft as a percentage of the maximum speed setting.

*(Refer to the FEEDBACKS function block)*

| SPEED ERROR | Tag No. 1207 | *Range: —.xx %* |
|---|---|---|

The difference between the demanded speed and the actual speed.

*(Refer to the SPEED LOOP function block)*

| DRIVE FREQUENCY | Tag No. 591 | *Range: —.xx Hz* |
|---|---|---|

Shows the drive output frequency in Hz.

*(Refer to the PATTERN GEN function block)*

## The DIAGNOSTICS Menu

| | | |
|---|---|---|
| **DIRECT INPUT** | **Tag No. 1205** | *Range: —.xx %* |

The value of the direct input, after scaling and clamping.

*(Refer to the SPEED LOOP function block)*

| | | |
|---|---|---|
| **TORQ DMD ISOLATE** | **Tag No. 1202** | *Range: FALSE / TRUE* |

Speed Control mode and Torque Control mode selection. Torque Control mode = TRUE.

*(Refer to the SPEED LOOP function block)*

| | | |
|---|---|---|
| **ACTUAL POS LIM** | **Tag No. 1212** | *Range: —.xx %* |

The final actual positive torque limit.

*(Refer to the TORQUE LIMIT function block)*

| | | |
|---|---|---|
| **ACTUAL NEG LIM** | **Tag No. 1213** | *Range: —.xx %* |

The final actual negative torque limit.

*(Refer to the TORQUE LIMIT function block)*

| | | |
|---|---|---|
| **AUX TORQUE DMD** | **Tag No. 1193** | *Range: —.xx %* |

The auxiliary motor torque as a percentage of rated motor torque.

*(Refer to the SPEED LOOP function block)*

| | | |
|---|---|---|
| **TORQUE DEMAND** | **Tag No. 1204** | *Range: —.xx %* |

The demanded motor torque as a percentage of rated motor torque.

*(Refer to the SPEED LOOP function block)*

| | | |
|---|---|---|
| **TORQUE FEEDBACK** | **Tag No. 70** | *Range: —.xx %* |

The estimated motor torque, as a percentage of rated motor torque.

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **FIELD  FEEDBACK** | **Tag No. 73** | *Range: —.xx %* |

A value of 100% indicates the motor is operating at rated magnetic flux (field).

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **MOTOR CURRENT %** | **Tag No. 66** | *Range: —.xx %* |

This diagnostic contains the level of rms line current being drawn from the drive and is seen as a % of the MOTOR CURRENT parameter setting in the MOTOR DATA function block.

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **MOTOR CURRENT A** | **Tag No. 67** | *Range: —.x A* |

This diagnostic contains the level of rms line current being drawn from the drive.

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **DC LINK VOLTS** | **Tag No. 75** | *Range: —. V* |

The internal dc voltage tested by the FEEDBACKS block.

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **TERMINAL VOLTS** | **Tag No. 1020** | *Range: —. V* |

This shows the rms voltage, between phases, applied by the drive to the motor terminals.

*(Refer to the FEEDBACKS function block)*

| | | |
|---|---|---|
| **BRAKING** | **Tag No. 81** | *Range: FALSE / TRUE* |

A read-only parameter indicating the state of the brake switch.

*(Refer to the DYNAMIC BRAKING function block)*

| | | |
|---|---|---|
| **DRIVE FREQUENCY** | **Tag No. 591** | *Range: —.x Hz* |

The drive output frequency.

*(Refer to the PATTERN GEN function block)*

## The DIAGNOSTICS Menu

| ACTIVE TRIPS | Tag No. 4 | *Range: 0000 to FFFF* |
|---|---|---|

Indicates which trips are currently active. These parameters are a coded representation of the trip status.

*(Refer to the TRIPS STATUS function block)*

| ACTIVE TRIPS + | Tag No. 740 | *Range: 0000 to FFFF* |
|---|---|---|

Indicates which trips are currently active. These parameters are a coded representation of the trip status.

*(Refer to the TRIPS STATUS function block)*

| FIRST TRIP | Tag No. 6 | *Range: Enumerated - refer to block* |
|---|---|---|

From when a trip occurs until that trip is reset, this parameter indicates the trip source. When several trips have occurred, this parameter indicates the first one that was detected.

*(Refer to the TRIPS STATUS function block)*

| ANALOG INPUT 1 | Tag No. 16 | *Range: —.xx %* |
|---|---|---|

(VALUE) The input reading with scaling and offset applied.

*(Refer to the ANALOG INPUT function block)*

| ANALOG INPUT 2 | Tag No. 25 | *Range: —.xx %* |
|---|---|---|

(VALUE) The input reading with scaling and offset applied.

*(Refer to the ANALOG INPUT function block)*

| ANALOG INPUT 3 | Tag No. 715 | *Range: —.xx %* |
|---|---|---|

(VALUE) The input reading with scaling and offset applied.

*(Refer to the ANALOG INPUT function block)*

| ANALOG INPUT 4 | Tag No. 722 | *Range: —.xx %* |
|---|---|---|

(VALUE) The input reading with scaling and offset applied.

*(Refer to the ANALOG INPUT function block)*

| DIGITAL INPUT 1 | Tag No. 31 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| DIGITAL INPUT 2 | Tag No. 34 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| DIGITAL INPUT 3 | Tag No. 37 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| DIGITAL INPUT 4 | Tag No. 40 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| DIGITAL INPUT 5 | Tag No. 43 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| DIGITAL INPUT 6 | Tag No. 726 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

## The DIAGNOSTICS Menu

| DIGITAL INPUT 7 | Tag No. 728 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE input, (after any inversion).

*(Refer to the DIGITAL INPUT function block)*

| EXTERNAL TRIP | Tag No. 234 | *Range: FALSE / TRUE* |
|---|---|---|

(EXTERNAL) A general purpose signal designed to be internally wired to a digital input block. When this signal goes TRUE this causes an EXTERNAL TRIP to occur, (unless this trip is disabled within the TRIPS area). This parameter is not saved in the drive's non-volatile memory and thus is reset to the default setting at power-up.

*(Refer to the I/O TRIPS function block)*

| ANALOG OUTPUT 1 | Tag No. 45 | *Range: —.xx %* |
|---|---|---|

(VALUE) The demanded value to output.

*(Refer to the ANALOG OUTPUT function block)*

| ANALOG OUTPUT 2 | Tag No. 731 | *Range: —.xx %* |
|---|---|---|

(VALUE) The demanded value to output.

*(Refer to the ANALOG OUTPUT function block)*

| ANALOG OUTPUT 3 | Tag No. 800 | *Range: —.xx %* |
|---|---|---|

(VALUE) The demanded value to output.

*(Refer to the ANALOG OUTPUT function block)*

| DIGITAL OUTPUT 1 | Tag No. 52 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE output demand.

*(Refer to the DIGITAL OUTPUT function block)*

| DIGITAL OUTPUT 2 | Tag No. 55 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE output demand.

*(Refer to the DIGITAL OUTPUT function block)*

| DIGITAL OUTPUT 3 | Tag No. 737 | *Range: FALSE / TRUE* |
|---|---|---|

(VALUE) The TRUE or FALSE output demand.

*(Refer to the DIGITAL OUTPUT function block)*

# The QUICK SETUP Menu

By loading a different macro, you are installing the default settings for that macro's application. Once a macro has been loaded (or the default Macro 1 is used), the parameters most likely to require attention are contained in the QUICK SETUP menu at level 1.

The Default values in the table below are correct for when the UK country code is selected and a 400V 5.5kW Frame C power board is fitted. Some parameters in the table are marked:

    \* Value dependent upon the Language field of the Product Code, e.g. UK
    \*\* Value dependent upon the overall "power-build", e.g. 400V, 5.5kW

The values may be different for your drive/application.

| Tag | QUICK SET-UP Parameters | Default | Brief Description |
|-----|-------------------------|---------|-------------------|
| 1105 | CONTROL MODE | VOLTS / HZ | Selects the control mode for the drive |
| 1032 | MAX SPEED | * 1500 RPM | Max speed clamp and scale factor for other speed parameters |
| 337 | MIN SPEED | -100.00 % | Min speed clamp |
| 258 | RAMP ACCEL TIME | 10.0 s | Acceleration time from 0Hz to max speed |
| 259 | RAMP DECEL TIME | 10.0 s | Deceleration time from max speed to 0Hz |
| 279 | RUN STOP MODE | RAMPED | Ramp to standstill when RUN signal removed |
| 246 | JOG SETPOINT | 10.0 % | Drive speed setpoint whilst jogging |
| 106 | VHZ BASE FREQ | ** 50.0 Hz | Determines the frequency at which maximum output volts is generated |
| 104 | V/F SHAPE | LINEAR LAW | Constant torque V to F characteristic |
| 50 | QUADRATIC TORQUE | FALSE | Selects between Constant or Quadratic mode of operation |
| 64 | MOTOR CURRENT | ** 11.3 A | Calibrates drive to motor full load current |
| 107 | FIXED BOOST | ** 6.00 % | Boosts starting torque by adding volts at low speed |
| 365 | CURRENT LIMIT | 100.00% | Level of motor current as % of FULL LOAD CALIB |
| 1159 | MOTOR BASE FREQ | ** 50.0 Hz | Frequency at which drive gives maximum output volts |
| 1160 | MOTOR VOLTAGE | ** 400.0 V | Maximum motor output voltage |
| 83 | NAMEPLATE RPM | ** 1445 RPM | Motor nameplate speed |
| 84 | MOTOR POLES | ** 4 | Number of motor poles |
| 124 | MOTOR CONNECTION | ** STAR | Type of motor connection |
| 761 | ENCODER SUPPLY | 10.0V | Set to supply voltage required by the encoder |
| 566 | ENCODER LINES | ** 2048 | Set to the number of lines used by the encoder |
| 567 | ENCODER INVERT | FALSE | Encoder direction |
| 603 | AUTOTUNE ENABLE | FALSE | Enables the Autotune feature |
| 65 | MAG CURRENT | ** 3.39 A | Calibrates drive to motor no load current |
| 119 | STATOR RES | ** 1.3625 $\Omega$ | Motor per-phase stator resistance |
| 120 | LEAKAGE INDUC | ** 43.37 mH | Motor per-phase stator leakage inductance |
| 121 | MUTUAL INDUC | ** 173.48 mH | Motor per-phase stator mutual (magnetising) inductance |
| 1163 | ROTOR TIME CONST | ** 276.04 ms | The motor model rotor time constant as determined by Autotune |
| 1187 | SPEED PROP GAIN | 20.00 | Sets the proportional gain of the loop |
| 1188 | SPEED INT TIME | 100 ms | The integral time constant of the speed loop |
| 13 | AIN 1 TYPE | 0..+10 V | Input range and type |
| 22 | AIN 2 TYPE | 0..+10 V | Input range and type |
| 712 | AIN 3 TYPE | 0..+10 V | Input range and type |
| 719 | AIN 4 TYPE | 0..+10 V | Input range and type |
| 231 | DISABLE TRIPS | 0000 >> | Sub-menu to set disabled trips |
| 742 | DISABLE TRIPS + | 0040 >> | Sub-menu to set disabled trips |
| 876 | VIEW LEVEL | TRUE | Selects full menu for MMI display |

**Table 5-1  Parameters for setting-up the drive**

# The SYSTEM Menu

## Saving/Restoring/Deleting Your Application

---

**Caution**

On power-up, the drive will always run APPLICATION.

---

**HINT:** The default APPLICATION supplied with the drive is a copy of Macro 1. Saving your current configuration to APPLICATION will ensure that it is always ready to run on power-up.

### SAVE CONFIG

The SAVE CONFIG menu saves your current settings to the displayed config name.

You can save to any config name listed. Saving to an existing config name, rather than a newly created config name, will overwrite the previous information.

By default, the only name in this list will be APPLICATION. As you create new config names, they will be added to this list. If you also save the new config into APPLICATION, it will always be restored on power-up.

***MMI Menu Map***

*1* | SYSTEM

*2* | SAVE CONFIG
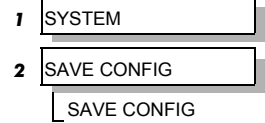
└ SAVE CONFIG

*Note:* *Because factory macros are read-only, they do not appear in the SAVE CONFIG menu.*

To save an application see below.
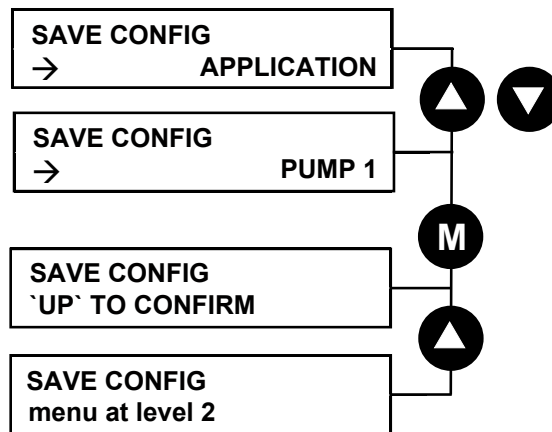


### RESTORE CONFIG

This menu restores the displayed application/macro to the drive.

To restore an application/macro see below.

***MMI Menu Map***

*1* | SYSTEM

*2* | RESTORE CONFIG

└ RESTORE CONFIG
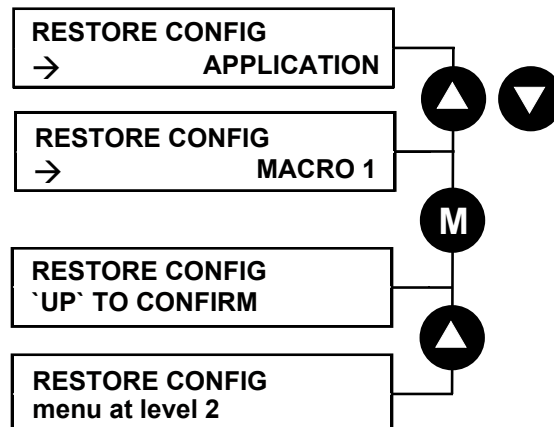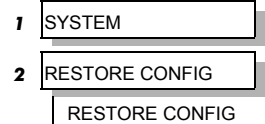
## NEW CONFIG NAME

Use the NEW CONFIG NAME parameter to create a new config name.

The Keypad provides a default name, APPLICATION, for you to save your application in. You can save more than one application using different names, e.g. PUMP 1, PUMP 2.

To enter a config name see below.  Refer to "Figure 5-5  String Entry", page 5-10 for details of how to enter a string.

**MMI Menu Map**

1  SYSTEM

2  NEW CONFIG NAME

   └ NEW CONFIG NAME

```
NEW CONFIG NAME
→           APPLICATION
```
                                    — string entry

```
NEW CONFIG NAME
→                 PUMP 1
```
                        **E**

```
NEW CONFIG NAME
`UP` TO CONFIRM
```
                        ▲

```
NEW CONFIG NAME
menu at level 2
```
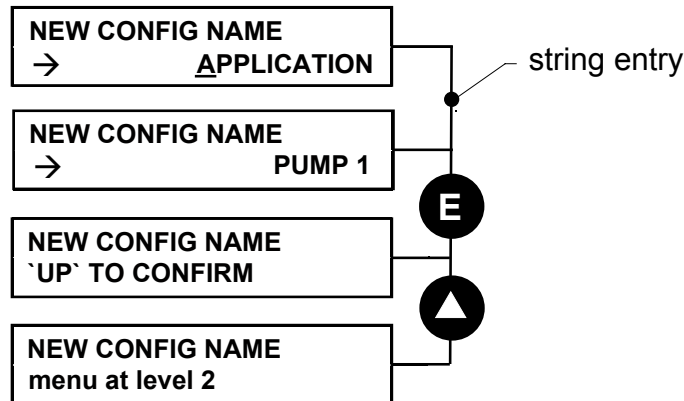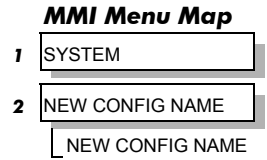
## DELETE CONFIG

You can delete your own applications in this menu.

***Note:*** *If you delete APPLICATION, don't worry. Software always provides a new APPLICATION on power-up which will be the same as MACRO 1.*

You cannot delete the factory macros.

To delete an application see below.

**MMI Menu Map**

1  SYSTEM

2  DELETE CONFIG

   └ DELETE CONFIG

```
DELETE CONFIG
→                 PUMP 1
```
                        ▲  ▼

```
DELETE CONFIG
→                 PUMP 2
```
                        **M**

```
DELETE CONFIG
`UP` TO CONFIRM
```
                        ▲

```
DELETE CONFIG
menu at level 2
```
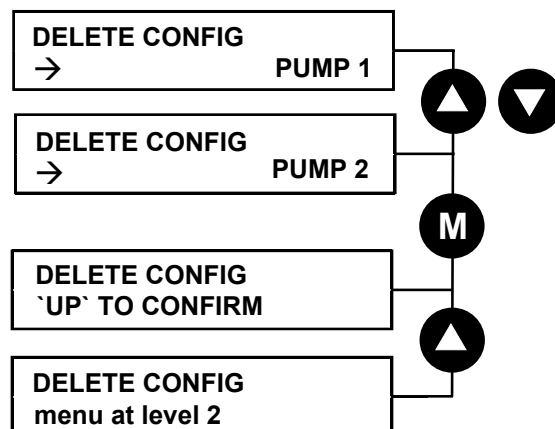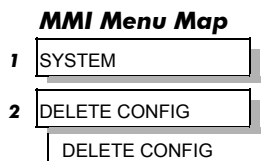
## Selecting the Language

This option selects a different display language.

```
LANGUAGE
              ENGLISH
```

```
LANGUAGE
→            ENGLISH
```

```
LANGUAGE
→               other
```

```
language
                other
```

**M**

▲ ▼

**E**
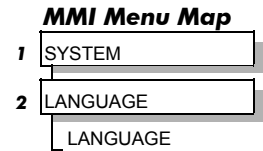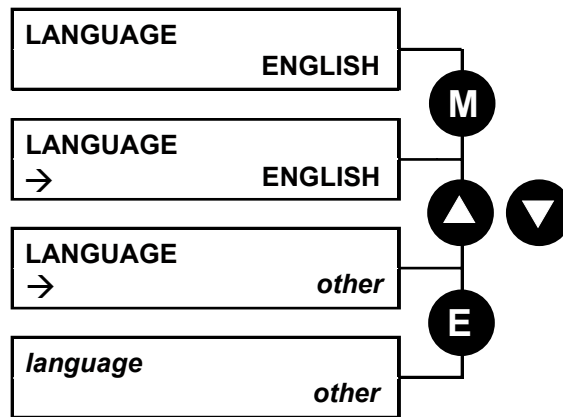
The available languages are: ENGLISH, GERMAN, FRENCH, SPANISH, ITALIAN, SWEDISH, POLISH, PORTUGUESE.

# Special Menu Features

## Quick Save Feature

From anywhere in the menu system, hold down the **PROG** key for approximately 3 seconds to move quickly to the SAVE CONFIG menu. You can save your application and return conveniently to your original display.

```
DIAGNOSTICS
menu at level 1
```
*for example*

**PROG** ⏜ *HOLD*

```
SAVE CONFIG
menu at level 2
```

**M**

```
SAVE CONFIG
→            APPLICATION
```
*for example*

**M**

```
SAVE CONFIG
"UP" TO CONFIRM
```

▲

```
SAVE CONFIG
menu at level 2
```

**PROG** *DISPLAYS OPERATOR MENU (NORMAL ACTION OF PROG KEY)*

```
SETPOINT (REMOTE)
=            0.0 %
```
*for example*

**PROG** *PRESS AGAIN TO RETURN TO PREVIOUS MENU/PARAMETER*

```
DIAGNOSTICS
menu at level 1
```
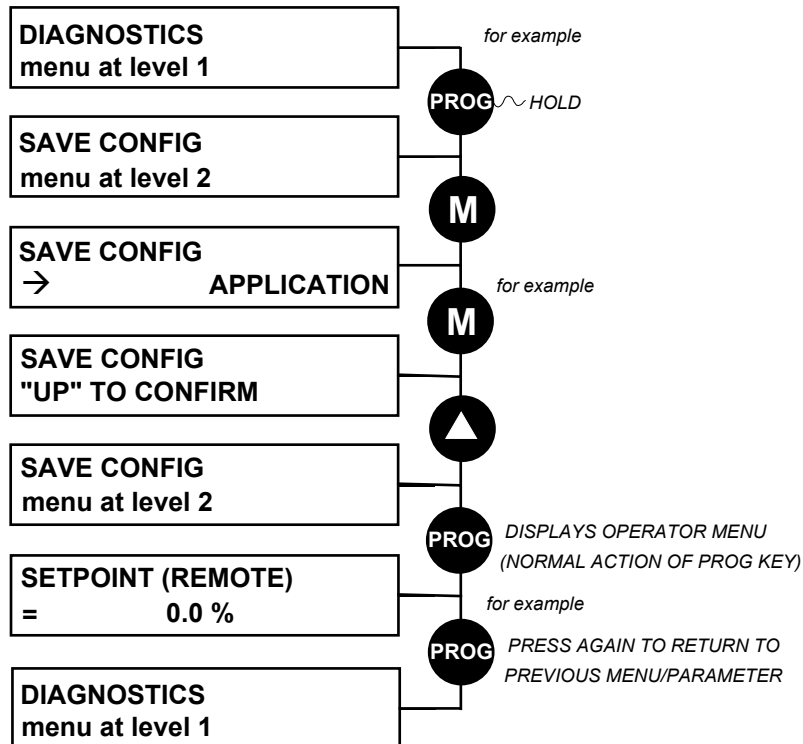
# Quick Tag Information

With a parameter displayed, hold down the **M** key for approximately 3 seconds to display the parameter's tag number (a message may be displayed during this time).

| RAMP TIME | |
|---|---|
| | **100.00%** |

**M** ∿ *HOLD FOR 3 SECONDS*

| RAMP TIME | |
|---|---|
| TAG | **326** |

**E**

| RAMP TIME | |
|---|---|
| | **100.00%** |
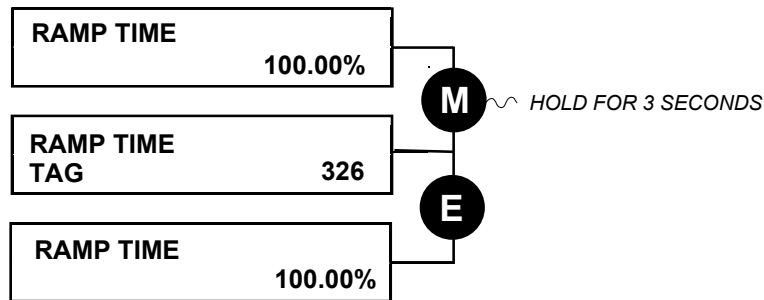
# Quick Link Information

When in Advanced view level and with the Quick Tag Information on display, press the **M** key in any *configurable* parameter to display link information about that parameter.

The drive is in Parameterisation Mode and links cannot be edited.

**Note:** *Quick Link Information is not available for parameters that are non-configurable.*

| DIGITAL OUTPUT 3 |
|---|
| menu at level 4 |

**M**

| VALUE | |
|---|---|
| | **FALSE** |

**M** ∿ *HOLD FOR 3 SECONDS FOR QUICK TAG INFORMATION*

| VALUE | |
|---|---|
| TAG | **52** |

**M** *PRESS AGAIN FOR QUICK LINK INFORMATION*

| SOURCE |
|---|
| NULL |

**E** *See Note*

| VALUE | |
|---|---|
| TAG | **52** |

**E**

| VALUE | |
|---|---|
| | **FALSE** |

**E**

| DIGITAL OUTPUT 3 |
|---|
| menu at level 4 |
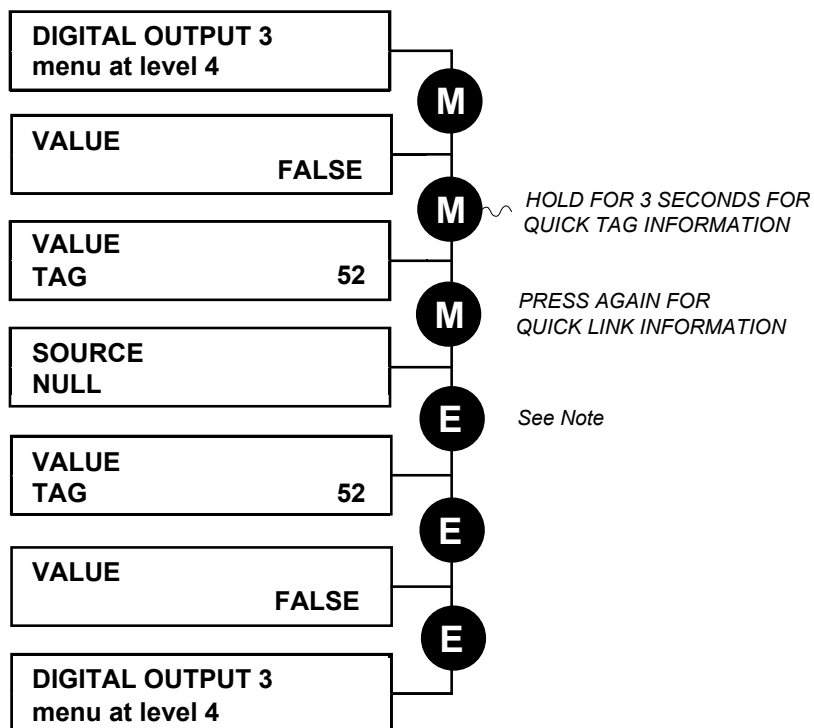
**Note:** *The drive must be in Configuration mode before links can be edited. Pressing the **M** key at this point will display the ENABLE CONFIG page. Refer to the Software Product Manual, Chapter 1: "Programming Your Application" - Making and Breaking Links in Configuration Mode.*

# Password Protection

When activated, the password prevents unauthorised parameter modification by making all parameters "read-only". If you attempt to modify a password protected parameter, you will be prompted for the password.

The password protection is activated/deactivated using the PASSWORD parameter.
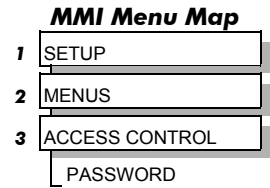
## To Activate Password Protection

By default the password feature is deactivated, i.e. 0000.

1. Enter a new password in the PASSWORD parameter (anything other than the default value of 0000), for example 0002.

2. Press the **E** key repeatedly until the Welcome screen is displayed. Pressing the **E** key again activates password protection.

```
┌─────────────────────┐
│ PASSWORD            │
│          XXXX       │          (M)
└─────────────────────┘

┌─────────────────────┐
│ PASSWORD            │
│ →          0000     │          (▲) (▼)
└─────────────────────┘

┌─────────────────────┐
│ PASSWORD            │
│ →          0002     │          (E) repeatedly
└─────────────────────┘

┌─────────────────────┐
│   WELCOME SCREEN    │          (E)
└─────────────────────┘

┌─────────────────────┐
│      PASSWORD       │
│      LOCKED         │
└─────────────────────┘
```
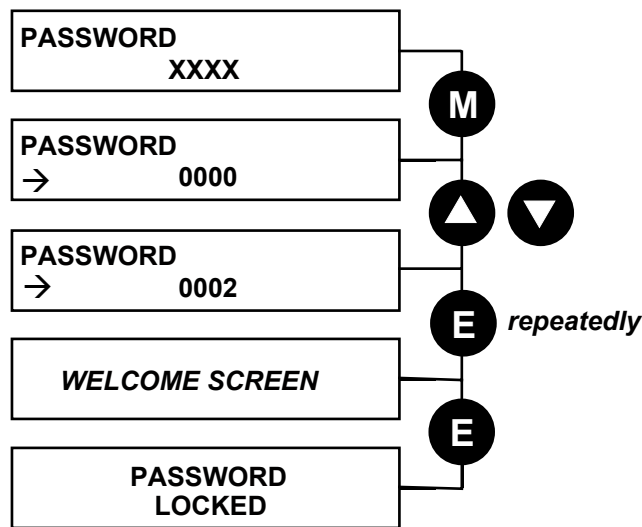
*Note:* *Perform a SAVE CONFIG if you need the password to be saved on power-down.*

## To De-activate Password Protection

If you try to change the value of a parameter with password protection activated, the PASSWORD screen is displayed for you to enter the current password. If you enter the password correctly password protection is temporarily de-activated.

## To Re-activate Password Protection

Re-activate an existing password by pressing the **E** key repeatedly until the PASSWORD LOCKED screen is displayed.

*Note:* *You can choose to have the password protect individual parameters in the OPERATOR menu. Under default conditions these are not protected. Refer to the Software Product Manual, Chapter 1: "Programming Your Application" - OPERATOR MENU::IGNORE PASSWORD and ACCESS CONTROL::NO SETPOINT PWRD.*

## To Remove Password Protection (default status)

Navigate to the PASSWORD parameter and enter the current password. Press the **E** key. Reset the password to 0000. Password protection is now removed.

You can check that password protection has been removed by repeatedly pressing the **E** key until the Welcome screen is displayed. Pressing the **E** key again will NOT display the PASSWORD LOCKED screen.

*Note:* *Perform a SAVE CONFIG if you need "no password" to be saved on power-down.*

# Power-up Key Combinations

## Resetting to Factory Defaults (2-button reset)

A special key combination restores to the drive the current product code default values and Macro 1 parameter values. This feature is only available at power-up as a security measure.

*Hold down the keys opposite:*
*Power-up the drive, continue to hold for at least 2 seconds*

**RESTORE DEFAULTS**
**"UP" TO CONFIRM**



*HOLD*

*UPDATES*          *IGNORES*
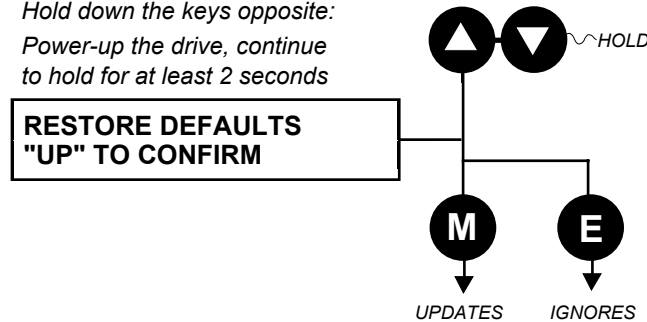
## Changing the Product Code (3-button reset)

On rare occasions it may be necessary to change the default settings by changing the Product Code. The Product Code is referred to in Chapter 2.

A special key combination is required to change the product code. This feature is only available at power-up as a security measure.

The 3-button reset will take you to the POWER BOARD menu in the expanded SYSTEM menu (highlighted in the diagram below).



SYSTEM

**POWER BOARD**
LANGUAGE
**DEFAULT TO 60HZ**
**REFORMAT FLASH** *
**RESTART** *
**EXIT TO BOOT** *
SAVE CONFIG
RESTORE CONFIG
**RESTORE DEFAULTS**
DELETE CONFIG
NEW CONFIG NAME

*HOLD*

*Hold down the keys opposite:*
*Power-up the drive, continue to hold for at least 2 seconds*

**POWER BOARD**
         **5.5kW  400V**

**POWER BOARD**
**menu at level 2**

*for example*

*see diagram below*

Select from the
expanded SYSTEM menu
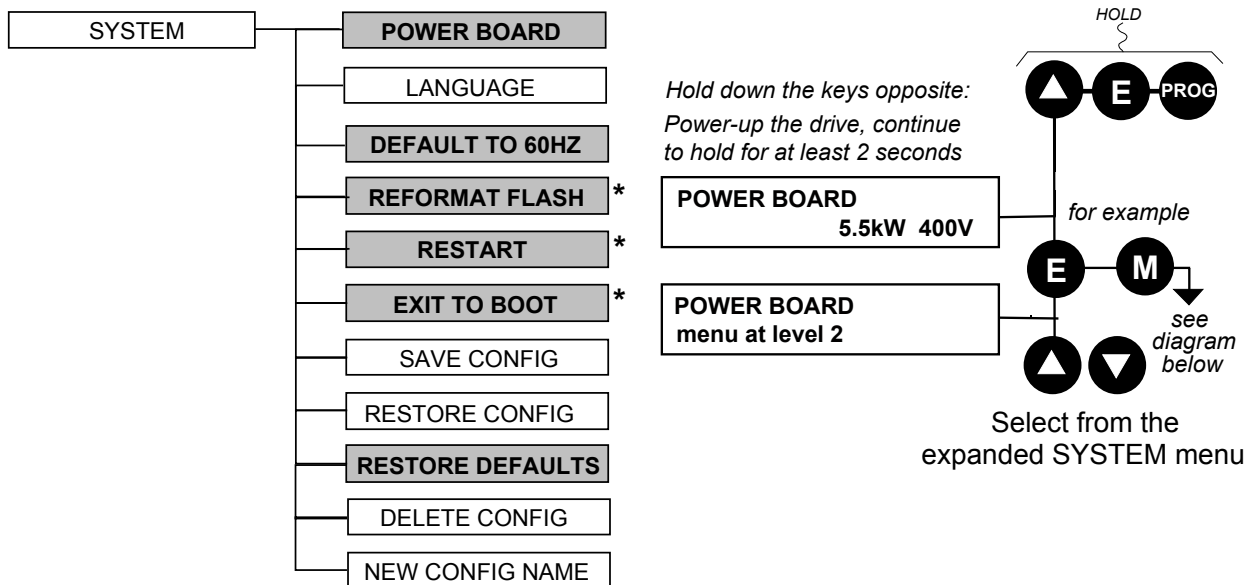
**IMPORTANT:** We recommend the menus marked **\***above are only used by SSD Drives or suitably qualified personnel.

Refer to The SYSTEM Menu, page 5-16 for all non-highlighted menus.

**POWER BOARD**

HOLD

*Hold down the keys opposite:*
*Power-up the drive, continue to hold for at least 2 seconds*

*Config mode is selected, indicated by all LEDs flashing*

( ▲ ) ( E ) ( PROG )

( E )

**POWER DATA CORRUPT**

**POWER BOARD**
        **????kW   ???V**

( M )

**POWER BOARD**
→        **????kW   ???V**

( ▲ ) ( ▼ )

**POWER BOARD**
→        **5.5kW   400V**

( E )

**LANGUAGE DEFAULTS LOADED**

( E )

*WELCOME SCREEN*

*Config mode is de-selected, LEDs cease flashing*
*The power data is stored*
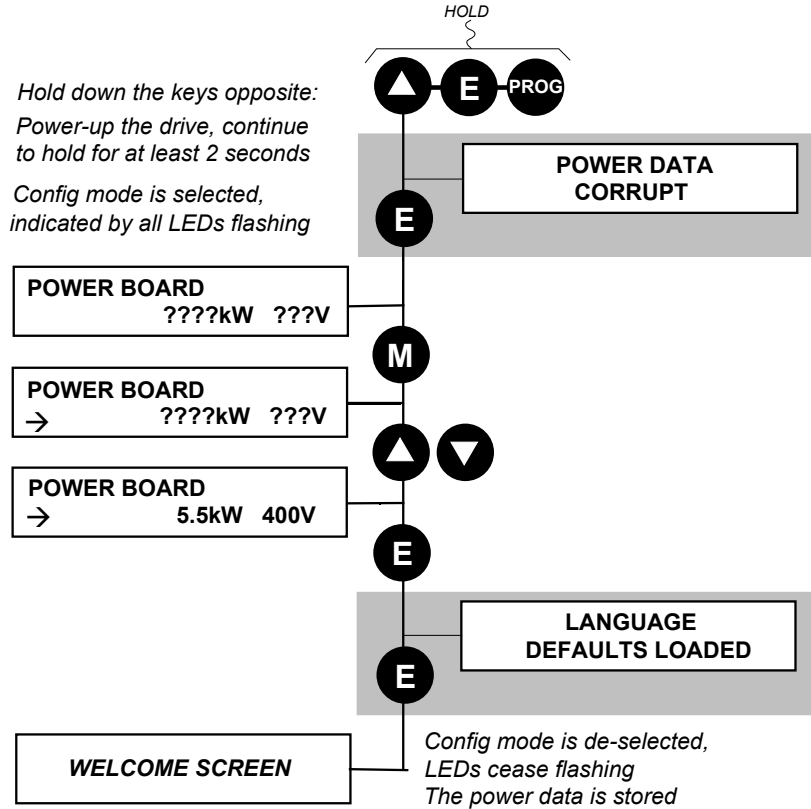
The diagram above shows a 3-button reset when there is no power data stored in the drive. If the drive has power data stored, then the "Power Data Corrupt" and "Language Defaults Loaded" alert messages will not be displayed, also the display will show the current power board selection, instead of "????kW  ???V".

### DEFAULT TO 60HZ
The setting of this parameter selects the drive operating frequency. It affects those parameters whose values are dependent upon the default base frequency of the drive. Settings will only be updated following a "restore macro" operation.

Refer to the Software Product Manual, Chapter 2: "Parameter Specification" - Frequency Dependent Defaults.

### RESTORE DEFAULTS
Refer to "Resetting to Factory Defaults (2-button reset)", page 5-21.

## Quick Enter Configuration Mode

You can initialise the drive in Configuration Mode by holding the **STOP** key during power-up.

*Hold down the key opposite:*
*Power-up the drive, continue to hold for at least 2 seconds*

( ◉ ) ∼∼HOLD

**AC MOTOR DRIVE**
**5.5kW 400V V1.1**

*for example*

( M )

*Menu System*
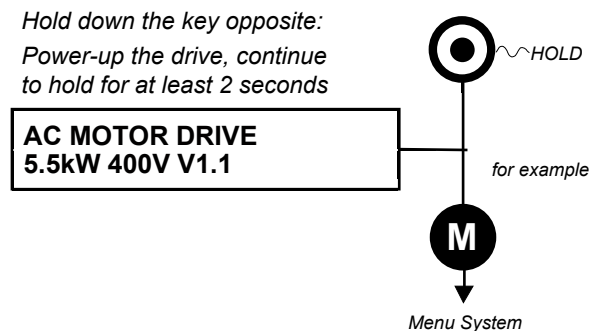
# TRIPS AND FAULT FINDING

## Trips

### What Happens when a Trip Occurs

When a trip occurs, the drive's power stage is immediately disabled causing the motor and load to coast to a stop. The trip is latched until action is taken to reset it. This ensures that trips due to transient conditions are captured and the drive is disabled, even when the original cause of the trip is no longer present

#### Drive Indications

If a trip condition is detected the unit displays and performs the following actions.

1.  The HEALTH LED flashes indicating a Trip condition has occurred. (Investigate, find and remove the cause of the trip.)

( DEFAULT )

1.  The programming block SEQ & REF::SEQUENCING LOGIC::TRIPPED signal is set to TRUE.

The DIGITAL OUTPUT 1 (HEALTH) digital output changes between TRUE/FALSE, depending on the output logic.

#### Keypad Indications (when connected)

If a trip condition is detected the MMI displays and performs the following actions.

1.  The HEALTH LED on the Keypad flashes indicating a Trip condition has occurred and a trip message is displayed stating the cause of the trip.

2.  The programming block SEQ & REF::SEQUENCING LOGIC::TRIPPED signal is set to TRUE.
    The DIGITAL OUTPUT 1 (HEALTH) digital output changes between TRUE/FALSE, depending on the output logic.

3.  The trip message(s) must be acknowledged by pressing the **STOP** key. The trip message may be cleared by pressing the **E** key. Refer to Chapter 5: "The Keypad" - Alert Message Displays.

### Resetting a Trip Condition

All trips must be reset before the drive can be re-enabled. A trip can only be reset once the trip condition is no longer active, i.e. a trip due to a heatsink over-temperature will not reset until the temperature is below the trip level.

*Note:*  *More than one trip can be active at any time. For example, it is possible for both the HEATSINK and the OVERVOLTAGE trips to be active. Alternatively it is possible for the drive to trip due to an OVERCURRENT error and then for the HEATSINK trip to become active after the drive has stopped (this may occur due to the thermal time constant of the heatsink).*

( DEFAULT )

Reset the trip(s) using the remote trip reset input, or by pressing the **STOP** key on the Keypad.

Success is indicated by the HEALTH LED (on the unit or MMI) ceasing to flash and returning to a healthy "ON" state. The programming block SEQ & REF::SEQUENCING LOGIC::TRIPPED output is reset to FALSE.

## Using the Keypad to Manage Trips

### Trip Messages

If the drive trips, then the display immediately shows a message indicating the reason for the trip. The possible trip messages are given in the table below.

| Trip Message and Meaning | Possible Reason for Trip |
|---|---|
| **OVERVOLTAGE**<br>The drive internal dc link voltage is too high | The supply voltage is too high<br>Trying to decelerate a large inertia load too quickly<br>The brake resistor is open circuit |
| **UNDERVOLTAGE**<br>The drive internal dc link voltage is too low | The supply voltage is too low<br>The supply has been lost<br>A supply phase is missing |
| **OVERCURRENT**<br>The motor current being drawn from the drive is too high | Trying to accelerate a large inertia load too quickly<br>Trying to decelerate a large inertia load too quickly<br>Application of shock load to motor<br>Short circuit between motor phases<br>Short circuit between motor phase and earth<br>Motor output cables too long or too many parallel motors connected to the drive<br>Fixed or auto boost levels are set too high |
| **HEATSINK**<br>The drive heatsink temperature is too high | The ambient air temperature is too high<br>Poor ventilation or spacing between drives |
| **EXTERNAL TRIP**<br>User trip caused via control terminals | +24V not present on external trip (e.g. terminal 19, Macro 1). |
| **INPUT 1 BREAK**<br>A signal break has been detected on analog input 1 (terminal 1) | Analog input is incorrectly configured for 4-20mA operation<br>Break in external control wiring |
| **INPUT 2 BREAK**<br>A signal break has been detected on analog input 2 (terminal 2) | Analog input is incorrectly configured for 4-20mA operation<br>Break in external control wiring |
| **MOTOR STALLED**<br>The motor has stalled (not rotating) | Motor loading too great<br>Current limit level is set too low<br>Stall trip duration is set too low<br>Fixed or auto boost levels are set too high |
| **BRAKE RESISTOR**<br>External dynamic braking resistor has been overloaded | Trying to decelerate a large inertia load too quickly or too often |
| **BRAKE SWITCH**<br>Internal dynamic braking switch has been overloaded | Trying to decelerate a large inertia load too quickly or too often |
| **OP STATION**<br>Keypad has been disconnected from drive whilst drive is running in local control | Keypad accidentally disconnected from drive |

| Trip Message and Meaning | Possible Reason for Trip |
|---|---|
| LOST COMMS | COMMS TIMEOUT parameter set too short (refer to COMMS CONTROL menu at level 3) |
| CONTACTOR FBK | The CONTACTOR CLOSED input in the SEQUENCING LOGIC function block remained FALSE after a run command was issued |
| SPEED FEEDBACK | SPEED ERROR > 50.00% for 10 seconds |
| AMBIENT TEMP | The ambient temperature in the drive is too high |
| MOTOR OVERTEMP<br>The motor temperature is too high | Excessive load<br><br>Motor voltage rating incorrect<br><br>FIXED BOOST and/or AUTO BOOST set too high<br><br>Prolonged operation of the motor at low speed without forced cooling<br><br>Check setting of INVERT THERMIST parameter in I/O TRIPS menu at level 3.<br><br>Break in motor thermistor connection |
| CURRENT LIMIT<br>If the current exceeds 180% of stack rated current for a period of 1 second, the drive will trip. This is caused by shock loads | Remove the cause of the shock load |
| 24V FAILURE<br>The 24V customer output has fallen below 17V | 24V customer output is short circuited<br>Excessive loading |
| LOW SPEED OVER I<br>The motor is drawing too much current (>100%) at zero output frequency | FIXED BOOST and/or AUTO BOOST set too high (refer to FLUXING menu at level 4) |
| *TRIP 22* | *Reserved* |
| ENCODER 1 FAULT | The Error input on the Encoder TB is in the Error state |
| DESAT (OVER I) | Instantaneous overcurrent. Refer to OVERCURRENT in this table |
| VDC RIPPLE | The dc link ripple voltage is too high. Check for a missing input phase. |
| BRAKE SHORT CCT<br>Brake resistor overcurrent | Check resistance brake resistor value is greater than minimum allowed |
| OVERSPEED | Speed feedback > 150% for 0.1 seconds |
| UNKNOWN | An unknown trip - refer to SSD Drives |
| MAX SPEED LOW | During Autotune the motor is required to run at the nameplate speed o f the motor. If MAX SPEED RPM limits the speed to less than this value, an error will be reported. Increase the value of MAX SPEED RPM up to the nameplate rpm of the motor (as a minimum). It may be reduced, if required, after the Autotune is complete. |

| Trip Message and Meaning | Possible Reason for Trip |
|---|---|
| MAINS VOLTS LOW | The mains input voltage is not sufficient to carry out the Autotune. Re-try when the mains has recovered. |
| NOT AT SPEED | The motor was unable to reach the required speed to carry out the Autotune. Possible reasons include:<br>• motor shaft not free to turn<br>• the motor data is incorrect |
| MAG CURRENT FAIL | It was not possible to find a suitable value of magnetising current to achieve the required operating condition for the motor. Check the motor data is correct, especially nameplate rpm and motor volts. Also check that the motor is correctly rated for the drive. |
| NEGATIVE SLIP F | Autotune has calculated a negative slip frequency, which is not valid. Nameplate rpm may have been set to a value higher than the base speed of the motor. Check nameplate rpm, base frequency, and pole pairs are correct. |
| TR TOO LARGE | The calculated value of rotor time constant is too large. Check the value of nameplate rpm. |
| TR TOO SMALL | The calculated value of rotor time constant is too small. Check the value of nameplate rpm. |
| MAX RPM DATA ERR | This error is reported when the MAX SPEED RPM is set to a value outside the range for which Autotune has gathered data. Autotune gathers data on the motor characteristics up to 30% beyond "max speed rpm". If MAX SPEED RPM is later increased beyond this range, the drive had no data for this new operating area, and so will report an error. To run the motor beyond this point it is necessary to re-autotune with MAX SPEED RPM set to a higher value. |
| STACK TRIP | The drive was unable to distinguish between an overcurrent/Dsat or overvoltage trip |
| LEAKGE L TIMEOUT | The leakage inductance measurement requires a test current to be inserted into the motor. It has not been possible to achieve the required level of current. Check that the motor is wired correctly. |
| POWER LOSS STOP | Power Loss Stop sequence has ramped Speed Setpoint to zero or timed out |
| MOTR TURNING ERR | The motor must be stationary when starting the Autotune |
| MOTR STALLED ERR | The motor must be able to rotate during Autotune |
| INVERSE TIME | The inverse time current limit is active:<br>• motor loading is too great<br>• fixed or autoboost levels are too high |

**Table 6-1  Trip Messages**

## Automatic Trip Reset

Using the Keypad, the drive can be configured to automatically attempt to reset a trip when an attempt is made to start driving the motor, or after a preset time once the trip condition has occurred. The following function blocks (MMI menus) are used to enable automatic trip resets.

> Seq & Ref::Auto Restart (Auto-Reset)
> Seq & Ref::Sequencing Logic

## Setting Trip Conditions

The following function blocks (MMI menus) are used to set trip conditions:

> Trips::I/O Trips
> Trips::Trips Status

## Viewing Trip Conditions

The following function blocks (MMI menus) can be viewed to investigate trip conditions:

> Seq & Ref::Sequencing Logic
> Trips::Trips History
> Trips::Trips Status

# Checksum Fail

When the drive powers-up, non-volatile memory is checked to ensure that it has not been corrupted. In the rare event of corruption being detected, the drive will not function. This may occur when replacing the control board with an unprogrammed control board.

## Drive Indications

**DEFAULT**

The failure is indicated by the HEALTH and RUN LEDs showing SHORT FLASH, ⬭●.

Referring to Chapter 4: "Operating the Drive" - Reading the Status LEDs, you will note that this also indicates Re-configuration mode, but this mode (and hence the indication) is not available to the drive unless controlled by an MMI or Comms link.

Because you are controlling the drive locally (no MMI or Comms link etc.), the unit must be returned to SSD Drives for reprogramming, refer to Chapter 7: "Routine Maintenance and Repair". However, if you have access to an Keypad or suitable PC programming tool, the unit can be reset.

## Keypad Indications (when connected)

The MMI displays the message opposite.

Acknowledge the message by pressing the **E** key. This action automatically loads and saves Macro 1 default parameters and the ENGLISH 50Hz Product Code.

If your unit was using a different Product Code or macro, you must reload the Product Code of your choice, reload the macro of your choice, and perform a Parameter Save (SAVE/COMMAND menu) in that order.

```
   * CHECKSUM FAIL*
   DEFAULTS LOADED

HEALTH          LOCAL
   ○        SEQ ○   ○ REF
```

If data will not save correctly, the Keytpad will display a failure message. In this case, the drive has developed a fault and must be returned to SSD Drives. Refer to Chapter 7: "Routine Maintenance and Repair".
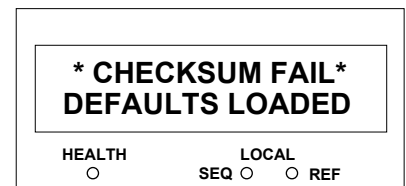
# Fault Finding

| Problem | Possible Cause | Remedy |
| --- | --- | --- |
| Drive will not power-up | Fuse blown | Check supply details, replace with correct fuse. |
| | | Check Product Code against Model No. |
| | Faulty cabling | Check all connections are correct and secure. |
| | | Check cable continuity |
| Drive fuse keeps blowing | Faulty cabling or connections wrong | Check for problem and rectify before replacing with correct fuse |
| | Faulty drive | Contact SSD Drives |
| Cannot obtain HEALTH state | Incorrect or no supply available | Check supply details |
| Motor will not run at switch-on | Motor jammed | Stop the drive and clear the jam |
| Motor runs and stops | Motor becomes jammed | Stop the drive and clear the jam |
| Motor won't rotate or runs in reverse | Encoder fault | Check encoder connections |
| | Open circuit speed reference potentiometer | Check terminal |

**Table 6-2  Fault Finding**

# ROUTINE MAINTENANCE AND REPAIR

## Routine Maintenance

Periodically inspect the drive for build-up of dust or obstructions that may affect ventilation of the unit. Remove this using dry air.

## Repair

There are no user-serviceable components.

**IMPORTANT:** MAKE NO ATTEMPT TO REPAIR THE UNIT - RETURN IT TO SSD DRIVES.

### Saving Your Application Data

In the event of a repair, application data will be saved whenever possible. However, we advise you to copy your application settings before returning the unit.

### Returning the Unit to SSD Drives

Please have the following information available:

- The model and serial number - see the unit's rating label
- Details of the fault

Contact your nearest SSD Drives Service Centre to arrange return of the item.

You will be given a *Returned Material Authorisation.* Use this as a reference on all paperwork you return with the faulty item. Pack and despatch the item in the original packing materials; or at least an anti-static enclosure. Do not allow packaging chips to enter the unit.

### Disposal

This product contains materials which are consignable waste under the Special Waste Regulations 1996 which complies with the EC Hazardous Waste Directive - Directive 91/689/EEC.

We recommend you dispose of the appropriate materials in accordance with the valid environmental control laws. The following table shows which materials can be recycled and which have to be disposed of in a special way.

| Material | Recycle | Disposal |
| --- | --- | --- |
| metal | yes | no |
| plastics material | yes | no |
| printed circuit board | no | yes |

The printed circuit board should be disposed of in one of two ways:

1. High temperature incineration (minimum temperature 1200°C) by an incinerator authorised under parts A or B of the Environmental Protection Act

2. Disposal in an engineered land fill site that is licensed to take aluminium electrolytic capacitors. Do not dispose of in a land fill site set aside for domestic waste.

### Packaging

During transport our products are protected by suitable packaging. This is entirely environmentally compatible and should be taken for central disposal as secondary raw material.

# TECHNICAL SPECIFICATIONS

## Understanding the Product Code

### Model Number (Europe)

The unit is fully identified using a twelve block alphanumeric code which records how the drive was calibrated, and its various settings when dispatched from the factory.

The Product Code appears as the "Model No.". Each block of the Product Code is identified as below:

Typical example:

**690PD/0110/400/0011/GR/0/PROF/BO/0/0**

This is a Frame D 690+, 11kW, rated at 400V supply, standard livery, IP20, with Keypad fitted displaying German language, no encoder feedback option, Profibus Option card fitted and braking option fitted.

| Frame B – Model Number (Europe) | | |
|---|---|---|
| **Block No.** | **Variable** | **Description** |
| 1 | 690PB | Generic product |
| 2 | XXXX | Four numbers specifying the power output:<br>0007 = 0.75kW    0015 = 1.5kW    0022 = 2.2kW    0040 = 4.0kW<br>0055 = 5.5kW    0075 = 7.5kW |
| 3 | XXX | 230    220 to 240V (±10%) 50/60Hz<br>400    380 to 460V (±10%) 50/60Hz<br>500    380 to 500V (±10%) 50/60Hz |
| 4 | X | One digit specifying the supply phases<br>1 = Single<br>3 = Three |
| 5 | X | One character specifying the use of the Internal RFI Filter:<br>F = Internal Supply Filter fitted<br>0 = Not fitted |
| 6 | XXXX | Four digits specifying mechanical package including livery and mechanical package style, and any keypad (see Note):<br><br>First two digits      Livery<br>            00      Standard SSD Drives livery<br>            05      Distributor livery<br>01-04,06-99      Defined customer liveries<br><br>Third digit      Mechanical packaging style<br>            1      Standard (IP20), protected panel mounting with gland plate<br>            2      IP20 and falling dirt protection (UL Type 1)<br><br>Fourth digit      Keypad<br>            0      No Keypad<br>            1      6901 Keypad fitted |

| **Frame B – Model Number (Europe)** | | |
|---|---|---|
| **Block No.** | **Variable** | **Description** |
| 7 | XX | Two Characters specifying the user interface language including operating frequency. These characters are the same as used for computer keyboard specifications:<br><br>FR     French (50Hz)<br>GR    German (50Hz)<br>IT     Italian (50Hz)<br>PL    Polish (50Hz)<br>PO    Portuguese (50Hz)<br>SP    Spanish (50Hz)<br>SW   Swedish (50Hz)<br>UK   English (50Hz)<br>US   English (60Hz) |
| 8 | X | Characters specifying any feedback option installed over and above the standard features of the product.<br><br>0     No option fitted<br>HTTL  605B encoder card fitted behind the Keypad/Tech Box Option site |
| 9 | X | Characters specifying the communications option (see Note):<br><br>0     No technology option fitted<br>EI00  RS485 Comms option<br>PROF  Profibus protocol<br>LINK  LINK protocol<br>DNET  DeviceNet |
| 10 | X | Characters specifying the comms board fitted internally.<br><br>0     Not fitted |
| 11 | X | Characters specifying the system board fitted internally.<br>0     Not fitted<br>SHTTL  Fitted – Dual Encoder Option |
| 12 | X | Digits specifying engineering special options.<br>0     No special option |
| *Note:* *The Keypad and the Comms Technology Box occupy the same physical position in the product and are therefore mutually exclusive.* | | |

| **Frame C, D, E, F – Model Number (Europe)** | | |
|---|---|---|
| **Block No.** | **Variable** | **Description** |
| 1 | 690PC<br>690PD<br>690PE<br>690PF | Characters specifying the generic product:<br><br>690PC =    690PD =    690PE =    690PF =<br>Frame C    Frame D    Frame E    Frame F |
| 2 | XXXX | Four numbers specifying the power output:<br><br>Frame C     Frame D     Frame E     Frame F<br><br>0055 = 5.5kW  0110 = 11kW  0220 = 22kW  0300 = 30kW<br>0075 = 7.5kW  0150 = 15kW  0300 = 30kW  0370 = 37kW<br>0110 = 11kW  0180 = 18.5kW 0370 = 37kW  0450 = 45kW<br>0150 = 15kW  0220 = 22kW  0450 = 45kW  0550 = 55kW<br>           0300 = 30kW           0750 = 75kW<br>                                    0900 = 90kW<br>                                      0910 = 90kW<br>                                        (150Hp) |
| 3 | XXX | Three numbers specifying the nominal input voltage rating:<br><br>230    220 to 240V (±10%) 50/60Hz<br>400    380 to 460V (±10%) 50/60Hz<br>500    380 to 500V (±10%) 50/60Hz |

| Frame C, D, E, F – Model Number (Europe) | | |
|---|---|---|
| Block No. | Variable | Description |
| 4 | XXXX | Four digits specifying the mechanical package including livery and mechanical package style: <br><br>First two digits     Livery <br>     00      Standard SSD Drives livery <br>     05      Distributor livery <br>     (01-04, 06-99 - Defined customer liveries ) <br><br>Third digit      Mechanical packaging style <br>     1      Standard (IP20), protected panel mounting with gland plate <br>     2      IP20 and falling dirt protection (UL Type 1) <br>     3      Enclosed (IP20), with through-panel mounting kit <br><br>Fourth digit      Keypad <br>     0      No Keypad <br>     1      6901 Keypad option fitted |
| 5 | XX | Two characters specifying the user interface language including operating frequency. These characters are the same as used for computer keyboard specifications: <br><br>     FR      French (50Hz) <br>     GR      German (50Hz) <br>     IT      Italian (50Hz) <br>     PL      Polish (50Hz) <br>     PO      Portuguese (50Hz) <br>     SP      Spanish (50Hz) <br>     SW      Swedish (50Hz) <br>     UK      English (50Hz) <br>     US      English (60Hz) |
| 6 | X | Characters specifying the speed feedback option (Technology Box 1) installed over and above the standard features of the product: <br><br>     0      No additional option fitted <br>     HTTL      Wire ended encoder feedback HTTL |
| 7 | X | Characters specifying the communications option (Technology Box 2): <br><br>     0      No technology option fitted <br>     EI00      RS485 Comms option <br>     PROF      Profibus protocol <br>     LINK      LINK protocol <br>     DNET      DeviceNet |
| 8 | X | Characters specifying the Comms board fitted internally: <br><br>     0      Not fitted |
| 9 | X | Characters specifying the system board fitted internally: <br><br>     0      Not fitted <br>     SHTTL      Fitted – Dual Encoder Option |
| 10 | X | Characters specifying the braking option: <br><br>     0      Brake power switch not fitted (Frames D, E & F only) <br>     BO      Brake power switch fitted - no braking resistors supplied <br>Note: External braking resistors should be specified and ordered separately. |
| 11 | X | Characters specifying the auxiliary mains power supply. <br><br>     0      No auxiliary supply required (Frame C – E) <br>     115      110 to 120V (±10%), 50/60Hz (Frame F) <br>     230      220 to 240V (±10%), 50/60Hz (Frame F) |
| 12 | X | Digits specifying engineering special options: <br><br>     0      No special option |

## Catalog Number (North America)

The unit is identified using a 6 block alphanumeric code which records how the drive was calibrated, and its various settings when dispatched from the factory.

The Product Code appears as the "Cat No.". Each block of the Product Code is identified as below:

Typical example:

**690+/0010/460/1BN**

This is a 10Hp 690+ Frame C, rated at 460 Volts supply, NEMA 1, Braking option fitted, No System board.

| Frame B, C, D, E, F – Catalog Number (North America) | | |
|---|---|---|
| Block No. | Variable | Description |
| 1 | 690+ | Generic product |
| 2 | X | Characters specifying the power output in Hp:<br><br>Frame B       Frame D       Frame F<br><br>0001 = 1Hp    0020 = 20Hp    0075 = 75Hp<br>0002 = 2Hp    0025 = 25Hp    0100 = 100Hp<br>0003 = 3Hp    0030 = 30Hp    0125 = 125Hp<br>0005 = 5Hp    0040D = 40Hp    0150 = 150Hp<br>0007B = 7.5Hp<br>0010B = 10Hp    Frame E<br><br>Frame C    0040 = 40Hp<br>       0050 = 50Hp<br>0007 = 7.5Hp    0060 = 60Hp<br>0010 = 10Hp<br>0015 = 15Hp<br>0020C = 20Hp |
| 3 | XXX | Three numbers specifying the nominal input voltage rating:<br><br>    230    230 (±10%) 50/60Hz<br>    460    380 to 460V (±10%) 50/60Hz |
| 4 | XXX | Enclosure options:<br><br>    1 - Nema 1 (IP20 and falling dirt protection (UL Type 1)<br>    C - Chassis (IP20 only) |
| 5 | XX | Characters specifying the braking option:<br><br>    N  Brake power switch not fitted (Frames D & E only)<br>    B  Brake power switch fitted - no braking resistors supplied<br>Note: External braking resistors should be specified and ordered separately. |
| 6 | XX | Characters specifying the systems board:<br><br>    N  Not fitted<br>    S  System board fitted |

## Environmental Details

| Operating Temperature | Operating temperature is defined as the ambient temperature to the immediate surround of the drive, when the drive and other equipment adjacent to it is operating at worst case conditions. |
|---|---|
| CONSTANT QUADRATIC | 0°C to 45°C (0°C to 40°C with top cover fitted), derate up to a maximum of 50°C<br>0°C to 40°C (0°C to 35°C with top cover fitted), derate up to a maximum of 50°C<br><br>Output power is derated linearly at 2% per degree centigrade for temperature exceeding the maximum rating ambient for the drive. |
| Storage Temperature | -25°C to +55°C |
| Shipping Temperature | -25°C to +70 °C |
| Product Enclosure Rating | Wall Mounted (top cover must be fitted) — IP40 - top cover surface (Europe) / IP20 - remainder of surfaces (Europe) / UL (c-UL) Type 1 (North America/Canada)<br>Cubicle Mounted (without top cover fitted) — IP20 / UL (c-UL) Open Type (North America/Canada)<br>Through-panel Mounted (without top cover fitted) — IP20 / UL (c-UL) Open Type (North America/Canada) |
| Altitude | If greater than 1000m above sea level, derate by 1% per 100m to a maximum of 5000m |
| Humidity | Maximum 85% relative humidity at 40°C non-condensing |
| Atmosphere | Non flammable, non corrosive and dust free |
| Climatic Conditions | Class 3k3, as defined by EN50178 (1998) |
| Vibration | Test Fc of EN60068-2-6<br>10Hz<=f<=57Hz sinusoidal 0.075mm amplitude<br>57Hz<=f<=150Hz sinusoidal 1g<br>10 sweep cycles per axis on each of three mutually perpendicular axis |
| Safety | |
| Overvoltage Category | Overvoltage Category III (numeral defining an impulse withstand level) |
| Pollution Degree | Pollution Degree II (non-conductive pollution, except for temporary condensation)<br>Pollution Degree III (dirty air rating for through-panel mounted parts) |
| Europe | When fitted inside a cubicle, or when wall-mounted and the top cover is firmly screwed in position, this product conforms with the Low Voltage Directive 73/23/EEC with amendment 93/68/EEC, Article 13 and Annex III using EN50178 (1998) to show compliance. |
| North America/Canada | Without the top cover fitted, complies with the requirements of UL508C as an open-type drive. When the top cover is fitted, complies with the requirements of UL508C as Type 1 Enclosed (for direct wall mounting applications) when specified with Model Number Block 6 (Frame B) or Modle Number Block 4 (Frame C, D, E, F) designation xx20 or xx21 only. |

## Earthing/Safety Details

| Earthing | Permanent earthing is mandatory on all units.<br><br>• Use a copper protective earth conductor 10mm² minimum cross-section, or install a second conductor in parallel with the protective conductor to a separate protective earth terminal<br>• The conductor itself must meet local requirements for a protective earth conductor |
|---|---|
| Input Supply Details (TN) and (IT) | Drives without filters are suitable for earth (TN) or non-earth referenced (IT) supplies.<br>The drive is only suitable for earth referenced supplies (TN) when fitted with an internal filter.<br>External filters are available for use on TN and IT (non-earth referenced) supplies. |
| Prospective Short Circuit Current (PSCC) | Refer to the appropriate Electircal Ratings table. |
| Earth Leakage Current | >10mA (all models) |

## Cabling Requirements for EMC Compliance

| | Power Supply Cable | Motor Cable | External AC Supply EMC Filter to Drive Cable | Brake Resistor Cable | Signal/Control Cable |
|---|---|---|---|---|---|
| Cable Type (for EMC Compliance) | Unscreened | Screened/armoured | Screened/armoured | Screened/armoured | Screened |
| Segregation | From all other wiring (clean) | From all other wiring (noisy) | | | From all other wiring (sensitive) |
| Length Limitations With Internal AC Supply EMC Filter (Frame B) | Unlimited | 0.25 - 4.0kW = 50m* <br> 5.5 - 6.0kW = 25m | | 25 metres | 25 metres |
| Length Limitations With External AC Supply EMC Filter | Unlimited | 50 metres | 0.3 metres | 25 metres | 25 metres |
| Screen to Earth Connection | | Both ends | Both ends | Both ends | Drive end only |
| Output Choke | | 300 metres maximum | | | |

\* Maximum motor cable length under any circumstances

## Cooling Fans

The forced-vent cooling of the drive is achieved by 1, or in some cases 2 fans. The Fan Rating gives the volume of air venting from the drive. All except the Frame F fans are internally-supplied 24V fans.

| Drive Product Code | Drive Catalog Code | Fan Ratings |
|---|---|---|
| **FRAME B** | | |
| 690PB/0007/.., 690PB/0015/.., 690PB/0022/.. & 690PB/0040/.. | 690+/0001/.., 690+/0002/.., 690+/0003/.. & 690+/0005/.. | 24cfm (41 m³/hr) |
| 690PB/0055/.. & 690PB/0060/.. | 690+/0007/.. & 690+/0010/.. | 30cfm (51 m³/hr) |
| **FRAME C** | | |
| 690PC/0055/.. | 690+/0055/.. | 42.5cfm (72 m³/hr) |
| 690PC/0075/.. | 690+/0010/.. | 25cfm (42.5 m³/hr) |
| 690PC/0110/.. & 690PC/0150/.. | 690+/0015/.. & 690+/0020C/.. | 35cfm (59.5 m³/hr) |
| **FRAME D** | | |
| 690PD/0150, 690PD/0180 & 690PD/0220 | 690+/0020/.., 690+/0025/.. & 690+/0030/.. | 55cfm (93.4 m³/hr) |
| 690PD/0300 | 690+/0040/.. | 81cfm (138 m³/hr) |
| **FRAME E** | | |
| All models | All models | 160cfm (272 m³/hr) |
| **FRAME F** <br> One single phase fan is provided, supplied from an auxiliary input. There are two voltage variants, either 115V ac or 220Vac. The fan is powered from a single phase supply which uses a capacitor to generate the quadrature phase. Protect the fan using a 3A fuse. <br><br> 110/120V : 130W, 10µF, Stator - 16Ω <br> 220/240V : 140W, 2.5µF, Stator - 62Ω | | |
| All models | All models | 270cfm (459 m³/hr) |

## Electrical Ratings (230V Build Variant)

**Power Supply = 220-240V ±10%, 50/60Hz ±5%**

Motor power, output current and input current must not be exceeded under steady state operating conditions.

**Operation at 208V ±10% (Frames C, D, E & F)**

Nominal motor powers are reduced by 10% when operated at 208V ±10%. Output currents remain unchanged.

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME B :** Input currents for kW ratings are at 230V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit rating 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PB/0007/230/1/.. | | 0.75kW | 4.0 | 11 | | 80 | 3, 6, 9 | 425 |
| | 690+0001/230../1 | 1Hp | 4.0 | 11 | | 80 | 3, 6, 9 | 425 |
| 690PB/0015/230/1/.. | | 1.5kW | 7.0 | 19 | | 120 | 3, 6, 9 | 425 |
| | 690+0002/230../1 | 2Hp | 7.0 | 19 | | 120 | 3, 6, 9 | 425 |
| 690PB/0022/230/1/.. | | 2.2kW | 10.5 | 24 | | 170 | 3, 6, 9 | 425 |
| | 690+0003/230../1 | 3Hp | 10.5 | 24 | | 170 | 3, 6, 9 | 425 |
| 690PB/0007/230/3/.. | | 0.75kW | 4.0 | 6 | | 70 | 3, 6, 9 | 425 |
| | 690+0001/230.. | 1Hp | 4.0 | 6 | | 70 | 3, 6, 9 | 425 |
| 690PB/0015/230/3/.. | | 1.5kW | 7.0 | 10 | | 100 | 3, 6, 9 | 425 |
| | 690+0002/230.. | 2Hp | 7.0 | 10 | | 100 | 3, 6, 9 | 425 |
| 690PB/0022/230/3/.. | | 2.2kW | 10.5 | 13 | | 150 | 3, 6, 9 | 425 |
| | 690+0003/230.. | 3Hp | 10.5 | 13 | | 150 | 3, 6, 9 | 425 |
| 690PB/0040/230/3/.. | | 4kW | 16.5 | 20 | | 200 | 3 | 425 |
| 690PB/0040/230/3/.. | | 4kW | 14.5 | 20 | | 200 | 6 | 425 |
| 690PB/0040/230/3/.. | | 4kW | 13.0 | 20 | | 200 | 9 | 425 |
| | 690+0005/230.. | 5Hp | 16.5 | 20 | | 200 | 3 | 425 |
| | 690+0005/230.. | 5Hp | 14.5 | 20 | | 200 | 6 | 425 |
| | 690+0005/230.. | 5Hp | 13.0 | 20 | | 200 | 9 | 425 |
| **FRAME C :** Input currents for kW ratings are at 230V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit rating 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PC/0055/230/3/.. | | 5.5kW | 22 | 25 | 270 | 330 | 3 | 4000 |
| | 690+0007/230.. | 7.5Hp | 22 | 25 | 270 | 330 | 3 | 4000 |
| 690PC/0075/230/3/.. | | 7.5kW | 28 | 33 | 290 | 350 | 3 | 6000 |
| | 690+0010/230.. | 10Hp | 28 | 33 | 290 | 350 | 3 | 6000 |
| **Quadratic** (Output Overload Motoring 110% for 60s, 130% for 0.5s short term rating) | | | | | | | | |
| 690PC/0055/230/3/.. | | 7.5kW | 28 | 31 | 330 | 390 | 3 | 4000 |
| | 690+0007/230.. | 10Hp | 28 | 31 | 330 | 390 | 3 | 4000 |
| 690PC/0075/230/3/.. | | 11kW | 42 | 49.3 | 500 | 560 | 3 | 6000 |
| | 690+0010/230.. | 15Hp | 42 | 49.3 | 500 | 560 | 3 | 6000 |

# Electrical Ratings (230V Build Variant)

**Power Supply =  220-240V ±10%, 50/60Hz ±5%**

Motor power, output current and input current must not be exceeded under steady state operating conditions.

**Operation at 208V ±10% (Frames C, D, E & F)**

Nominal motor powers are reduced by 10% when operated at 208V ±10%. Output currents remain unchanged.

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME D :** Input currents for kW ratings are at 230V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit rating 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PD/0110/230/3/.. | | 11kW | 42 | 45 | 570 | 640 | 3 | 6000 |
| | 690+0015/230.. | 15Hp | 42 | 45 | 570 | 640 | 3 | 6000 |
| 690PD/0150/230/3/.. | | 15kW | 54 | 53 | 670 | 740 | 3 | 6000 |
| | 690+0020/230.. | 20Hp | 54 | 53 | 670 | 740 | 3 | 6000 |
| 690PD/0180/230/3/.. | | 18.5kW | 68 | 65 | 850 | 920 | 3 | 6000 |
| | 690+0025/230.. | 25Hp | 68 | 65 | 850 | 920 | 3 | 6000 |
| **Quadratic** (Output Overload Motoring 110% for 60s, 130% for 0.5s short term rating) | | | | | | | | |
| 690PD/0110/230/3/.. | | 15kW | 54 | 54 | 750 | 820 | 3 | 6000 |
| | 690+0015/230.. | 20Hp | 54 | 54 | 750 | 820 | 3 | 6000 |
| 690PD/0150/230/3/.. | | 18.5kW | 68 | 65 | 850 | 920 | 3 | 6000 |
| | 690+0020/230.. | 25Hp | 68 | 65 | 850 | 920 | 3 | 6000 |
| **FRAME E :** Input currents for kW ratings are at 230V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 18kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PE/0220/230/3/.. | | 22kW | 80 | 91 | 800 | 920 | 3 | 18000 |
| | 690+0030/230.. | 30Hp | 80 | 91 | 800 | 920 | 3 | 18000 |
| **Quadratic** (Output Overload Motoring 110% for 60s, 130% for 0.5s short term rating) | | | | | | | | |
| 690PE/0220/230/3/.. | | 30kW | 104 | 116 | 1050 | 1200 | 3 | 18000 |
| | 690+0030/230.. | 40Hp | 104 | 116 | 1050 | 1200 | 3 | 18000 |
| **FRAME F :** Input currents for kW ratings are at 230V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 18kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PF/0300/230/3/.. | | 30kW | 104 | 102 | 850 | 1100 | 3 | 100000 |
| | 690+0040/230.. | 40Hp | 104 | 102 | 850 | 1100 | 3 | 100000 |
| 690PF/0370/230/3/.. | | 37kW | 130 | 126 | 1100 | 1450 | 3 | 100000 |
| | 690+0050/230.. | 50Hp | 130 | 126 | 1100 | 1450 | 3 | 100000 |
| 690PF/0450/230/3/.. | | 45kW | 154 | 148 | 1200 | 1650 | 3 | 100000 |
| | 690+0060/230.. | 60Hp | 154 | 148 | 1200 | 1650 | 3 | 100000 |
| **Quadratic** (Output Overload Motoring 110% for 60s, 125% for 0.5s short term rating) | | | | | | | | |
| 690PF/0300/230/3/.. | | 37kW | 130 | 126 | 1150 | 1500 | 3 | 100000 |
| | 690+0040/230.. | 50Hp | 130 | 126 | 1150 | 1500 | 3 | 100000 |
| 690PF/0370/230/3/.. | | 45kW | 154 | 148 | 1350 | 1800 | 3 | 100000 |
| | 690+0050/230.. | 60Hp | 154 | 148 | 1350 | 1800 | 3 | 100000 |
| 690PF/0450/230/3/.. | | 55kW | 192 | 184 | 1600 | 2100 | 3 | 100000 |
| | 690+0060/230.. | 75Hp | 192 | 184 | 1600 | 2100 | 3 | 100000 |

# Electrical Ratings (400V Build Variant)

**Power Supply = 380-460V ±10%, 50/60Hz ±5%**

Motor power, output current and input current must not be exceeded under steady state operating conditions.

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME B :** Input currents for kW ratings are at 400V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 1s short term rating) | | | | | | | | |
| 690PB/0007/400/3/.. | | 0.75kW | 2.5 | 3.7 | | 70 | 3, 6, 9 | 340 |
| | 690+0001/460/.. | 1Hp | 2.5 | 2.9 | | 65 | 3, 6, 9 | 340 |
| 690PB/0015/400/3/.. | | 1.5kW | 4.5 | 6 | | 100 | 3, 6, 9 | 340 |
| | 690+0002/460/.. | 2Hp | 4.5 | 5 | | 95 | 3, 6, 9 | 340 |
| 690PB/0022/400/3/.. | | 2.2kW | 5.5 | 8 | | 130 | 3, 6, 9 | 340 |
| | 690+0003/460/.. | 3Hp | 5.5 | 6.6 | | 120 | 3, 6, 9 | 340 |
| 690PB/0040/400/3/.. | | 4kW | 9.5 | 12.6 | | 200 | 3 | 340 |
| 690PB/0040/400/3/.. | | 4kW | 8.5 | 12.6 | | 200 | 6 | 340 |
| 690PB/0040/400/3/.. | | 4kW | 7.5 | 12.6 | | 200 | 9 | 340 |
| | 690+0005/460/.. | 5Hp | 9.5 | 10.2 | | 190 | 3 | 340 |
| | 690+0005/460/.. | 5Hp | 8.5 | 10.2 | | 190 | 6 | 340 |
| | 690+0005/460/.. | 5Hp | 7.5 | 10.2 | | 190 | 9 | 340 |
| 690PB/0055/400/3/.. | | 5.5kW | 12 | 18 | | 220 | 3 | 1150 |
| | 690+0007/460/.. | 7.5Hp | 11 | 15 | | 200 | 3 | 1150 |
| 690PB/0060/400/3/.. | | 6.0kW | 14 | 19 | | 260 | 3 | 1150 |
| | 690+0010/460/.. | 10Hp | 14 | 19 | | 250 | 3 | 1150 |
| **FRAME C :** Input currents for kW ratings are at 400V 50Hz ac input, and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 10kA.<br>* For UL Listed products rated at 15kW/20Hp, a supply voltage of 460V is required. The higher current ratings are applicable to non UL applications only. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180 % for 0.5s short term rating) | | | | | | | | |
| 690PC/0055/400/.. | | 5.5kW | 12 | 14.7 | 170 | 220 | 3, 6 | 1250 |
| | 690+0007/460/.. | 7.5Hp | 12 | 12.4 | 155 | 205 | 3, 6 | 1250 |
| 690PC/0075/400/.. | | 7.5kW | 16 | 19 | 240 | 290 | 3, 6 | 4000 |
| | 690+0010/460/.. | 10Hp | 14 | 16 | 225 | 275 | 3, 6 | 4000 |
| 690PC/0110/400/.. | | 11kW | 23 | 26.1 | 280 | 330 | 3, 6 | 4000 |
| | 690+0015/460/.. | 15Hp | 21 | 22.1 | 260 | 310 | 3, 6 | 4000 |
| 690PC/0150/400/.. | | 15kW | 30 | 37 | 440 | 500 | 3 | 6000 |
| | 690+0020/460/.. | 20Hp | 27 | 31.2 | 410 | 470 | 3 | 6000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PC/0055/400/.. | | 7.5kW | 16 | 18.9 | 260 | 310 | 3 | 1250 |
| | 690+0007/460/.. | 10Hp | 16 | 15.6 | 245 | 295 | 3 | 1250 |
| 690PC/0075/400/.. | | 11kW | 23 | 26.1 | 300 | 350 | 3 | 4000 |
| | 690+0010/460/.. | 15Hp | 21 | 22.1 | 280 | 320 | 3 | 4000 |
| 690PC/0110/400/.. | | 15kW | 30 | 33.6 | 440 | 500 | 3 | 4000 |
| | * 690+0015/460/.. | 20Hp | 27 | 28.5 | 410 | 470 | 3 | 4000 |
| 690PC/0150/400/.. | | 18.5kW | 37 | 44 | 550 | 610 | 3 | 6000 |
| | 690+0020/460/.. | 25Hp | 34 | 38 | 530 | 580 | 3 | 6000 |

## Electrical Ratings (400V Build Variant)

**Power Supply = 380-460V ±10%, 50/60Hz ±5%**

Motor power, output current and input current must not be exceeded under steady state operating conditions.

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME D :** Input currents for kW ratings are at 400V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 10kA. <br> * For UL Listed products rated at 30kW/40Hp, a supply voltage of 460V is required. The higher current ratings are applicable to non UL applications only. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PD/0150/400/.. | | 15kW | 31 | 34.8 | 420 | 480 | 3, 6 | 4000 |
| | 690+0020/460/.. | 20Hp | 31 | 28.5 | 400 | 460 | 3, 6 | 4000 |
| 690PD/0180/400/.. | | 18.5kW | 38 | 40.5 | 545 | 605 | 3, 6 | 6000 |
| | 690+0025/460/.. | 25Hp | 38 | 34.2 | 515 | 575 | 3, 6 | 6000 |
| 690PD/0220/400/.. | | 22kW | 45 | 47.2 | 670 | 730 | 3, 6 | 6000 |
| | 690+0030/460/.. | 30Hp | 45 | 40 | 640 | 700 | 3, 6 | 6000 |
| 690PD/0300/400/.. | | 30kW | 59 | 66 | 760 | 860 | 3 | 15000 |
| | 690+0040/460/.. | 40Hp | 52 | 56 | 740 | 830 | 3 | 15000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PD/0150/400/.. | | 18.5kW | 38 | 40.5 | 545 | 605 | 3 | 4000 |
| | 690+0020/460/.. | 25Hp | 38 | 34.2 | 515 | 575 | 3 | 4000 |
| 690PD/0180/400/.. | | 22kW | 45 | 47.2 | 670 | 730 | 3 | 6000 |
| | 690+0025/460/.. | 30Hp | 45 | 40 | 640 | 700 | 3 | 6000 |
| 690PD/0220/400/.. | | 30kW | 59 | 61 | 760 | 860 | 3 | 6000 |
| | * 690+0030/460/.. | 40Hp | 52 | 51 | 740 | 830 | 3 | 6000 |
| 690PD/0300/400/.. | | 37kW | 73 | 84 | 920 | 1030 | 3 | 15000 |
| | 690+0040/460/.. | 50Hp | 65 | 68 | 890 | 980 | 3 | 15000 |
| **FRAME E :** Input currents for kW ratings are at 400V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 18kA. <br> * For UL Listed products rated at 30kW/40Hp, a supply voltage of 460V is required. The higher current ratings are applicable to non UL applications only. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PE/0300/400/.. | | 30kW | 59 | 68 | 590 | 690 | 3, 6 | 15000 |
| | 690+0040/460/.. | 40Hp | 59 | 57 | 590 | 690 | 3, 6 | 15000 |
| 690PE/0370/400/.. | | 37kW | 73 | 81 | 730 | 850 | 3, 6 | 18000 |
| | 690+0050/460/.. | 50Hp | 73 | 68 | 730 | 850 | 3, 6 | 18000 |
| 690PE/0450/400/.. | | 45kW | 87 | 95 | 880 | 880 | 3, 6 | 18000 |
| | 690+0060/460/.. | 60Hp | 87 | 80 | 880 | 880 | 3, 6 | 18000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PE/0300/400/.. | | 37kW | 73 | 81 | 733 | 848 | 3 | 15000 |
| | 690+0040/460/.. | 50Hp | 73 | 68 | 733 | 848 | 3 | 15000 |
| 690PE/0370/400/.. | | 45kW | 87 | 95 | 901 | 1029 | 3 | 18000 |
| | 690+0050/460/.. | 60Hp | 87 | 80 | 901 | 1029 | 3 | 18000 |
| 690PE/0450/400/.. | | 55kW | 105 | 110 | 1094 | 1242 | 3 | 18000 |
| | 690+0060/460/.. | 75Hp | 105 | 95 | 1094 | 1242 | 3 | 18000 |

## Electrical Ratings (400V Build Variant)

**Power Supply = 380-460V ±10%, 50/60Hz ±5%**

Motor power, output current and input current must not be exceeded under steady state operating conditions.

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME F :** Input currents for kW ratings are at 400V 50Hz ac input and for Hp ratings at 460V 60Hz ac input. Prospective short circuit current 18kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PF/0550/400/.. |  | 55kW | 105 | 114 | 920 | 1220 | 3 | 100,000 |
|  | 690+0075/460/.. | 75Hp | 100 | 99 | 900 | 1130 | 3 | 100,000 |
| 690PF/0750/400/.. |  | 75kW | 145 | 143 | 1320 | 1670 | 3 | 100,000 |
|  | 690+0100/460/.. | 100Hp | 130 | 124 | 1200 | 1500 | 3 | 100,000 |
| 690PF/0900/400/.. |  | 90kW | 180 | 164 | 1490 | 1950 | 3 | 100,000 |
|  | 690+0125/460/.. | 125Hp | 156 | 148 | 1340 | 1780 | 3 | 100,000 |
| 690PF/0910/400/.. |  | 90kW | 180 | 164 | 1490 | 1950 | 3 | 100,000 |
|  | 690+0150/460/.. | 150Hp | 180 | 169 | 1670 | 2180 | 3 | 100,000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PF/0550/400/.. |  | 75kW | 145 | 143 | 1400 | 1670 | 3 | 100,000 |
|  | 690+0075/460/.. | 100Hp | 125 | 124 | 1200 | 1500 | 3 | 100,000 |
| 690PF/0750/400/.. |  | 90kW | 165 | 164 | 1580 | 1950 | 3 | 100,000 |
|  | 690+0100/460/.. | 125Hp | 156 | 148 | 1340 | 1780 | 3 | 100,000 |
| 690PF/0900/400/.. |  | 110kW | 205 | 195 | 1800 | 1950 | 3 | 100,000 |
|  | 690+0125/460/.. | 150Hp | 180 | 169 | 1670 | 2180 | 3 | 100,000 |
| 690PF/0910/400/.. |  | 110kW | 205 | 195 | 1800 | 1950 | 3 | 100,000 |
|  | 690+0150/460/.. | 150Hp | 180 | 169 | 1670 | 2180 | 3 | 100,000 |

## Electrical Ratings (500V Build Variant)

**Power Supply = 380-500V ±10%, 50/60Hz ±5%**

500V unit full power ratings are only available at 500V. The unit can be operated between 380-500V supply voltage with reduced output power below 500V.

Motor power, output current and input current must not be exceeded under steady state operating conditions.

*Note:* *The improved ratings offered by software versions 5.4 onwards are made possible by internal hardware changes to the drive. The ratings are not achievable on older drives running software versions 5.4 onwards.*

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME B :**  Input currents for kW ratings are at 500V 50Hz ac input. Prospective short circuit current 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 1s short term rating) | | | | | | | | |
| 690PB/0022/500/3/.. | | 2.2kW | 5 | 6.5 | | 110 | 3 | 1150 |
| 690PB/0040/500/3/.. | | 4kW | 8 | 10.4 | | 165 | 3 | 1150 |
| 690PB/0055/500/3/.. | | 5.5kW | 11 | 15.3 | | 200 | 3 | 1150 |
| **FRAME C :**  Input currents for kW ratings are at 500V 50Hz ac input. Prospective short circuit current 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PC/0055/500/.. | | 5.5kW | 11 | 14 | 155 | 275 | 3, 6 | 1250 |
| 690PC/0075/500/.. | | 7.5kW | 14 | 22 | 225 | 310 | 3, 6 | 4000 |
| 690PC/0110/500/.. | | 11kW | 21 | 26 | 260 | 470 | 3, 6 | 4000 |
| 690PC/0150/500/.. | | 15kW | 27 | 29.7 | 410 | 605 | 3 | 6000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PC/0055/500/.. | | 7.5kW | 14 | 20 | 225 | 300 | 3 | 1250 |
| 690PC/0075/500/.. | | 11kW | 21 | 26 | 260 | 350 | 3 | 4000 |
| 690PC/0110/500/.. | | 15kW | 27 | 32 | 410 | 310 | 3 | 4000 |
| 690PC/0150/500/.. | | 18.5kW | 34 | 36 | 545 | 470 | 3 | 6000 |
| **FRAME D :**  Input currents for kW ratings at 500V 50Hz ac input. Prospective short circuit current 10kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PD/0150/500/.. | | 15kW | 28 | 27 | 420 | 480 | 3, 6 | 4000 |
| 690PD/0180/500/.. | | 18.5kW | 36 | 33 | 545 | 605 | 3, 6 | 6000 |
| 690PD/0220/500/.. | | 22kW | 42 | 39 | 670 | 730 | 3, 6 | 6000 |
| 690PD/0300/500/.. | | 30kW | 52 | 54 | 740 | 830 | 3 | 15000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PD/0150/500/.. | | 18.5kW | 36 | 33 | 420 | 480 | 3, 6 | 4000 |
| 690PD/0180/500/.. | | 22kW | 42 | 39 | 545 | 605 | 3, 6 | 6000 |
| 690PD/0220/500/.. | | 30kW | 52 | 50 | 670 | 730 | 3, 6 | 6000 |
| 690PD/0300/500/.. | | 37kW | 65 | 68 | 890 | 980 | 3 | 15000 |

# Electrical Ratings (500V Build Variant)

**Power Supply = 380-500V ±10%, 50/60Hz ±5%**

500V unit full power ratings are only available at 500V. The unit can be operated between 380-500V supply voltage with reduced output power below 500V.

Motor power, output current and input current must not be exceeded under steady state operating conditions.

*Note:* *The improved ratings offered by software versions 5.4 onwards are made possible by internal hardware changes to the drive. The ratings are not achievable on older drives running software versions 5.4 onwards.*

| Model Number (Europe) | Catalog Number (North America) | Motor Power | Output Current (A) | Input Current (A) | Heatsink Power Loss (W) | Total Power Loss (W) | Maximum Switching Frequency (kHz) | Input Bridge I²t (A²s) |
|---|---|---|---|---|---|---|---|---|
| **FRAME E :** Input currents for kW ratings at 500V 50Hz ac input. Prospective short circuit current 18kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PE/0300/500/.. | | 30kW | 54 | 55 | 647 | 749 | 3, 6 | 15000 |
| 690PE/0370/500/.. | | 37kW | 67 | 69 | 799 | 911 | 3, 6 | 18000 |
| 690PE/0450/500/.. | | 45kW | 79 | 82 | 957 | 1083 | 3, 6 | 18000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PE/0300/500/.. | | 37kW | 67 | 67 | 623 | 738 | 3 | 15000 |
| 690PE/0370/500/.. | | 45kW | 79 | 82 | 766 | 894 | 3 | 18000 |
| 690PE/0450/500/.. | | 55kW | 98 | 98 | 930 | 1078 | 3 | 18000 |
| **FRAME F :** Input currents for kW ratings at 500V 50Hz ac input. Prospective short circuit current 18kA. | | | | | | | | |
| **Constant** (Output Overload Motoring 150% for 60s, 180% for 0.5s short term rating) | | | | | | | | |
| 690PF/0550/500/.. | | 55kW | 100 | 93 | 900 | 1130 | 3 | 100,000 |
| 690PF/0750/500/.. | | 75kW | 125 | 118 | 1200 | 1500 | 3 | 100,000 |
| 690PF/0900/500/.. | | 90kW | 156 | 140 | 1340 | 1780 | 3 | 100,000 |
| **Quadratic** (Output Overload Motoring 110% for 60s) | | | | | | | | |
| 690PF/0550/500/.. | | 75kW | 125 | 118 | 1200 | 1500 | 3 | 100,000 |
| 690PF/0750/500/.. | | 90kW | 156 | 140 | 1340 | 1780 | 3 | 100,000 |
| 690PF/0090/500/.. | | 110kW | 180 | 166 | 1670 | 2180 | 3 | 100,000 |

## Input Fuse Ratings (Europe)

Refer to Chapter 9 for North American fuse ratings.

| Product Code | Input Fuse Rating (A) | | Product Code | Input Fuse Rating (A) | |
|---|---|---|---|---|---|
| Model Number | Constant | Quadratic | Model Number | Constant | Quadratic |
| **230V BUILD VARIANT** 220-240V ±10%, 45-65Hz * | | | | | |
| **Frame B** | | | **Frame C** | | |
| 690PB/0007/230/1/.. | 12 | - | 690PC/0055/230/3/.. | 25 | 32 |
| 690PB/0015/230/1/.. | 20 | - | 690PC/0075/230/3/.. | 40 | 50 |
| 690PB/0022/230/1/.. | 25 | - | | | |
| 690PB/0007/230/3/.. | 10 | - | | | |
| 690PB/0015/230/3/.. | 12 | - | | | |
| 690PB/0022/230/3/.. | 16 | - | | | |
| 690PB/0040/230/3/.. | 20 | - | | | |
| **Frame D** | | | **Frame E** | | |
| 690PD/0110/230/3/.. | 50 | 63 | 690PE/0220/230/3/.. | 100 | 125 |
| 690PD/0150/230/3/.. | 63 | 80 | | | |
| 690PD/0180/230/3/.. | 80 | - | | | |
| **Frame F** | | | | | |
| 690PF/0300/230/3/.. | 125 | 160 | | | |
| 690PF/0370/230/3/.. | 160 | 160 | | | |
| 690PF/0450/230/3/.. | 160 | 200 | | | |
| **400V BUILD VARIANT** 380-460V ±10%, 45-65Hz * | | | | | |
| **Frame B** | | | **Frame C** | | |
| 690PB/0007/400/3/.. | 6 | - | 690PC/0055/400/3/.. | 16 | 20 |
| 690PB/0015/400/3/.. | 8 | - | 690PC/0075/400/3/.. | 20 | 32 |
| 690PB/0022/400/3/.. | 10 | - | 690PC/0110/400/3/.. | 32 | 40 |
| 690PB/0040/400/3/.. | 16 | - | 690PC/0150/400/3/.. | 40 | 50 |
| 690PB/0055/400/3/.. | 20 | - | | | |
| 690PB/0060/400/3/.. | 20 | - | | | |
| **Frame D** | | | **Frame E** | | |
| 690PD/0150/400/3/.. | 40 | 50 | 690PE/0300/400/3/.. | 80 | 100 |
| 690PD/0180/400/3/.. | 50 | 50 | 690PE/0370/400/3/.. | 100 | 100 |
| 690PD/0220/400/3/.. | 50 | 63 | 690PE/0450/400/3/.. | 100 | 125 |
| 690PD/0300/400/3/.. | 80 | 100 | | | |
| **Frame F** | | | | | |
| 690PF/0550/400/3/.. | 125 | 160 | | | |
| 690PF/0750/400/3/.. | 160 | 200 | | | |
| 690PF/0900/400/3/.. | 200 | 200 | | | |
| 690PF/0910/400/3/.. | 200 | 200 | | | |
| **500V BUILD VARIANT** 380-500V ±10%, 45-65Hz * | | | | | |
| **Frame B** | | | **Frame C** | | |
| 690PB/0022/500/3/.. | 8 | - | 690PC/0055/500/3/.. | 16 | 20 |
| 690PB/0040/500/3/.. | 12 | - | 690PC/0075/500/3/.. | 25 | 32 |
| 690PB/0055/500/3/.. | 16 | - | 690PC/0110/500/3/.. | 32 | 32 |
| | | | 690PC/0150/500/3/.. | 32 | 40 |
| **Frame D** | | | **Frame E** | | |
| 690PD/0150/500/3/.. | 32 | 40 | 690PE/0300/500/3/.. | 63 | 80 |
| 690PD/0180/500/3/.. | 40 | 40 | 690PE/0370/500/3/.. | 80 | 100 |
| 690PD/0220/500/3/.. | 40 | 50 | 690PE/0450/500/3/.. | 100 | 100 |
| 690PD/0300/500/3/.. | 63 | 80 | | | |
| **Frame F** | | | | | |
| 690PF/0550/500/3/.. | 100 | 125 | | | |
| 690PF/0750/500/3/.. | 125 | 160 | | | |
| 690PF/0900/500/3/.. | 160 | 200 | | | |

**\* Note : Frame B only is 50Hz ±5% or 60Hz ±5%**

## External AC Supply (RFI) Filters

| Drive | Filter Part No. | Motor Power (kW/Hp) | Phase | Watt Loss (W) | Fault Leakage Current (mA) | Current (A) | Maximum Supply Voltage (V) | EMC Performance Class | Maximum Motor Cable Length (m) |
|---|---|---|---|---|---|---|---|---|---|
| Frame B | CO467841U020 (TN Filter) | 0.75-6/1-10 constant | 3 | 10 | 36 | 20 | 480 | B | 50 |
| | CO467842U020 (TN/IT Filter) | | | 10 | 38 | | 500 | | |
| Frame C | CO467841U044 (TN Filter) | 5.5-15/7.5-20 constant | 3 | 22 | 77 | 44 | 480 | B | 50 |
| | CO467842U044 (TN/IT Filter) | 7.5-18.5/10-25 quadratic | | 22 | 80 | | 500 | | |
| Frame D | CO467841U084 (TN Filter) | 15-30/20-40 constant | 3 | 30 | 82 | 84 | 480 | B | 50 |
| | CO467842U084 (TN/IT Filter) | 18.5-37/25-50 quadratic | | 30 | 86 | | 500 | | |
| Frame E | CO467841U105 (TN Filter) | 30-45/40-60 constant | 3 | 36 | 217 | 105 | 480 | B | 50 |
| | CO467842U105 (TN/IT Filter) | 37-55/50-75 quadratic | | 36 | 200 | | 500 | | |
| Frame F | CO467841U215 (TN Filter) | 55-90/75-150 constant | 3 | 67 | 432 | 215 | 480 | B | 50 |
| | CO467842U215 (TN/IT Filter) | 75-110/100-150 quadratic | | 67 | 450 | | 500 | | |

Filters suitable for 50-60Hz ±5%, switching frequency 3 kHz only

## EMC Compliance

| Standard EN 61800-3 | | Frame B | Frame C | Frame D | Frame E | Frame F |
|---|---|---|---|---|---|---|
| Conducted emissions Table 9 | First Environment Unrestricted Distribution | Up to 4.0kW when fitted with the internal filter Over 4.0kW when fitted with the specified external filter | When fitted with the specified external filter | When fitted with the specified external filter | When fitted with the specified external filter | When fitted with the specified external filter |
| Conducted emissions Table 9 | First Environment Restricted Distribution | Over 4.0kW when fitted with the internal filter | When fitted with the specified external filter | When fitted with the specified external filter | When fitted with the specified external filter | When fitted with the specified external filter |
| Radiated Emissions Table 10 | First Environment Unrestricted Distribution | Up to 4.0kW | No | No | No | No |
| Radiated Emissions Table 10 | First Environment Restricted Distribution | Above 4.0kW | Yes | Yes | Yes | Yes |
| Conducted emissions Table 11 | Second environment Where I<=100A | Yes | Yes | Yes | Yes | Yes |
| Conducted emissions Table 11 | Second environment Where I>=100A | N/A | N/A | N/A | N/A | Yes |
| Radiated Emissions Table 12 | Second environment | Yes | Yes | Yes | Yes | Yes |

## Internal Dynamic Brake Switch (Frame B)

| Model Number (Europe) | Motor Power (kW/hp) | Brake Switch Peak Current (A) | Peak Brake Dissipation (kW/hp) | Minimum Brake Resistor Value (Ω) |
|---|---|---|---|---|
| | | 100% duty continuous | | |
| **230V Build Variant: 220-240V ±10%**  DC link brake voltage: 390V | | | | |
| 690PB/0007/230/1/.. | 0.75/1 | 10 | 4/5 | 56 |
| 690PB/0015/230/1/.. | 1.5/2 | 10 | 4/5 | 56 |
| 690PB/0022/230/1/.. | 2.2/3 | 10 | 4/5 | 56 |
| 690PB/0007/230/3/.. | 0.75/1 | 10 | 4/5 | 56 |
| 690PB/0015/230/3/.. | 1.5/2 | 10 | 4/5 | 56 |
| 690PB/0022/230/3/.. | 2.2/3 | 10 | 4/5 | 56 |
| 690PB/0040/230/3/.. | 4/5 | 15 | 6/8 | 33 |
| **400V Build Variant: 380-460V ±10%**  DC link brake voltage: 750V | | | | |
| 690PB/0007/400/3/.. | 0.75/1 | 10 | 7.5/10 | 100 |
| 690PB/0015/400/3/.. | 1.5/2 | 10 | 7.5/10 | 100 |
| 690PB/0022/400/3/.. | 2.2/3 | 10 | 7.5/10 | 100 |
| 690PB/0040/400/3/.. | 4/5 | 10 | 7.5/10 | 100 |
| 690PB/0055/400/3/.. | 5.5/7.5 | 10 | 7.5/10 | 80 |
| 690PB/0060/400/3/.. | 6.0/10 | 10 | 7.5/10 | 80 |
| **500V Build Variant: 500V ±10%**  DC link brake voltage: 750V | | | | |
| 690PB/0007/500/3/.. | 0.75/1 | 10 | 7.5/10 | 100 |
| 690PB/0015/500/3/.. | 1.5/2 | 10 | 7.5/10 | 100 |
| 690PB/0022/500/3/.. | 2.2/3 | 10 | 7.5/10 | 100 |
| 690PB/0040/500/3/.. | 4/5 | 10 | 7.5/10 | 100 |
| 690PB/0055/500/3/.. | 5.5/7.5 | 10 | 7.5/10 | 90 |

## Internal Dynamic Brake Switch (Frame C)

| Model Number (Europe) | Motor Power (kW/hp) | Brake Switch Peak Current (A) | Peak Brake Dissipation (kW/hp) | Brake Switch Continuous Current (A) | Continuous Brake Dissipation (kW/hp) | Minimum Brake Resistor Value (Ω) |
|---|---|---|---|---|---|---|
| | | 20s maximum, 30% duty | | | | |
| **230V Build Variant: 220-240V ±10%**  DC link brake voltage: 390V | | | | | | |
| 690PC/0055/230/.. | 5.5/7.5 | 13.5 | 5.2/6.9 | 4.0 | 1.6/2.1 | 29 |
| 690PC/0075/230/.. | 7.5/10 | 17.7 | 6.9/9.2 | 5.3 | 2.1/2.8 | 22 |
| **400V Build Variant: 380-460V ±10%, 45-65Hz**  DC link brake voltage: 750V | | | | | | |
| 690PC/0055/400/.. | 5.5/7.5 | 7.5 | 5.5/7.5 | 2.3 | 1.7/2.3 | 100 |
| 690PC/0075/400/.. | 7.5/10 | 15 | 11/15 | 4.5 | 3.4/4.5 | 50 |
| 690PC/0110/400/.. | 11/15 | 15 | 11/15 | 4.5 | 3.4/4.5 | 50 |
| 690PC/0150/400/.. | 15/20 | 15 | 11/15 | 4.5 | 3.4/4.5 | 50 |
| **500V Build Variant: 500V ±10%, 45-65Hz**  DC link brake voltage: 815V | | | | | | |
| 690PC/0055/500/.. | 5.5/7.5 | 7.5 | 6.1/8.2 | 2.25 | 1.8/2.5 | 100 |
| 690PC/0075/500/.. | 7.5/10 | 15 | 12.2/16.3 | 4.5 | 3.7/4.9 | 50 |
| 690PC/0110/500/.. | 11/15 | 15 | 12.2/16.3 | 4.5 | 3.7/4.9 | 50 |
| 690PC/0150/500/.. | 15/20 | 15 | 12.2/16.3 | 4.5 | 3.7/4.9 | 50 |

| Internal Dynamic Brake Switch (Frame D) | | | | | | |
|---|---|---|---|---|---|---|
| Model Number (Europe) | Motor Power (kW/hp) | Brake Switch Peak Current (A) | Peak Brake Dissipation (kW/hp) | Brake Switch Continuous Current (A) | Continuous Brake Dissipation (kW/hp) | Minimum Brake Resistor Value (Ω) |
| | | 20s maximum, 30% duty | | | | |
| 230V Build Variant: 220-240V ±10%   DC link brake voltage: 390V | | | | | | |
| 690PD/0110/230/.. | 11/15 | 28 | 10.9/14.5 | 8.4 | 3.3/4.4 | 14 |
| 690PD/0150/230/.. | 15/20 | 39 | 15.2/20.3 | 11.7 | 4.6/6.1 | 10 |
| 690PD/0180/230/.. | 18.5/25 | 49 | 19.0/25.3 | 14.7 | 5.7/7.6 | 8 |
| 400V Build Variant: 380-460V ±10%, 45-65Hz  DC link brake voltage: 750V | | | | | | |
| 690PD/0150/400/.. | 15/20 | 30 | 22/30 | 9.5 | 7/10 | 27 |
| 690PD/0180/400/.. | 18.5/25 | 30 | 22/30 | 9.5 | 7/10 | 27 |
| 690PD/0220/400/.. | 22/30 | 30 | 22/30 | 9.5 | 7/10 | 27 |
| 690PD/0300/400/.. | 30/37 | 37 | 30/40 | 12.5 | 9/12 | 21 |
| 500V Build Variant: 500V ±10%, 45-65Hz  DC link brake voltage: 815V | | | | | | |
| 690PD/0150/500/.. | 15/20 | 27 | 22/30 | 8.5 | 7/10 | 33 |
| 690PD/0180/500/.. | 18.5/25 | 27 | 22/30 | 8.5 | 7/10 | 33 |
| 690PD/0220/500/.. | 22/30 | 27 | 22/30 | 8.5 | 7/10 | 33 |
| 690PD/0300/500/.. | 30/37 | 34 | 30/40 | 11 | 9/12 | 24 |

| Internal Dynamic Brake Switch (Frame E) | | | | | | |
|---|---|---|---|---|---|---|
| Model Number (Europe) | Motor Power (kW/hp) | Brake Switch Peak Current (A) | Peak Brake Dissipation (kW/hp) | Brake Switch Continuous Current (A) | Continuous Brake Dissipation (kW/hp) | Minimum Brake Resistor Value (Ω) |
| | | 20s maximum, 30% duty | | | | |
| 230V Build Variant: 220-240V ±10%   DC link brake voltage: 390V | | | | | | |
| 690PE/0220/230/.. | 22/30 | 56 | 21.7/28.9 | 16.8 | 6.5/8.7 | 7 |
| 400V Build Variant: 380-460V ±10%, 45-65Hz  DC link brake voltage: 750V | | | | | | |
| 690PE/0300/400/.. | 30/40 | 40 | 30/40 | 12 | 9/12 | 19 |
| 690PE/0370/400/.. | 37/50 | 50 | 37/50 | 15 | 10.5/14 | 15 |
| 690PE/0450/400/.. | 45/60 | 60 | 45/60 | 18 | 13.5/18 | 12 |
| 500V Build Variant: 500V ±10%, 45-65Hz  DC link brake voltage: 820V | | | | | | |
| 690PE/0300/500/.. | 30/40 | 37 | 30/40 | 11 | 9/12 | 22 |
| 690PE/0370/500/.. | 37/50 | 46 | 37/50 | 14 | 10.5/14 | 18 |
| 690PE/0450/500/.. | 45/60 | 55 | 45/60 | 17 | 13.5/18 | 15 |
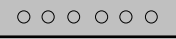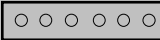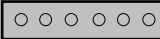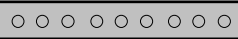
## Internal Dynamic Brake Switch (Frame F)

| Model Number (Europe) | Motor Power (kW/hp) | Brake Switch Peak Current (A) | Peak Brake Dissipation (kW/hp) | Brake Switch Continuous Current (A) | Continuous Brake Dissipation (kW/hp) | Minimum Brake Resistor Value (Ω) |
|---|---|---|---|---|---|---|
| | | 20s maximum, 25% duty | | | | |
| **230V Build Variant: 220-240V ±10%**   DC link brake voltage: 390V | | | | | | |
| 690PF/0300/230/.. | 30/40 | 94 | 30/41 | 23.4 | 23/12 | 5 |
| 690PF/0370/230/.. | 37/50 | 107 | 38/51 | 29.4 | 11/15 | 4 |
| 690PF/0450/230/.. | 45/60 | 125 | 51/68 | 39.0 | 15/20 | 3 |
| **400V Build Variant: 380-460V ±10%, 45-65Hz**  DC link brake voltage: 750V | | | | | | |
| 690PF/0550/400/.. | 55/75 | 94 | 62/83 | 25 | 18/25 | 8 |
| 690PF/0750/400/.. | 75/100 | 125 | 90/125 | 32 | 24/32 | 6 |
| 690PF/0900/400/.. | 90/125 | 136 | 102/137 | 32 | 24/32 | 5.5 |
| 690P/0910/400/.. | 90/150 | 136 | 102/137 | 32 | 24/32 | 5.5 |
| **500V Build Variant: 500V ±10%, 45-65Hz**  DC link brake voltage: 820V | | | | | | |
| 690PF/0550/500/.. | 55/75 | 82 | 68 | 25 | 20.5/27 | 10 |
| 690PF/0750/500/.. | 75/100 | 102 | 83 | 31 | 25.5/34 | 8 |
| 690PF/0900/500/.. | 90/125 | 102 | 83 | 31 | 25.5/34 | 8 |

## Control Terminals

| Terminal No. | Name | Range | Description<br>(Default functions are for Macro 1) |
|---|---|---|---|
| | ANALOG I/O TERMINAL BLOCK<br>This is a 10-way connector carrying all customer analog I/O. | | |
| 1 | 0V | | 0V reference for analog i/o |
| 2 | AIN1 (SPEED) | 0-10V, ±10V, 0-20V<br>0-20mA, 4-20mA | Configurable analog input<br>Default function = Speed Setpoint |
| 3 | AIN2 (TRIM) | 0-10V, ±10V, 0-20V<br>0-20mA, 4-20mA | Configurable analog input<br>Default function = Speed Trim |
| 4 | AIN3 | 0-10V, ±10V, 0-20V | Configurable analog input |
| 5 | AIN4 | 0-10V, ±10V, 0-20V | Configurable analog input |
| 6 | AOUT1 (RAMP) | 0-10V, 0-20mA,<br>4-20mA | Configurable analog output<br>Default function = Ramp Output |
| 7 | AOUT2 | ±10V | Configurable analog output<br>No default function |
| 8 | AOUT3 | ±10V | Configurable analog output<br>No default function |
| 9 | +10V REF | 10V | 10V reference for analog i/o<br>Load 10mA maximum |
| 10 | -10V REF | -10V | -10V reference for analog i/o<br>Load 10mA maximum |
| | DIGITAL INPUT TERMINAL BLOCK<br>This is a 10-way connector carrying all digital inputs. | | |
| 11 | 0V | | All inputs below 24V=high , 0V=low |
| 12 | DIN1 (RUN FWD) | 0-24V | Configurable digital input<br>Default function = RUN FWD<br>0V = Stop, 24V = Run |
| 13 | DIN2 (RUN REV) | 0-24V | Configurable digital input<br>Default function = RUN REV<br>0V = Stop, 24V = Run |
| 14 | DIN3 (NOT STOP) | 0-24V | Configurable digital input<br>Default function = NOT STOP<br>0V = Stop, 24V = Run |
| 15 | DIN4 (REMOTE REVERSE) | 0-24V | Configurable digital input<br>Default function = DIRECTION<br>0V = Forward, 24V = Reverse |
| 16 | DIN 5 (JOG) | 0-24V | Configurable digital input<br>Default function = JOG<br>24V = Jog, 0V = Stop |
| 17 | DIN6 | 0-24V | Configurable digital input<br>No default function |
| 18 | DIN7 (REMOTE TRIP RESET) | 0-24V | Configurable digital input<br>Default function = TRIP RESET<br>24V = Reset |
| 19 | DIN8 (EXT TRIP) | 0-24V | Non-configurable digital input<br>Default function = EXTERNAL TRIP (active low)<br>24V = No Trip, 0V = Trip |
| 20 | +24VC | | Customer +24V (max load 150mA) |
| | RELAY OUTPUT TERMINAL BLOCK<br>Relay outputs are volt free, normally open contacts. Rated to 230V 3A resistive load.<br>Alternatively they may be used down to 1mA, 12V levels. This is a 6-way connector. | | |
| 21<br>22 | DOUT1_A<br>DOUT1_B | normally-open relay contacts | Default function DOUT1 closed = healthy |
| 23<br>24 | DOUT2_A<br>DOUT2_B | normally-open relay contacts | Default function DOUT2 closed = running |
| 25<br>26 | DOUT3_A<br>DOUT3_B | normally-open relay contacts | No default function |

## System Board Terminals (option)

| Terminal No. | Name | Range | Description (Default functions are for Macro 1) |
|---|---|---|---|
| **Terminal A**   1 2 3 4 5 6 | | | |
| 1 | External 0V | | User-supplied 0V reference |
| 2 | DIGIO11 | If driving a relay coil with a digital output we recommend to fit a flywheel diode across the coil. | Configurable digital input/output |
| 3 | DIGIO12 | | Configurable digital input/output |
| 4 | DIGIO13 | | Configurable digital input/output |
| 5 | DIGIO14 | | Configurable digital input/output |
| 6 | DIGIO15 | | Configurable digital input/output |
| **Terminal B**   1 2 3 4 5 6 7 8 9 | | | |
| 1 | External 24V In | 24V dc (±10%) 1A | User-supplied power supply |
| 2 | Reference Encoder A | | Input |
| 3 | Reference Encoder /A | | Input |
| 4 | Reference Encoder B | | Input |
| 5 | Reference Encoder /B | | Input |
| 6 | Reference Encoder Z | | Input |
| 7 | Reference Encoder /Z | | Input |
| 8 | Encoder Supply Out | 5V, 12V, 18V, 24V | User selectable (max load 500mA) |
| 9 | External 0V | | User-supplied 0V reference |
| **Terminal C**   1 2 3 4 5 6 | | | |
| 1 | Slave Encoder A | | Input |
| 2 | Slave Encoder /A | | Input |
| 3 | Slave Encoder B | | Input |
| 4 | Slave Encoder /B | | Input |
| 5 | Slave Encoder Z | | Input |
| 6 | Slave Encoder /Z | | Input |
| **Terminal D**   1 2 3 4 5 6 | | | |
| 1 | Repeat Encoder Output A | | Output (repeats Slave Encoder) |
| 2 | Repeat Encoder Output /A | | Output (repeats Slave Encoder) |
| 3 | Repeat Encoder Output B | | Output (repeats Slave Encoder) |
| 4 | Repeat Encoder Output /B | | Output (repeats Slave Encoder) |
| 5 | Repeat Encoder Output Z | | Output (repeats Slave Encoder) |
| 6 | Repeat Encoder Output /Z | | Output (repeats Slave Encoder) |

## Analog Inputs/Outputs

|  | Inputs | Output |
|---|---|---|
| Range | 0-10V, ±10V, 0-20mA or 4-20mA (range set in software) | 0-10V (10mA maximum), 0-20mA or 4-20mA (range set in software) |
| Impedance | Voltage range = 47kΩ<br>Current range = 220Ω | Voltage range = 100Ω<br>Current range = 100Ω |
| Resolution | 10 bits (1 in 1024) | 10 bits (1 in 1024) |
| Sample Rate | 5ms (one selected input can be 1ms) | 5ms |

### System Board
With System Board option fitted, the ±10V range is enhanced as follows:

|  |  |  |
|---|---|---|
| Range | ±10V (range set in software) |  |
| Impedance | Voltage range = 14kΩ |  |
| Resolution | 12 bit + sign ( 1 in 8192) |  |
| Sample Rate | 5ms (one selected input can be 1ms) |  |

## Digital Inputs

| Operating Range | 0-5V dc = OFF, 15-24V dc = ON<br>(-30V dc absolute minimum, +30V dc absolute maximum) |  |
|---|---|---|
| Input Impedance | 6.8kΩ |  |
| Sample Rate | 5ms |  |

## Digital Outputs

These are volt-free relay contacts. 50V dc max, 0.3A max (for inductive loads up to L/R=40ms, a suitable freewheel diode must be used).

| Maximum Voltage | 230V ac |
|---|---|
| Maximum Current | 3A resistive load |

## System Board Digital Inputs/Outputs (DIGIO11-15)

These are individually, user-configurable as an Input or Output. Refer to the Software Product Manual, Chapter 1: "Programming Your Application" – DIGITAL INPUTS and DIGITAL OUTPUTS.

|  | Input | Output |
|---|---|---|
| Maximum Voltage | EXT 24Vin + 0.6V | 24V dc |
| Maximum Current |  | 100mA |
| Operating Range | 0-5V dc = OFF,<br>15-24V dc = ON<br>(-30V dc absolute minimum, +30V dc absolute maximum)  | 24V dc = ON *<br>0V dc = OFF<br><br>* range: 19.1V (full load) to 25.1V (no load) |
| Input Impedance | 6.8kΩ |  |
| Sample Rate | 5ms | 5ms |

## Supply Harmonic Analysis (Frame B Constant)

(With or without the internal filter)

Assumptions: 10000A short circuit supply capability, equivalent to 73µH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | | | | | | | 400 | | | | | | 500 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Single Phase | | | Three Phase | | | | | | | | | | | | |
| Motor Power (kW) | 0.75 | 1.5 | 2.2 | 0.75 | 1.5 | 2.2 | 4.0 | 0.75 | 1.5 | 2.2 | 4.0 | 5.5 | 6.0 | 2.2 | 4.0 | 5.5 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | | | | | | | |
| 1 | 3.8 | 7.5 | 11.0 | 2.1 | 4.2 | 6.2 | 11.4 | 1.2 | 2.5 | 3.6 | 6.5 | 8.9 | 9.7 | 2.8 | 5.2 | 7.1 |
| 3 | 3.7 | 7.2 | 10.5 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 3.5 | 6.7 | 9.6 | 2.0 | 3.9 | 5.7 | 10.0 | 1.2 | 2.3 | 3.4 | 6.0 | 8.1 | 8.8 | 2.7 | 4.8 | 6.6 |
| 7 | 3.3 | 6.1 | 8.4 | 1.9 | 3.6 | 5.1 | 8.9 | 1.1 | 2.2 | 3.2 | 5.6 | 7.4 | 8.0 | 2.5 | 4.5 | 6.1 |
| 9 | 3.0 | 5.3 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 2.6 | 4.4 | 5.5 | 1.7 | 2.9 | 3.9 | 5.9 | 1.0 | 1.9 | 2.6 | 4.4 | 5.5 | 5.9 | 2.1 | 3.6 | 4.8 |
| 13 | 2.2 | 3.5 | 4.0 | 1.5 | 2.5 | 3.1 | 4.4 | 0.9 | 1.8 | 2.3 | 3.8 | 4.5 | 4.8 | 1.9 | 3.1 | 4.0 |
| 15 | 1.9 | 2.6 | 2.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 1.5 | 1.8 | 1.5 | 1.2 | 1.6 | 1.8 | 1.8 | 0.8 | 1.5 | 1.6 | 2.5 | 2.6 | 2.7 | 1.3 | 2.1 | 2.6 |
| 19 | 1.1 | 1.1 | 0.6 | 1.0 | 1.3 | 1.2 | 0.9 | 0.7 | 1.3 | 1.3 | 1.9 | 1.7 | 1.8 | 1.1 | 1.6 | 1.9 |
| 21 | 0.8 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 0.5 | 0.2 | 0.4 | 0.7 | 0.6 | 0.4 | 0.5 | 0.5 | 0.9 | 0.7 | 0.9 | 0.6 | 0.5 | 0.7 | 0.8 | 0.8 |
| 25 | 0.3 | 0.2 | 0.5 | 0.5 | 0.4 | 0.3 | 0.6 | 0.5 | 0.7 | 0.5 | 0.5 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 |
| 27 | 0.1 | 0.3 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.1 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.5 | 0.3 | 0.4 | 0.2 | 0.2 | 0.4 | 0.5 | 0.2 | 0.2 | 0.3 |
| 31 | 0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.4 | 0.5 | 0.2 | 0.2 | 0.3 |
| 33 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 |
| 37 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| 39 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | 8.9 | 16.2 | 22.4 | 4.6 | 8.1 | 11.2 | 19.2 | 2.8 | 5.4 | 7.2 | 12.4 | 16.2 | 17.5 | 5.8 | 10.0 | 13.5 |
| THD (V) % | 0.37 | 0.64 | 0.80 | 0.46 | 0.67 | 0.83 | 1.22 | 0.19 | 0.33 | 0.37 | 0.58 | 0.68 | 0.73 | 0.31 | 0.48 | 0.62 |

## Supply Harmonic Analysis (Frame C Constant)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | | 400 | | | | 500 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | |
| Motor Power (kW) | 5.5 | 7.5 | 5.5 | 7.5 | 11.0 | 15.0 | 5.5 | 7.5 | 11.0 | 15.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | |
| 1 | 18.5 | 23.8 | 10.1 | 13.0 | 18.6 | 25.1 | 9.7 | 17.8 | 18.6 | 19.5 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 13.0 | 18.0 | 7.9 | 10.3 | 14.2 | 19.9 | 7.7 | 13.9 | 14.4 | 15.9 |
| 7 | 8.9 | 13.3 | 6.1 | 8.1 | 10.8 | 15.6 | 6.0 | 10.7 | 11.0 | 12.8 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 2.2 | 4.6 | 2.4 | 3.6 | 4.0 | 6.8 | 2.6 | 4.3 | 4.3 | 6.2 |
| 13 | 1.2 | 2.0 | 1.2 | 1.9 | 1.8 | 3.5 | 1.4 | 2.1 | 2.1 | 3.5 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 1.0 | 1.5 | 0.6 | 0.8 | 1.2 | 1.5 | 0.6 | 1.2 | 1.2 | 1.2 |
| 19 | 0.6 | 1.3 | 0.6 | 0.9 | 1.1 | 1.5 | 0.6 | 1.1 | 1.1 | 1.3 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 0.5 | 0.6 | 0.3 | 0.5 | 0.5 | 0.9 | 0.3 | 0.6 | 0.6 | 0.9 |
| 25 | 0.4 | 0.6 | 0.3 | 0.3 | 0.5 | 0.6 | 0.3 | 0.5 | 0.5 | 0.6 |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.3 | 0.4 | 0.2 | 0.3 | 0.4 | 0.6 | 0.2 | 0.4 | 0.4 | 0.5 |
| 31 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.5 | 0.2 | 0.3 | 0.3 | 0.5 |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.3 | 0.3 |
| 37 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0.3 |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | **24.5** | **33.2** | **14.5** | **18.9** | **26.2** | **36.5** | **14.2** | **25.5** | **26.5** | **29.2** |
| THD (V) % | 0.57 | 0.86 | 0.40 | 0.54 | 0.70 | 1.03 | 0.40 | 0.70 | 0.72 | 0.87 |

## Supply Harmonic Analysis (Frame C Quadratic)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum\limits_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | | 400 | | | | 500 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | |
| Motor Power (kW) | 5.5 | 7.5 | 5.5 | 7.5 | 11.0 | 15.0 | 5.5 | 7.5 | 11.0 | 15.0 |
| Typical Motor Efficiency % | 90 | | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | |
| 1 | 23.7 | | 13.3 | 18.2 | 25.1 | 30.7 | 14.2 | 16.2 | 23.1 | 24.3 |
| 3 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| 5 | 15.9 | | 10.1 | 14.0 | 18.6 | 23.9 | 10.8 | 12.7 | 17.5 | 19.4 |
| 7 | 10.4 | | 7.5 | 10.6 | 13.5 | 18.4 | 8.2 | 9.9 | 13.0 | 15.3 |
| 9 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 2.1 | | 2.7 | 4.0 | 4.3 | 7.3 | 3.0 | 4.2 | 4.6 | 6.8 |
| 13 | 1.6 | | 1.2 | 1.8 | 1.8 | 3.4 | 1.4 | 2.1 | 2.0 | 3.6 |
| 15 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 1.1 | | 0.8 | 1.2 | 1.5 | 1.8 | 0.9 | 1.1 | 1.5 | 1.5 |
| 19 | 0.7 | | 0.7 | 1.0 | 1.2 | 1.8 | 0.8 | 1.1 | 1.3 | 1.6 |
| 21 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 0.6 | | 0.3 | 0.5 | 0.6 | 0.8 | 0.4 | 0.5 | 0.6 | 0.9 |
| 25 | 0.5 | | 0.3 | 0.5 | 0.6 | 0.7 | 0.4 | 0.4 | 0.6 | 0.7 |
| 27 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.3 | | 0.2 | 0.4 | 0.4 | 0.7 | 0.3 | 0.4 | 0.4 | 0.6 |
| 31 | 0.3 | | 0.2 | 0.3 | 0.3 | 0.5 | 0.2 | 0.3 | 0.3 | 0.5 |
| 33 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.2 | | 0.2 | 0.2 | 0.3 | 0.4 | 0.2 | 0.2 | 0.3 | 0.3 |
| 37 | 0.3 | | 0.1 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 |
| 39 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.1 | | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 |
| 42 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.2 | | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 |
| 44 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.1 | | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 48 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.2 | | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 50 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | 30.6 | | 18.6 | 25.7 | 34.4 | 43.9 | 19.9 | 23.4 | 32.2 | 35.6 |
| THD (V) % | 0.68 | | 0.4848 | 0.6858 | 0.8634 | 1.1883 | 0.5286 | 0.6545 | 0.8396 | 1.0236 |

## Supply Harmonic Analysis (Frame D Constant)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \ x \ 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \ \%$$

| Fundamental Voltage (V) | 230 | | | 400 | | | | 500 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | | |
| Motor Power (kW) | 11.0 | 15.0 | 18.0 | 15.0 | 18.0 | 22.0 | 30.0 | 15.0 | 18.0 | 22.0 | 30.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | | |
| 1 | 37.4 | 46.7 | 59.2 | 25.8 | 30.6 | 36.3 | 51.5 | 19.4 | 24.2 | 29.0 | * |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | |
| 5 | 20.8 | 21.1 | 23.3 | 18.6 | 21.6 | 24.8 | 34.2 | 14.9 | 17.9 | 20.9 | |
| 7 | 12.7 | 11.5 | 11.5 | 13.1 | 14.7 | 16.4 | 21.8 | 11.3 | 13.0 | 14.7 | |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 11 | 2.5 | 3.4 | 4.4 | 3.7 | 3.7 | 3.6 | 4.2 | 4.3 | 4.2 | 4.2 | |
| 13 | 2.5 | 2.6 | 3.0 | 1.8 | 2.0 | 2.4 | 3.4 | 2.1 | 2.0 | 2.1 | |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 17 | 1.4 | 1.9 | 2.5 | 1.6 | 1.7 | 1.8 | 2.2 | 1.4 | 1.7 | 1.8 | |
| 19 | 1.2 | 1.4 | 1.7 | 1.1 | 1.1 | 1.1 | 1.4 | 1.2 | 1.2 | 1.3 | |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 23 | 0.9 | 1.2 | 1.6 | 0.7 | 0.9 | 1.0 | 1.3 | 0.6 | 0.7 | 0.8 | |
| 25 | 0.7 | 0.9 | 1.2 | 0.7 | 0.7 | 0.8 | 0.9 | 0.5 | 0.7 | 0.8 | |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 29 | 0.7 | 0.9 | 1.1 | 0.4 | 0.5 | 0.6 | 0.7 | 0.4 | 0.4 | 0.4 | |
| 31 | 0.5 | 0.7 | 0.9 | 0.4 | 0.5 | 0.5 | 0.6 | 0.3 | 0.4 | 0.4 | |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 35 | 0.5 | 0.6 | 0.8 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | |
| 37 | 0.4 | 0.5 | 0.7 | 0.2 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 41 | 0.4 | 0.5 | 0.6 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 43 | 0.3 | 0.4 | 0.5 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 47 | 0.3 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 49 | 0.2 | 0.3 | 0.4 | 0.1 | 0.2 | 0.2 | 0.3 | 0.1 | 0.1 | 0.2 | |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total RMS Current (A) | 44.9 | 52.8 | 65.0 | 34.8 | 40.5 | 47.2 | 65.8 | 27.5 | 33.2 | 39.1 | |
| THD (V) % | 0.90 | 0.93 | 1.05 | 0.85 | 0.96 | 1.08 | 1.44 | 0.74 | 0.85 | 0.96 | |

\* Please contact SSD Drives.

## Supply Harmonic Analysis (Frame D Quadratic)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | | | 400 | | | | 500 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | | |
| Motor Power (kW) | 11.0 | 15.0 | 18.0 | 15.0 | 18.0 | 22.0 | 30.0 | 15.0 | 18.0 | 22.0 | 30.0 |
| Typical Motor Efficiency % | 90 | 90 | | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | | |
| 1 | 47.2 | 59.2 | | 30.6 | 36.3 | 48.2 | 67.7 | 23.4 | 29.0 | 38.6 | * |
| 3 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | |
| 5 | 22.5 | 23.3 | | 21.6 | 24.8 | 31.0 | 41.7 | 17.6 | 20.9 | 26.6 | |
| 7 | 12.5 | 11.5 | | 14.7 | 16.4 | 19.6 | 25.5 | 13.0 | 14.7 | 17.8 | |
| 9 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 11 | 3.3 | 4.4 | | 3.7 | 3.6 | 3.4 | 4.0 | 4.5 | 4.2 | 4.1 | |
| 13 | 2.7 | 3.0 | | 2.0 | 2.4 | 3.3 | 4.7 | 2.1 | 2.1 | 2.6 | |
| 15 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 17 | 1.8 | 2.5 | | 1.7 | 1.8 | 1.8 | 2.1 | 1.6 | 1.8 | 2.0 | |
| 19 | 1.3 | 1.7 | | 1.1 | 1.1 | 1.4 | 1.9 | 1.3 | 1.3 | 1.2 | |
| 21 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 23 | 1.2 | 1.6 | | 0.9 | 1.0 | 1.0 | 1.3 | 0.6 | 0.8 | 1.1 | |
| 25 | 0.9 | 1.2 | | 0.7 | 0.8 | 0.8 | 1.1 | 0.6 | 0.8 | 0.8 | |
| 27 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 29 | 0.8 | 1.1 | | 0.5 | 0.6 | 0.6 | 0.9 | 0.4 | 0.4 | 0.6 | |
| 31 | 0.7 | 0.9 | | 0.5 | 0.5 | 0.6 | 0.7 | 0.4 | 0.4 | 0.5 | |
| 33 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 35 | 0.6 | 0.8 | | 0.3 | 0.3 | 0.4 | 0.6 | 0.3 | 0.3 | 0.4 | |
| 37 | 0.5 | 0.7 | | 0.3 | 0.3 | 0.5 | 0.5 | 0.3 | 0.3 | 0.4 | |
| 39 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 40 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 41 | 0.4 | 0.6 | | 0.2 | 0.2 | 0.2 | 0.5 | 0.2 | 0.2 | 0.3 | |
| 42 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 43 | 0.4 | 0.5 | | 0.2 | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | |
| 44 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 45 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 46 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 47 | 0.3 | 0.4 | | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | |
| 48 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 49 | 0.3 | 0.4 | | 0.2 | 0.2 | 0.3 | 0.3 | 0.1 | 0.2 | 0.2 | |
| 50 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total RMS Current (A) | **54.0** | **65.0** | | **40.5** | **47.2** | **60.8** | **83.8** | **32.6** | **39.1** | **50.5** | |
| THD (V) % | 0.97 | 1.05 | | 0.96 | 1.08 | 1.30 | 1.72 | 0.85 | 0.96 | 1.16 | |

* Please contact SSD Drives.

## Supply Harmonic Analysis (Frame E Constant)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | 400 | | | 500 | | |
|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | |
| Motor Power (kW) | 22.0 | 30.0 | 37.0 | 45.0 | 30.0 | 37.0 | 45.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | |
| 1 | 76.7 | 52.3 | 62.8 | 75.5 | 41.1 | 52.4 | 64.4 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| 5 | 42.4 | 35.3 | 42.2 | 48.4 | 29.3 | 36.7 | 43.1 |
| 7 | 22.2 | 22.9 | 27.2 | 29.4 | 20.2 | 24.8 | 27.6 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 4.4 | 4.5 | 5.2 | 4.9 | 5.3 | 5.9 | 5.5 |
| 13 | 4.3 | 3.2 | 3.8 | 4.9 | 2.7 | 3.4 | 4.3 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 2.0 | 2.3 | 2.7 | 2.5 | 2.5 | 2.9 | 2.9 |
| 19 | 1.7 | 1.4 | 1.6 | 1.9 | 1.6 | 1.8 | 1.8 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 1.2 | 1.3 | 1.5 | 1.5 | 1.1 | 1.4 | 1.6 |
| 25 | 0.9 | 0.9 | 1.1 | 1.0 | 1.0 | 1.2 | 1.1 |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.7 | 0.7 | 0.8 | 0.9 | 0.6 | 0.8 | 0.9 |
| 31 | 0.5 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 | 0.8 |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.5 | 0.4 | 0.5 | 0.6 | 0.4 | 0.5 | 0.6 |
| 37 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | **90.7** | **67.5** | **80.8** | **94.7** | **54.8** | **69.1** | **82.6** |
| THD (V) % | 1.65 | 2.58 | 3.70 | 3.41 | 1.31 | 1.61 | 1.82 |

## Supply Harmonic Analysis (Frame E Quadratic)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \; x \; 100 \; = \; \frac{\sqrt{\sum\limits_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \; \% $$

| Fundamental Voltage (V) | 230 | 400 | | | 500 | | |
|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | |
| Motor Power (kW) | 22.0 | 30.0 | 37.0 | 45.0 | 30.0 | 37.0 | 45.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | |
| 1 | 102.1 | 64.3 | 74.8 | 89.1 | 51.5 | 63.6 | 75.5 |
| 3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| 5 | 49.1 | 41.9 | 48.7 | 55.2 | 35.4 | 43.1 | 48.9 |
| 7 | 21.7 | 26.0 | 30.3 | 32.2 | 23.3 | 28.0 | 30.1 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 6.3 | 4.4 | 5.0 | 5.1 | 5.1 | 5.7 | 5.4 |
| 13 | 4.1 | 4.0 | 4.6 | 5.9 | 3.3 | 4.1 | 5.1 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 2.8 | 2.3 | 2.7 | 2.5 | 2.6 | 3.0 | 2.8 |
| 19 | 1.7 | 1.6 | 1.8 | 2.3 | 1.5 | 1.8 | 2.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 1.6 | 1.4 | 1.6 | 1.5 | 1.4 | 1.6 | 1.6 |
| 25 | 1.0 | 0.9 | 1.1 | 1.2 | 1.0 | 1.2 | 1.1 |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 1.0 | 0.8 | 1.0 | 1.0 | 0.7 | 0.9 | 1.0 |
| 31 | 0.7 | 0.6 | 0.7 | 0.8 | 0.7 | 0.8 | 0.7 |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.7 | 0.5 | 0.6 | 0.7 | 0.4 | 0.6 | 0.6 |
| 37 | 0.5 | 0.5 | 0.5 | 0.6 | 0.4 | 0.6 | 0.5 |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.5 | 0.4 | 0.4 | 0.5 | 0.3 | 0.4 | 0.4 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.4 | 0.3 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.3 | 0.2 | 0.3 | 0.4 | 0.2 | 0.3 | 0.3 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | **115.6** | **81.3** | **94.6** | **110.0** | **67.1** | **82.2** | **95.2** |
| THD (V) % | 1.84 | 2.98 | 3.46 | 3.84 | 1.52 | 1.84 | 1.02 |

# Supply Harmonic Analysis (Frame F Constant)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \times 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \%$$

| Fundamental Voltage (V) | 230 | | | 400 | | | | 500 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | |
| Motor Power (kW) | 30.0 | 37.0 | 45.0 | 55.0 | 75.0 | 90.0 | 90.0 (150HP) | 55.0 | 75.0 | 90.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | |
| 1 | 94.7 | 118.2 | 140.1 | 99.2 | 132.1 | 152.1 | 156.6 | 79.7 | 104.8 | 126.7 |
| 3 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| 5 | 35.9 | 41.6 | 45.9 | 44.9 | 53.4 | 57.8 | 58.9 | 42.4 | 49.3 | 54.5 |
| 7 | 11.9 | 11.9 | 11.8 | 19.5 | 19.5 | 19.1 | 19.0 | 22.1 | 22.5 | 22.2 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| 11 | 6.5 | 7.7 | 8.5 | 6.9 | 9.0 | 10.0 | 10.3 | 5.7 | 7.5 | 8.9 |
| 13 | 2.9 | 3.5 | 4.2 | 4.0 | 4.3 | 4.6 | 4.7 | 4.6 | 4.6 | 4.7 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 2.7 | 3.1 | 3.2 | 3.1 | 3.9 | 4.2 | 4.3 | 2.6 | 3.3 | 3.9 |
| 19 | 1.6 | 2.1 | 2.4 | 1.8 | 2.2 | 2.6 | 2.7 | 1.8 | 2.0 | 2.2 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 1.4 | 1.4 | 1.4 | 1.7 | 2.0 | 2.1 | 2.1 | 1.5 | 1.9 | 2.1 |
| 25 | 1.1 | 1.3 | 1.4 | 1.1 | 1.5 | 1.7 | 1.7 | 1.0 | 1.2 | 1.4 |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.7 | 0.8 | 0.8 | 1.0 | 1.1 | 1.1 | 1.1 | 0.9 | 1.1 | 1.2 |
| 31 | 0.7 | 0.8 | 0.7 | 0.8 | 1.0 | 1.1 | 1.1 | 0.6 | 0.8 | 1.0 |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.6 | 0.7 | 0.7 |
| 37 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.4 | 0.6 | 0.7 |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.5 | 0.5 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | **102.3** | **126.2** | **148.2** | **110.9** | **144.3** | **164.3** | **168.9** | **93.3** | **118.4** | **140.2** |
| THD (V) % | 1.33 | 1.52 | 1.66 | 1.71 | 1.98 | 2.12 | 2.15 | 1.67 | 1.90 | 2.06 |

## Supply Harmonic Analysis (Frame F Quadratic)

Assumptions: 10000A short circuit supply capability, equivalent to 73μH supply impedance at 400V where $Q_{1n}$ is the rated rms value of the fundamental voltage of the supply transformer. The results conform to stage 1, stage 2 and stage 3 of the Engineering Recommendation G.5/3 September 1976, Classification 'C': Limits for Harmonics in the UK Electricity Industry.

$$THD(V) \ x \ 100 = \frac{\sqrt{\sum_{h=40}^{h=2} Q_{h^2}}}{Q_{1n}} \ \%$$

| Fundamental Voltage (V) | 230 | | | 400 | | | | 500 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Drive Type | Three Phase | | | | | | | | | |
| Motor Power (kW) | 30.0 | 37.0 | 45.0 | 55.0 | 75.0 | 90.0 | 90.0 (150HP) | 55.0 | 75.0 | 90.0 |
| Typical Motor Efficiency % | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Harmonic No. | RMS Current (A) | | | | | | | | | |
| 1 | 118.2 | 140.1 | 175.5 | 132.0 | 151.6 | 184.4 | 156.6 | 104.8 | 126.7 | 152.5 |
| 3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| 5 | 40.9 | 45.9 | 52.3 | 52.6 | 57.8 | 64.7 | 58.9 | 48.5 | 54.5 | 60.5 |
| 7 | 11.5 | 11.8 | 12.3 | 18.8 | 19.1 | 18.6 | 19.0 | 21.9 | 22.2 | 21.7 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 7.6 | 8.5 | 9.5 | 9.0 | 10.1 | 11.5 | 10.3 | 7.5 | 8.9 | 10.5 |
| 13 | 3.5 | 4.2 | 5.3 | 4.2 | 4.6 | 5.4 | 4.7 | 4.5 | 4.7 | 4.9 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 3.0 | 3.2 | 3.1 | 3.8 | 4.2 | 4.5 | 4.3 | 3.3 | 3.9 | 4.5 |
| 19 | 2.1 | 2.4 | 2.8 | 2.3 | 2.6 | 3.2 | 2.7 | 2.0 | 2.2 | 2.6 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | 1.4 | 1.4 | 1.4 | 2.0 | 2.1 | 2.0 | 2.1 | 1.9 | 2.1 | 2.3 |
| 25 | 1.3 | 1.4 | 1.3 | 1.5 | 1.7 | 1.9 | 1.7 | 1.2 | 1.4 | 1.7 |
| 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.7 | 0.8 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.3 |
| 31 | 0.7 | 0.7 | 0.8 | 1.0 | 1.1 | 1.1 | 1.1 | 0.8 | 1.0 | 1.1 |
| 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | 0.5 | 0.6 | 0.7 | 0.6 | 0.7 | 0.8 | 0.7 | 0.7 | 0.7 | 0.8 |
| 37 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.7 | 0.8 |
| 39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 41 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 |
| 42 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 | 0.5 |
| 44 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 46 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 47 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 |
| 48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 49 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| 50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total RMS Current (A) | **125.9** | **148.2** | **183.9** | **143.8** | **163.8** | **196.8** | **168.9** | **118.0** | **140.2** | **166.0** |
| THD (V) % | 1.49 | 1.66 | 1.87 | 1.95 | 2.13 | 2.34 | 2.15 | 1.87 | 2.06 | 2.25 |

# CERTIFICATION FOR THE DRIVE

## Requirements for EMC Compliance

All Variable Speed Drives (VSDs) potentially produce electrical emissions which are radiated into the environment and conducted back into the ac supply. VSDs are inherently immune to any additional external electrical noise. The following information is provided to maximise the Electro Magnetic Compatibility (EMC) of VSDs and systems in their intended operating environment, by minimising their emissions and maximising their immunity.

### Minimising Radiated Emissions

EN50081-1 (1992)/EN50081-2 (1994)/EN55011/EN55022 radiated emission measurements are made between 30MHz and 1GHz in the far field at a distance of 10 to 30 metres. Limits lower than 30MHz or in close proximity are not specified. Emissions from individual components tend to be additive.

- Use a screened/armoured cable between VSD/cubicle and motor containing the motor protective earth (PE) connection. It should have a 360° screen termination. Earth screen at both ends connecting to the motor frame and cubicle (or gland box if wall mounted). Maintain the screen integrity using 360° terminations.

*Note:* *Some hazardous area installations may preclude direct earthing at both ends of the screen, in this case earth one end via a 1μF 50Vac capacitor, and the other as normal.*

- Keep unshielded cable as short as possible inside the cubicle.

- Always maintain the integrity of the shield.

- If the cable is interrupted to insert contactors etc., re-connect the screen using the shortest possible route.

- Keep the length of screen stripped-back as short as possible when making screen connections.

- Ideally use 360° screen terminations using cable glands or 'U' clips on power screen rails.

If a shielded cable is not available, lay unshielded motor cables in a metal conduit which will act as a shield. The conduit must be continuous with a direct electrical contact to the VSD and motor housing. If links are necessary, use braid with a minimum cross sectional area of 10mm$^2$.

*Note:* *Some motor gland boxes and conduit glands are made of plastic, if this is the case, then braid must be connected between the screen and the chassis. In addition at the motor end, ensure that the screen is electrically connected to the motor frame since some terminal boxes are insulated from the frame by gasket/paint.*

### Earthing Requirements

**IMPORTANT:** Protective earthing always takes precedence over EMC earthing.

#### Protective Earth (PE) Connections

*Note:* *In accordance with installations to EN60204, only one protective earth conductor is permitted at each protective earth terminal contacting point.*

Local wiring regulations may require the protective earth connection of the motor to be connected locally, i.e. not as specified in these instructions. This will not cause shielding problems because of the relatively high RF impedance of the local earth connection.

#### EMC Earth Connections

For compliance with EMC requirements, we recommend that the "0V/signal ground" is separately earthed. When a number of units are used in a system, these terminals should be connected together at a single, local earthing point.

Control and signal cables for the encoder, all analog inputs, and communications require screening with the screen connected only at the VSD end. However, if high frequency noise is still a problem, earth screen at the non VSD end via a 0.1μF capacitor.

*Note:* *Connect the screen (at the VSD end) to the VSD protective earth point, and not to the control board terminals.*

## Cabling Requirements

*Note:* *Refer to Chapter 8: "Technical Specifications" for additional Cabling Requirements.*

### Planning Cable Runs

- Use the shortest possible motor cable lengths.

- Use a single length of cable to a star junction point to feed multiple motors.

- Keep electrically noisy and sensitive cables apart.

- Keep electrically noisy and sensitive parallel cable runs to a minimum. Separate parallel cable runs by at least 0.25 metres. For runs longer than 10 metres, separation should be increased proportionally. For example if the parallel runs were 50m, then the separation would be (50/10) x 0.25m = 1.25m.

- Sensitive cables should cross noisy cables at 90°.

- Never run sensitive cables close or parallel to the motor, dc link and braking chopper circuit for any distance.

- Never run supply, dc link or motor cables in the same bundle as the signal/control and feedback cables, even if they are screened.

- Ensure EMC filter input and output cables are separately routed and do not couple across the filter.

### Increasing Motor Cable Length

Because cable capacitance and hence conducted emissions increase with motor cable length, conformance to EMC limits is only guaranteed with the specified ac supply filter option using a maximum cable length as specified in Chapter 11: "Technical Specifications".

This maximum cable length can be improved using the specified external input or output filters. Refer to Chapter 8: "Technical Specifications" - External AC Supply (RFI) Filters.

Screened/armoured cable has significant capacitance between the conductors and screen which increases linearly with cable length (typically 200pF/m but varies with cable type and current rating).

Long cable lengths may have the following undesirable effects:

- Tripping on `overcurrent' as the cable capacitance is charged and discharged at the switching frequency.

- Producing increased conducted emissions which degrade the performance of the EMC filter due to saturation.

- Causing RCDs (Residual Current Devices) to trip due to increased high frequency earth current.

- Producing increased heating inside the EMC ac supply filter from the increased conducted emissions.

These effects can be overcome by adding chokes or output filters at the output of the VSD.

## EMC Installation Options

The unit, when installed for Class A or Class B operation, will be compliant with EN55011 (1991)/ EN55022 (1994) for radiated emissions, as described below.

### Screening & Earthing (wall mounted, Class A)

**IMPORTANT:** This unit must be fitted with the optional top cover.

The unit is installed for Class A operation when wall mounted using the recommended ac supply filter and having complied with all cabling requirements.

*Note:* *The installation requirements of local safety standards must be achieved regarding the safety of electrical equipment for machines.*

- A single-star point earthing policy as shown in Figure 9-2 is required.

- The protective earth connection (PE) to the motor must be run inside the screened cable between the motor and VSD and be connected to the protective earth terminal in the gland box, or on the VSD.

- The internal/external ac supply filter must be permanently earthed. Refer to Chapter 8: "Technical Specifications" - Earthing/Safety Details.

- The signal/control cables should be screened.

*Note:* *Refer to Chapter 8: "Technical Specifications" for details on Cabling Requirements.*

### Screening & Earthing (cubicle mounted, Class B)

*Note:* *The installation requirements of local safety standards must be achieved regarding the safety of electrical equipment for machines.. Refer to Chapter 3: "Installing the Drive" - Protective Earth (PE) Connections ⏚.*

The unit is installed for Class B operation when mounted inside a cubicle having 10dB attenuation between 30 and 100MHz (typically the attenuation provided by a metal cabinet with no aperture of dimension greater than 0.15m), using the recommended ac supply filter and having met all cabling requirements.

*Note:* *Radiated magnetic and electric fields inside the cubicle will be high and any components fitted inside must be sufficiently immune.*

The VSD, external filter and associated equipment are mounted onto a conducting, metal mounting panel. Do not use cubicle constructions that use insulating mounting panels or undefined mounting structures. Cables between the VSD and motor must be screened or armoured and terminated at the VSD or locally on the back panel.

## Single VSD - Single Motor

Apply a single point series earthing strategy for a single VSD mounted in a cubicle as shown.

The protective earth connection (PE) to the motor must be run inside the screened cable between the motor and VSD and be connected to the motor protective earth terminal on the VSD.
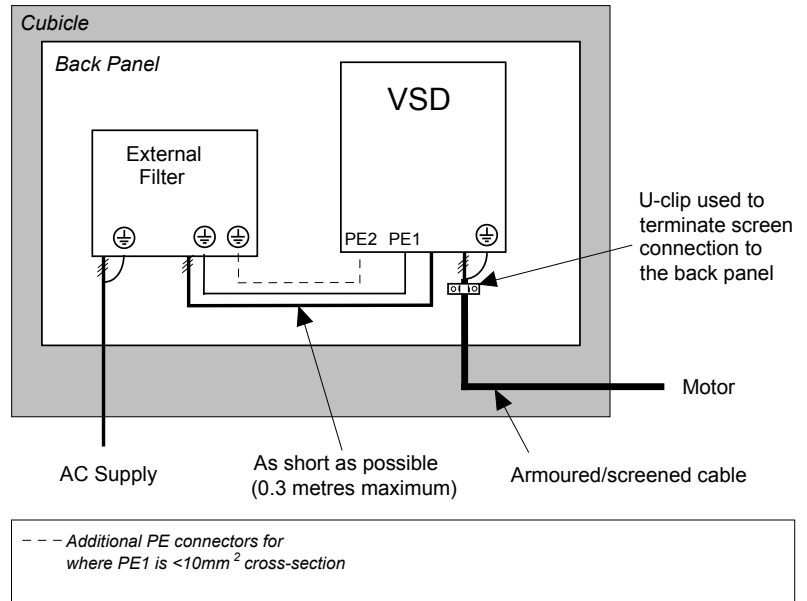


**Figure 9-1 EMC and Safety Earthing Cabling**

## Single VSD - Multiple Motors

***Note:*** *Refer to Chapter 10: "Application Notes" - Using Multiple Motors on a Single Drive.*

If connecting multiple motors to a single VSD, use a star junction point for motor cable connections. Use a metal box with entry and exit cable glands to maintain shield integrity. Refer to Chapter 10: Application Notes" - Using Multiple Motors on a Single Drive.

# Star Point Earthing

A star-point earthing policy separates 'noisy' and 'clean' earths. Four separate earth busbars (three are insulated from the mounting panel) connect to a single earth point (star point) near the incoming safety earth from the main supply. Flexible, large cross-section cable is used to ensure a low HF impedance. Busbars are arranged so that connection to the single earth point is as short as possible.

### 1 Clean Earth Busbar (insulated from the mounting panel)

Used as a reference point for all signal and control cabling. This may be further subdivided into an analog and a digital reference busbar, each separately connected to the star earthing point. The digital reference is also used for any 24V control.

***Note:*** *The 690+ uses a single clean earth busbar for analog and digital.*

### 2 Dirty Earth Busbar (insulated from the mounting panel)

Used for all power earths, i.e. protective earth connection. It is also used as a reference for any 110 or 220V control used, and for the control transformer screen.

### 3 Metal Work Earth Busbar

The back panel is used as this earth busbar, and should provide earthing points for all parts of the cubicle including panels and doors. This busbar is also used for power screened cables which terminate near to (10cm) or directly into a VSD - such as motor cables, braking choppers and their resistors, or between VSDs - refer to the appropriate product manual to identify these. Use U-clips to clamp the screened cables to the back panel to ensure optimum HF connection.

### 4 Signal/Control Screen Earth Busbar (insulated from the mounting panel)

Used for signal/control screened cables which **do not** go directly to the VSD. Place this busbar as close as possible to the point of cable entry. 'U' clamp the screened cables to the busbars to ensure an optimum HF connection.
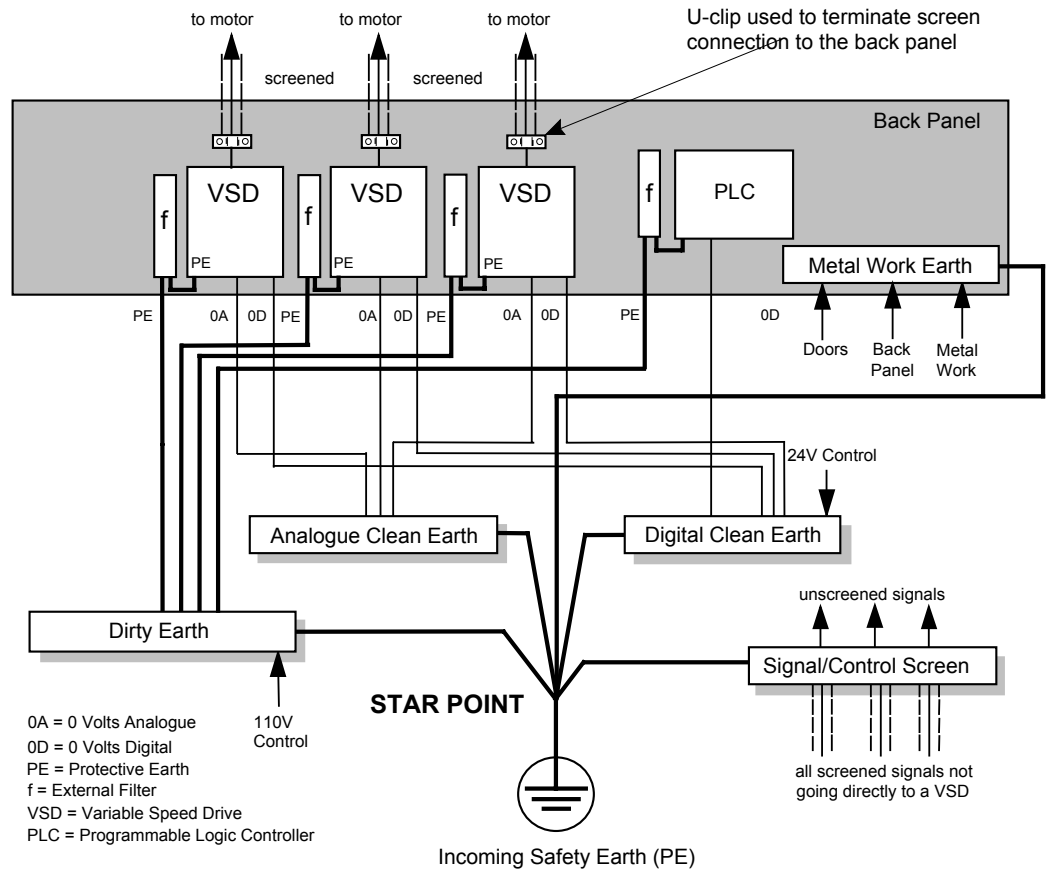
Figure 9-2  Star Point Earthing

0A = 0 Volts Analogue
0D = 0 Volts Digital
PE = Protective Earth
f = External Filter
VSD = Variable Speed Drive
PLC = Programmable Logic Controller

## Sensitive Equipment

The proximity of the source and victim circuit has a large effect on radiated coupling. The electromagnetic fields produced by VSDs falls off rapidly with distance from the cabling/cubicle. Remember that the radiated fields from EMC compliant drive systems are measured at least 10m from the equipment, over the band 30-1000MHz. Any equipment placed closer than this will see larger magnitude fields, especially when very close to the drive.

Do not place magnetic/electric field sensitive equipment within 0.25 metres of the following parts of the VSD system:

- Variable Speed Drive (VSD)
- EMC output filters
- Input or output chokes/transformers
- The cable between VSD and motor (even when screened/armoured)
- Connections to external braking chopper and resistor (even when screened/armoured)
- AC/DC brushed motors (due to commutation)
- DC link connections (even when screened/armoured)
- Relays and contactors (even when suppressed)

From experience, the following equipment is particularly sensitive and requires careful installation.

- Any transducers which produce low level analog outputs (<1V) , e.g. load cells, strain gauges, thermocouples, piezoelectric transducers, anemometers, LVDTs
- Wide band width control inputs (>100Hz)
- AM radios (long and medium wave only)
- Video cameras and closed circuit TV
- Office personal computers
- Capacitive devices such as proximity sensors and level transducers
- Mains borne communication systems
- Equipment not suitable for operation in the intended EMC environment, i.e. with insufficient immunity to new EMC standards

# Requirements for UL Compliance

### Solid-State Motor Overload Protection

These devices provide Class 10 motor overload protection. The maximum internal overload protection level (current limit) is 150% for 60 seconds in Constant mode, and 110% for 60s in Quadratic mode. Refer to the Software Product Manual, Chapter 1: Programming Your Application - CURRENT LIMIT for user current limit adjustment information.

An external motor overload protective device must be provided by the installer where the motor has a full-load ampere rating of less than 50% of the drive output rating; or when the MOTOR STALLED trip is TRUE (TRIPS STATUS::DISABLE TRIPS>> MOTOR STALLED); or when the STALL TIME parameter is increased above 480 seconds (refer to the 690+ Software Manual, Chapter 1 : STALL TRIP).

### Short Circuit Rating

The following drives are suitable for use on a circuit capable of delivering not more than:

Frame B: 10,000 RMS Symmetrical Amperes, 230/460/500V maximum (as appropriate)
Frame C: 10,000 RMS Symmetrical Amperes, 230/460/500V maximum (as appropriate)
Frame D: 10,000 RMS Symmetrical Amperes, 230/460/500V maximum (as appropriate)
Frame E: 18,000 RMS Symmetrical Amperes, 230/460/500V maximum (as appropriate)
Frame F: 18,000 RMS Symmetrical Amperes, 230/460/500V maximum (as appropriate)

### Solid-State Short-Circuit Protection

These devices are provided with Solid-State Short-Circuit (output) Protection. Branch circuit protection requirements must be in accordance with the latest edition of the National Electrical Code NEC/NFPA-70.

### Recommended Branch Circuit Protection

It is recommended that UL Listed (JDDZ) non-renewable cartridge fuses, Class K5 or H; or UL Listed (JDRX) renewable cartridge fuses, Class H, are installed upstream of the drive. Refer to Chapter 8: "Technical Specifications" - Power Details for recommended fuse ratings.

### Motor Base Frequency

The motor base frequency rating is 480Hz maximum.

### Field Wiring Temperature Rating

Use 75°C Copper conductors only.

### Field Wiring Terminal Markings

For correct field wiring connections that are to be made to each terminal refer to Chapter 3: "Installing the Drive" - Power Wiring Connections, and Control Wiring Connections.

### Terminal Tightening Torques

Refer to Chapter 3: "Installing the Drive" - Terminal Tightening Torques.

# Recommended Wire Sizes

North American wire sizes (AWG) are based on NEC/NFPA-70 for ampacities of thermoplastic-insulated (75ºC) copper conductors assuming not more than three current-carrying conductors in raceway or cable, based on ambient temperature of 30ºC.

The wire sizes allow for an ampacity of 125% of the rated input and output amperes for motor branch-circuit conductors as specified in NEC/NFPA-70.

| FRAME B Terminal acceptance range: 18-10 AWG | | | |
|---|---|---|---|
| Model Catalog Code for North America | Power Input AWG | Power Output AWG | Brake Output AWG |
| **230V Build Variant: 220-240V ±10%** | | | |
| CONSTANT | | | |
| 690+/0001/230/../1 | 14 | 14 | 14 |
| 690+/0002/230/../1 | 10 | 14 | 14 |
| 690+/0003/230/../1 | 10 | 14 | 14 |
| 690+/0001/230/.. | 14 | 14 | 14 |
| 690+/0002/230/.. | 14 | 14 | 14 |
| 690+/0003/230/.. | 12 | 14 | 14 |
| 690+/0005/230/.. | 10 | 10 | 10 |
| **400V Build Variant: 460V ±10%** | | | |
| CONSTANT | | | |
| 690+/0001/460/.. | 14 | 14 | 14 |
| 690+/0002/460/.. | 14 | 14 | 14 |
| 690+/0003/460/.. | 14 | 14 | 14 |
| 690+/0005/460/.. | 14 | 14 | 14 |
| 690+/0007/460/.. | 12 | 14 | 12 |
| 690+/0010/460/.. | 10 | 12 | 10 |

| FRAME C Terminal acceptance range: 18-6 AWG | | | |
|---|---|---|---|
| Model Catalog Code for North America | Power Input AWG | Power Output AWG | Brake Output AWG |
| **230V Build Variant: 220-240V ±10%** | | | |
| CONSTANT | | | |
| 690+/0007/230/.. | 8 | 10 | 12 |
| 690+/0010/230/.. | 8 | 8 | 12 |
| QUADRATIC | | | |
| 690+/0007/230/.. | 8 | 8 | 14 |
| 690+/0015/230/.. | 6 | 6 | 14 |
| **400V Build Variant: 460V ±10%** | | | |
| CONSTANT | | | |
| 690+/0007/460/.. | 12 | 14 | 12 |
| 690+/0010/460/.. | 12 | 12 | 12 |
| 690+/0015/460/.. | 10 | 10 | 12 |
| 690+/0020/460/.. | 8 | 8 | 12 |
| QUADRATIC | | | |
| 690+/0007/460/.. | 12 | 12 | 14 |
| 690+/0010/460/.. | 10 | 10 | 12 |
| 690+/0015/460/.. | 8 | 8 | 12 |
| 690+/0020/460/.. | 8 | 8 | 12 |

| FRAME D | | | |
|---|---|---|---|
| Terminal acceptance range: 14-4 AWG | | | |
| Model Catalog Code for North America | Power Input AWG | Power Output AWG | Brake Output AWG |
| **230V Build Variant: 220-240V ±10%** | | | |
| CONSTANT | | | |
| 690+/0015/230/.. | 6 | 6 | 10 |
| 690+/0020/230/.. | 4 | 4 | 10 |
| 690+/0025/230/.. | 4 | 4 | 10 |
| QUADRATIC | | | |
| 690+/0015/230/.. | 4 | 4 | 10 |
| 690+/0020/230/.. | 4 | 4 | 10 |
| **400V Build Variant: 460V ±10%** | | | |
| CONSTANT | | | |
| 690+/0020/460/.. | 8 | 8 | 10 |
| 690+/0025/460/.. | 8 | 8 | 10 |
| 690+/0030/460/.. | 8 | 6 | 10 |
| 690+/0040/460/.. | 4 | 6 | 10 |
| QUADRATIC | | | |
| 690+/0020/460/.. | 8 | 8 | 10 |
| 690+/0025/460/.. | 8 | 6 | 10 |
| 690+/0030/460/.. | 6 | 6 | 10 |
| 690+/0040/460/.. | 4 | 4 | 10 |

| FRAME E | | | |
|---|---|---|---|
| Terminal acceptance range: 6-1/0 AWG | | | |
| Model Catalog Code for North America | Power Input AWG | Power Output AWG | Brake Output AWG |
| **230V Build Variant: 220-240V ±10%** | | | |
| CONSTANT | | | |
| 690+/0030/230/.. | 2 | 3 | 8 |
| QUADRATIC | | | |
| 690+/0030/230/.. | 1/0 | 1 | 8 |
| **400V Build Variant: 460V ±10%** | | | |
| CONSTANT | | | |
| 690+/0040/460/.. | 4 | 4 | 8 |
| 690+/0050/460/.. | 4 | 3 | 8 |
| 690+/0060/460/.. | 3 | 2 | 8 |
| QUADRATIC | | | |
| 690+/0040/460/.. | 4 | 3 | 8 |
| 690+/0050/460/.. | 3 | 2 | 8 |
| 690+/0060/460/.. | 1 | 1 | 8 |

| Model Catalog Code for North America | Power Input AWG | Power Output AWG | Brake Output AWG |
|---|---|---|---|
| **FRAME F** Terminal acceptance range: 2AWG-250kcmil | | | |
| **230V Build Variant: 220-240V ±10%** | | | |
| **CONSTANT** | | | |
| 690+/0040/230/.. | 1 | 1 | 8 |
| 690+/0050/230/.. | 2/0 | 2/0 | 8 |
| 690+/0060/230/.. | 3/0 | 3/0 | 8 |
| **QUADRATIC** | | | |
| 690+/0040/230/.. | 2/0 | 2/0 | 8 |
| 690+/0050/230/.. | 3/0 | 3/0 | 8 |
| 690+/0060/230/.. | 4/0 | 250kcmil | 8 |
| **400V Build Variant: 460V ±10%** | | | |
| **CONSTANT** | | | |
| 690+0075/460/.. | 1 | 1 | 8 |
| 690+0100/460/.. | 2/0 | 2/0 | 8 |
| 690+0125/460/.. | 3/0 | 3/0 | 8 |
| 690+0150/460/.. | 4/0 | 4/0 | 8 |
| **QUADRATIC** | | | |
| 690+0075/460/.. | 2/0 | 2/0 | 8 |
| 690+0100/460/.. | 3/0 | 3/0 | 8 |
| 690+0125/460/.. | 4/0 | 4/0 | 8 |
| 690+0150/460/.. | 4/0 | 4/0 | 8 |

## Field Grounding Terminals

The field grounding terminals are identified with the International Grounding Symbol (IEC Publication 417, Symbol 5019).

## Operating Ambient Temperature

| | | | |
|---|---|---|---|
| Constant Duty | Open Type | Cubicle Mounted | 45°C |
| | UL Type 1 Enclosed | Wall Mounted with top cover | 40°C |
| Quadratic Duty | Open Type | Cubicle Mounted | 40°C |
| | UL Type 1 Enclosed | Wall Mounted with top cover | 35°C |

## Direct Wall-Mountable Models

All models of this drive with a Product Code Block 6 (Frame B) or Block 4 (Frames C, D, E) designation xx2x are suitable for direct wall mounting applications as they have a "Type 1 Enclosure" rating.

In order to preserve this enclosure rating, it is important to maintain the environmental integrity of the enclosure. Therefore, the installer must provide correct Type 1 closures for all unused clearance holes provided within the drive's glandplate.

Type 1 Enclosed models are suitable for use in no worse than a Pollution Degree 2 environment.

| Input Fuse Ratings (North America) | | | | | | c UL US LISTED |
|---|---|---|---|---|---|---|

| Catalog Number | Input Fuse Rating (A) | | Catalog Number | Input Fuse Rating (A) | |
|---|---|---|---|---|---|
| | Constant | Quadratic | | Constant | Quadratic |
| **230V BUILD VARIANT** 220-240V ±10%, 45-65Hz * | | | | | |
| Frame B | | | Frame C | | |
| 690+/0001/230../1 | 15 | - | 690+/0007/230.. | 30 | 35 |
| 690+/0002/230../1 | 25 | - | 690+/0010/230.. | 35 | 50 |
| 690+/0003/230../1 | 30 | - | | | |
| 690+/0001/230.. | 10 | - | | | |
| 690+/0002/230.. | 15 | - | | | |
| 690+/0003/230.. | 15 | - | | | |
| 690+/0005/230.. | 25 | - | | | |
| Frame D | | | Frame E | | |
| 690+/0015/230.. | 50 | 60 | 690+/0030/230.. | 100 | 125 |
| 690+/0020/230.. | 60 | 70 | | | |
| 690+/0025/230.. | 70 | - | | | |
| Frame F | | | | | |
| 690+/0040/230.. | 110 | 150 | | | |
| 690+/0050/230.. | 150 | 150 | | | |
| 690+/0060/230.. | 150 | 200 | | | |
| **400V BUILD VARIANT** 380-460V ±10%, 45-65Hz * | | | | | |
| Frame B | | | Frame C | | |
| 690+0001/460/.. | 6 | - | 690+/0007/460/.. | 15 | 20 |
| 690+0002/460/.. | 10 | - | 690+/0010/460/.. | 20 | 25 |
| 690+0003/460/.. | 10 | - | 690+/0015/460/.. | 25 | 30 |
| 690+0005/460/.. | 15 | - | 690+/0020/460/.. | 35 | 40 |
| 690+0007/460/.. | 20 | - | | | |
| 690+0010/460/.. | 25 | - | | | |
| Frame D | | | Frame E | | |
| 690+/0020/460/.. | 30 | 40 | 690+/0040/460/.. | 60 | 70 |
| 690+/0025/460/.. | 40 | 45 | 690+/0050/460/.. | 70 | 90 |
| 690+/0030/460/.. | 45 | 60 | 690+/0060/460/.. | 90 | 100 |
| 690+/0040/460/.. | 60 | 70 | | | |
| Frame F | | | | | |
| 690+/0075/460/.. | 110 | 125 | | | |
| 690+/0100/460/.. | 125 | 150 | | | |
| 690+/0125/460/.. | 150 | 175 | | | |
| 690+/0150/460/.. | 175 | 175 | | | |
| **\* Note : Frame B only is 50Hz ±5% or 60Hz ±5%** | | | | | |

# European Directives and the CE Mark

The following information is supplied to provide a basic understanding of the EMC and low voltage directives CE marking requirements. The following literature is recommended for further information:

- *Recommendations for Application of Power Drive Systems (PDS), European Council Directives - CE Marking and Technical Standardisation* - (CEMEP)

  Available from your local trade association or SSD Drives office

- *EMC Installation Guidelines for Modules and Systems* - (SSD Drives)

  Available from your local SSD Drives office, part number HA388879

The European machines and drives manufacturers via their national trade associations have formed the European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP). SSD Drives and other major European drives manufacturers are working to the CEMEP recommendations on CE marking. The CE mark shows that a product complies with the relevant EU directives, in our case the Low Voltage Directive and, in some instances, the EMC Directive.

## CE Marking for Low Voltage Directive

When installed in accordance with this manual, the 690+ AC Drive is CE marked by SSD Drives Ltd in accordance with the low voltage directive (S.I. No. 3260 implements this LVD directive into UK law). An EC Declaration of Conformity (low voltage directive) is included at the end of this chapter.

## CE Marking for EMC - Who is Responsible?

*Note:* *The specified EMC emission and immunity performance of this unit can only be achieved when the unit is installed to the EMC Installation Instructions given in this manual.*

According to S.I. No. 2373 which implements the EMC directive into UK law, the requirement for CE marking this unit falls into two categories:

1. Where the supplied unit has an intrinsic/direct function to the end user, then the unit is classed as *relevant apparatus*.

2. Where the supplied unit is incorporated into a higher system/apparatus or machine which includes (at least) the motor, cable and a driven load but is unable to function without this unit, then the unit is classed as a *component*.

### ■ *Relevant Apparatus* - SSD Drives Responsibility

Occasionally, say in a case where an existing fixed speed motor - such as a fan or pump - is converted to variable speed with an add-on drive module *(relevant apparatus)*, it becomes the responsibility of SSD Drives to apply the CE mark and issue an EC Declaration of Conformity for the EMC Directive. This declaration and the CE mark is included at the end of this chapter.

### ■ *Component* - Customer Responsibility

The majority of SSD Drives' products are classed as *components* and therefore we cannot apply the CE mark or produce an EC Declaration of Conformity in respect of EMC. It is therefore the manufacturer/supplier/installer of the higher system/apparatus or machine who must conform to the EMC directive and CE mark.

## Legal Requirements for CE Marking

**IMPORTANT:** Before installation, clearly understand who is responsible for conformance with the EMC directive. Misappropriation of the CE mark is a criminal offence.

It is important that you have now defined who is responsible for conforming to the EMC directive, either:

### ■ SSD Drives Responsibility

You intend to use the unit as *relevant apparatus.*

When the specified EMC filter is correctly fitted to the unit following EMC installation instructions, it complies with the relevant standards indicated in the following tables. The fitting of the filter is mandatory for the CE marking of this unit to apply.

The relevant declarations are to be found at the end of this chapter. The CE mark is displayed on the EC Declaration of Conformity (EMC Directive) provided at the end of this chapter.

### ■ Customer Responsibility

You intend to use the unit as a *component,* therefore you have a choice:

1.  To fit the specified filter following EMC installation instructions, which may help you gain EMC compliance for the final machine/system.

2.  Not to fit the specified filter, but use a combination of global or local filtering and screening methods, natural migration through distance, or the use of distributed parasitic elements of the existing installation.

*Note:* *When two or more EMC compliant components are combined to form the final machine/system, the resulting machine/system may no longer be compliant, (emissions tend to be additive, immunity is determined by the least immune component). Understand the EMC environment and applicable standards to keep additional compliance costs to a minimum.*

## Applying for CE Marking for EMC

We have supplied a Manufacturer's EMC Declaration at the end of this chapter that you can use as a basis for your own justification of overall compliance with the EMC directive. There are three methods of demonstrating conformity:

1.  Self-certification to a relevant standard

2.  Third party testing to a relevant standard

3.  Writing a technical construction file stating the technical rationale as to why your final machine/system is compliant. An EMC "competent body" must then assess this and issue a technical report or certificate to demonstrate compliance.
    Refer to Article 10(2) of Directive 89/336/EEC.

With EMC compliance, an EC Declaration of Conformity and the CE mark will be issued for your final machine/system.

**IMPORTANT:** Professional end users with EMC expertise who are using drive modules and cubicle systems defined as components who supply, place on the market or install the relevant apparatus must take responsibility for demonstrating EMC conformance and applying the CE mark and issuing an EC Declaration of Conformity.

# Which Standards Apply?

## Power Drive Product Specific

The standards that may apply to this unit come under two broad categories:

1.  Emission - these standards limit the interference caused by operating (this) drive module.

2.  Immunity - these standards limit the effect of interference (on this unit) from other electrical and electronic apparatus.

Conformance can be demonstrated using the Product Specific Standard.

START

```
┌─────────────────────┐
│   IS SSD MODULE     │        NO
│ RELEVANT APPARATUS  │ ──────────────────────────┐
│WITH INTRINSIC FUNCTION│                          │
│ TO END USER (CEMEP  │                            │
│   VALIDITY FIELD 1) │                            │
└─────────────────────┘                            │
        │ YES                                       │
        │                              ┌────────────────────────┐
        │                              │  CEMEP VALIDITY FIELDS │
        │                              │      2, 3 AND 4        │
        │                              └────────────────────────┘
        │                                           │
┌─────────────────────┐       NO                    │
│ WILL THE SSD PRODUCT│ ──────────────┐  ┌────────────────────────┐
│   BE INSTALLED      │               │  │  OPTIONAL SSD FILTERS  │
│ ACCORDING TO THE    │               │  │ AVAILABLE TO ASSIST USERS│
│   INSTALLATION      │               │  │ IN CONFORMANCE WITH THE │
│   GUIDELINES        │               │  │     EMC DIRECTIVE      │
└─────────────────────┘               │  └────────────────────────┘
        │ YES                         │              │
┌─────────────────────┐               │  ┌────────────────────────┐
│ FIT THE SPECIFIED   │               │  │  EMC CHARACTERISTICS   │
│ SSD EMC FILTER      │               │  │   STATED IN MANUAL     │
└─────────────────────┘               │  └────────────────────────┘
        │                             │              │
┌─────────────────────┐               │  ┌────────────────────────┐
│ THE SSD EC DECLARATION│              │  │ EMC INSTALLATION GUIDELINES│
│ CONFORMITY FOR EMC IS VALID│         │  │   STATED IN MANUAL     │
│ FOR THE SPECIFIED MODULE│            │  └────────────────────────┘
└─────────────────────┘               │              │
        │                             │  ┌────────────────────────┐
┌─────────────────────┐               │  │ THE ED MANUFACTURERS DECLARATION│
│ EMC 'CE' MARK CAN BE APPLIED TO SSD│ │  │ FOR EMC IS VALID FOR THE SPECIFIED│
│ MODULE TO GENERIC EMC STANDARDS:│    │  │ MODULE WHEN INSTALLED CORRECTLY│
└─────────────────────┘               │  └────────────────────────┘
        │                             │              │
┌─────────────────────┐               │  ┌────────────────────────┐
│   EN61800-3 (1997)  │               │  │  A GLOBAL EMC SOLUTION │
└─────────────────────┘               │  │  MAY BE ADVANTAGEOUS   │
                                      │  └────────────────────────┘
                                      │              │
                                      └─→ NO EMC 'CE' MARK APPLIED TO SSD MODULE.
```

SSD = SSD DRIVES LIMITED
CEMEP : Refer to Chapter 12, "European Directives and the CE Mark"

RELEVANT APPARATUS
MANUFACTURER/SUPPLIER/INSTALLERS
RESPONSIBILITY TO CONFORM WITH EMC DIRECTIVE.
SSD EMC CHARACTERISTICS AND MANUFACTURERS
DECLARATION MAY BE USED AS A BASIS
IN THE OVERALL PRODUCT JUSTIFICATION

**Figure 9-3  SSD EMC `CE' Mark Validity Chart**

## Certificates

### 690P

**C E**   **EC DECLARATIONS OF CONFORMITY**

Date CE marked first applied: 01.04.2000

Issued for compliance with the EMC Directive when the unit is used as *relevant apparatus*.

#### EMC Directive

In accordance with the EEC Directive 89/336/EEC and amended by 92/31/EEC and 93/68/EEC, Article 10 and Annex 1, (EMC DIRECTIVE)

We SSD Drives Limited, address as below, declare under our sole responsibility that the above Electronic Products when installed and operated with reference to the instructions in the Product Manual (provided with each piece of equipment) is in accordance with the relevant clauses from the following standard:-

\* BSEN61800-3 (1997)

#### Low Voltage Directive

In accordance with the EEC Directive 73/23/EEC and amended by 93/68/EEC, Article 13 and Annex III, (LOW VOLTAGE DIRECTIVE)

We SSD Drives Limited, address as below, declare under our sole responsibility that the above Electronic Products when installed and operated with reference to the instructions in the Product Manual (provided with each piece of equipment), is in accordance with the relevant clauses from the following standard :-
EN50178 (1998)

The drive is CE marked in accordance with the low voltage directive for electrical equipment and appliances in the voltage range when installed correctly.

### MANUFACTURERS DECLARATIONS

This is provided to aid your justification for EMC compliance when the unit is used as a *component.*

#### EMC Declaration

We SSD Drives Limited, address as below, declare under our sole responsibility that the above Electronic Products when installed and operated with reference to the instructions in the Product Manual (provided with each piece of equipment) is in accordance with the relevant clauses from the following standard:-

\* BSEN61800-3 (1997)

#### Machinery Directive

The above Electronic Products are components to be incorporated into machinery and may not be operated alone. The complete machinery or installation using this equipment may only be put into service when the safety considerations of the Directive 89/392/EEC are fully adhered to. Particular reference should be made to EN60204-1 (Safety of Machinery - Electrical Equipment of Machines).
All instructions, warnings and safety information of the Product Manual must be adhered to.

Since the potential hazards are mainly electrical rather than mechanical, the drive does not fall under the machinery directive. However, we do supply a manufacturer's declaration for when the drive is used (as a *component*) in machinery.

*M. Payn*

Dr Martin Payn (Conformance Officer)

\*  *Compliant with the immunity requirements of the Standard without specified EMC filters.*
\*  *690PB only when fitted with an internal or external filter.*

**SSD DRIVES LIMITED**
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File Name: P:\EDL1\USER\PRODUCTS\CE\SAFETY\PRODUCTS\690P PRODUCT COMMON CONFORMANCE\HP465505.919

| ISS: | DATE | DRN: MP   CHKD: | DRAWING NUMBER: HK465505.C919 | |
|------|------|-----------------|-------------------------------|---|
| A | 01.04.00 | **SSD** DRIVES | TITLE:<br><br>Declarations of Conformity | SHT 1 OF 1 SHTS |

# APPLICATION NOTES

Application advice is available through our Technical Support Department, who can also arrange for on-site assistance if required. Refer to the back cover of this manual for the address of your local SSD Drives company.

- Always use gold flash relays, or others designed for low current operation (5mA), on all control wiring.

- Remove all power factor correction equipment from the motor side of the drive before use.

- Avoid using motors with low efficiency and small cos ø (power factor) as they require a larger kVA rated drive to produce the correct shaft kW.

## Synchronous Motor Control

Although intended primarily for use with induction (asynchronous) motors, drives can also be used for speed control of synchronous motors.  Synchronous motors can offer economic solutions in applications where tight control of speed is required together with the low maintenance characteristics of an ac motor.

The two most common types of synchronous ac motor are *permanent magnet* and *wound rotor*.

In contrast to induction motors, synchronous motors run at synchronous speed whether on full load or no load. Synchronous speed is set by the frequency of the supply applied to the stator. The stator flux can be kept constant by keeping the stator volts/frequency ratio constant, as with an induction motor.

Torque is produced in the motor by an increase in load angle between the stator and rotor fluxes. Maximum torque occurs when the load angle approaches 90°. If the load angle exceeds this value then torque drops and the motor will stall. Systems involving synchronous motors need careful design to ensure that the motor can accelerate the load and handle transient load changes without stalling.

## Brake Motors

Brake motors are used in applications requiring a mechanical brake for safety or other operational reasons. The motor can be a standard induction motor fitted with an electro-mechanical brake, or it could be a special conical rotor machine. In the case of a conical rotor machine the spring-loaded brake is controlled by the motor terminal voltage as follows:

- At rest the motor is braked.

- When the motor is energised an axial component of the magnetic field due to the conical air-gap overcomes the force of the brake spring and draws the rotor into the stator. This axial displacement releases the brake and allows the motor to accelerate like a normal induction motor.

- When the motor is de-energised the magnetic field collapses and the brake spring displaces the rotor, pushing the brake disc against the braking surface.

Drives can be used to control the speed of conical rotor brake motors since the linear V/F characteristic maintains the motor magnetic field constant over the speed range.  It will be necessary to set the  FIXED BOOST parameter to overcome motor losses at low speed (see FLUXING menu at level 3).

## Using Line Chokes

Line chokes are not required to limit input current to SSD Drives Inverters.   Controllers from 5.5kW ( 400v) or 2.2kW ( 230v) upwards are fitted with DC link chokes to limit the ripple current seen by the DC link capacitors and thus prolong their life.

Line chokes may be used to reduce the harmonic content of the supply current where this a particular requirement of the application or where greater protection from mains borne transients is required.

# Using Output Contactors

The use of output contactors is permitted. It is recommended that this type of operation be limited to emergency use only or in a system where the drive can be inhibited before closing or opening this contactor.

# Using Motor Chokes

Installations with motor cable runs in excess of 50m may suffer from nuisance overcurrent trips. This is due to the capacitance of the cable causing current spikes to be drawn from the drive output.  A choke may be fitted in the drive output which limits the capacitive current.  Screened cable has a higher capacitance and may cause problems in shorter runs.  The recommended choke values are shown in Table 13.1.

| Motor Power (kW) | Choke Inductance | RMS Current Rating | SSD Part No. |
|---|---|---|---|
| 0.75 | | | |
| 1.1 | | | |
| 1.5 | 2mH | 7.5A | CO055931 |
| 2.2 | | | |
| 4.0 | | | |
| 5.5 | 0.9mH | 22A | CO057283 |
| 7.5 | | | |
| 11 | 0.45mH | 33A | CO057284 |
| 15 | | | |
| 18 | 0.3mH | 44A | CO057285 |
| 22 | 50µH | 70A | CO055193 |
| 30 | | | |
| 37 | 50µH | 99A | CO055253 |
| 45 | 50µH | 99A | CO055253 |
| 55 | 50µH | 243A | CO057960 |
| 75 | 50µH | 360A | CO387886 |
| 90 | 50µH | 360A | CO387886 |
| 110 | 50µH | 360A | CO387886 |

**Table 10-1  Recommended Choke Values for Cables up to 300 Metres**

# Using Multiple Motors on a Single Drive

A single large drive can be used to supply several smaller motors provided that each individual motor has overload protection.

***Note:*** *Conventional V/F control strategy must be enabled for use with parallel motors. (Sensorless vector control strategy cannot be used). See the VECTOR ENABLE parameter under VECTOR SET-UP menu at level 2.*

The drive must be rated to supply the **total motor current**. It is not sufficient to simply sum the power ratings of the motors, since the drive has also to supply the magnetising current for each motor.

Note that the overload device will not prevent the motor overheating due to inadequate cooling at low speed. Force vented motors may be required; consult your motor supplier.
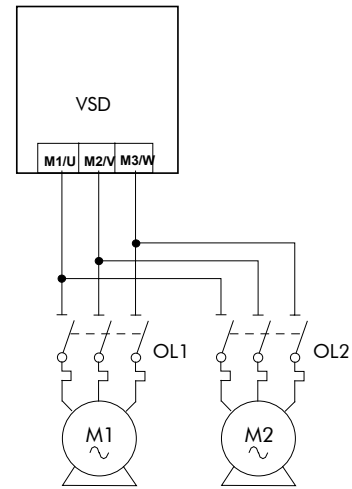


**Figure 10-1  Single Drives supplying multiple Motors**

---

> ## WARNING!
> All motors should be connected to the drive output before the START command is given.

---

### Caution
Restrict the total cable length on multiple motor installations as follows:

50 metres with no output choke fitted,
300 metres with choke.

---

# Dynamic Braking

During deceleration, or with an overhauling load, the motor acts as a generator. Energy flows back from the motor into the dc link capacitors within the drive. This causes the dc link voltage to rise. If the dc link voltage exceeds 810V for the 400V build (or 890V for the 500V build) then the drive will trip to protect the capacitors and the drive power devices. The amount of energy that can be absorbed in the capacitors is relatively small; typically more than 20% braking



**Figure 10-2  Dynamic Braking Circuit**

torque will cause the drive to trip on overvoltage. Dynamic braking increases the braking capability of the drive by dissipating the excess energy in a high power resistor connected across the dc link, see above. Refer to the Power Wiring Connection Diagrams in Chapter 3.

The Dynamic Braking Option is a PCB with an extra IGBT power device fitted. It is fitted inside the drive package and is connected to the negative side of the dc link.

When the dc link voltage rises above that specified for each Frame size (Chapter 8: "Technical Specifications" - Internal Dynamic Brake Switch) the brake unit switches the external resistor network across the dc link. The brake unit switches off again when the dc link voltage falls below the threshold level.  The amount of energy produced by the motor during regeneration depends upon the DECEL TIME parameter (refer to the REFERENCE RAMP and DYNAMIC BRAKING function blocks) and the inertia of the load.

Refer to Chapter 3: "Installing the Drive" - External Brake Resistor for brake resistor selection information.

# High Starting Torque

Applications requiring high motor starting torque (greater than 100% of rated torque) need careful setup of the drive voltage boost feature. For most motors, a FIXED BOOST parameter (FLUXING function block) setting of 6.0% is usually adequate. Setting the FIXED BOOST parameter level too high can cause the drive current limit feature to operate. If this occurs, the drive will be unable to ramp up in frequency. The IT LIMITING diagnostic (INVERSE TIME function block) will indicate TRUE when the inverse time current limit feature is operating. Simply reducing the level of the FIXED BOOST parameter will remove this problem. It is important to use the minimum level of FIXED BOOST necessary to accelerate the load. Using a level of FIXED BOOST higher than necessary will lead to increased motor heating and increased risk of drive overload.

*Note:* *Motor torques greater than 100% require high currents to be drawn from the drive. Thus, the CURRENT LIMIT parameter (CURRENT LIMIT function block) will have to be set accordingly such that the drive current limit feature will not activate when accelerating the load.*

The best motor starting performance can be achieved by setting up the SLIP COMP function block, refer to the Software Product Manual: "Programming Your Application" - SLIP COMP. Also setting the BASE VOLTS parameter (VOLTAGE CONTROL function block) to 115.4% and the FREQ SELECT parameter (PATTERN GEN function block) to 3kHz, can help to start difficult loads in the most extreme cases.

# Winder Applications

The drive contains function blocks for winder applications, refer to the Software Product Manual, Chapter 5: "Application Macros".

### Roll Diameter Calculation Accuracy

With any centre winding system it is most important, under all conditions, that the roll diameter is set within the winder block to accurately match the winding roll.

#### At Zero Speed

The diameter calculation division will not calculate accurately below a certain minimum line speed, and will not calculate at all at zero speed.

If the diameter is not accurately set at zero speed the winder may not start without large changes in web tension. It is therefore most important for good winder performance that the diameter is reset to the correct value before the machine is started. The following diagrams show typical ways to preset the roll diameter.
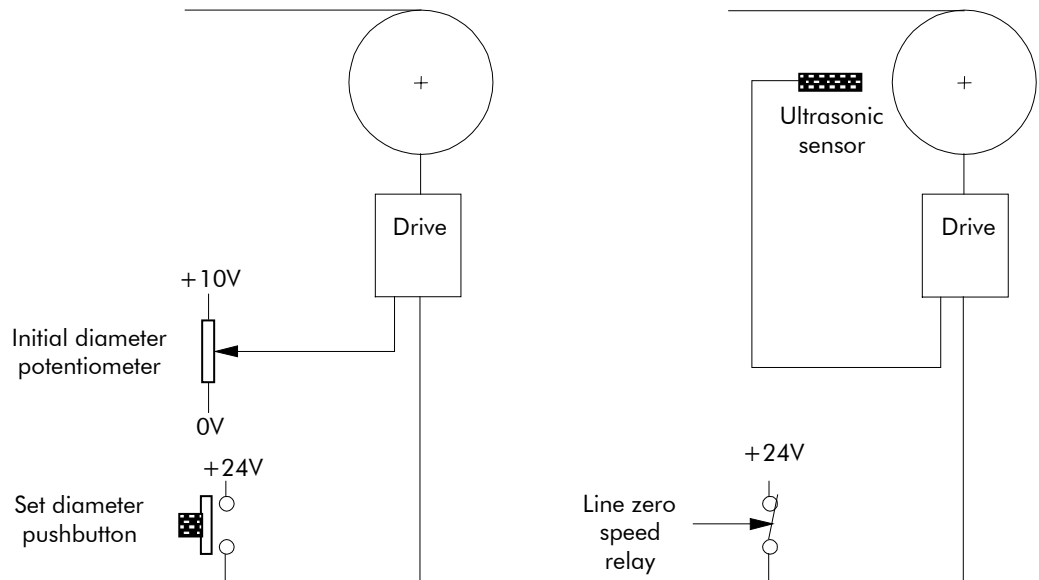
**Figure 10-3 Roll Diameter**

The left hand diagram above shows a simple, low accuracy way of pre-setting the roll diameter. Here, a potentiometer is used by the machine operator to set the roll diameter. The potentiometer is scaled such that 10V is 100% diameter. When the push button is pressed, the diameter calculator is preset to the potentiometer value. The push button should be suitably interlocked with the line drive so that the diameter cannot be preset when the machine is running.

The right hand diagram shows a more accurate method where the diameter is measured using an ultrasonic sensor. This measurement technique is especially useful for unwind applications where the diameter of the incoming roll is not known.

Other methods such as mechanical diameter followers, or lay on arms can be useful to provide the diameter signal. The requirements here are correct scaling and linearity over the diameter range.

It is also important to preset the diameter accurately in the case of twin turret winders. Here, the diameter should be accurately preset using either diameter measurement in the case of unwinds, or fixed potentiometers corresponding to the core diameters in the case of rewinds. The setting of the diameter will determine the speed match of the new roll in relation to the line speed.

The winder block diameter calculator is frozen below a Line Reference threshold, set by the MINIMUM SPEED parameter (DIAMETER CALC function block). The default value for this parameter in the Winder macro is set at 5%. This is satisfactory for most line speeds and diameter build-up ratios. The MINIMUM SPEED parameter must not be reduced significantly as diameter errors may result at low line speeds.

## When Running
Since the winder block calculates the roll diameter using a division of the Line Reference and Winder Speed feedback signals, it is important that these signals are accurate.

Ideally, in order to improve accuracy, the diameter calculation signals need to be the actual speeds of the line and winder. The reel speed reference however, needs to be driven from the Line Reference in order to give good acceleration performance for the winder.

The following diagram shows the Line Reference and Line Speed signals used to give an improved accuracy winder.
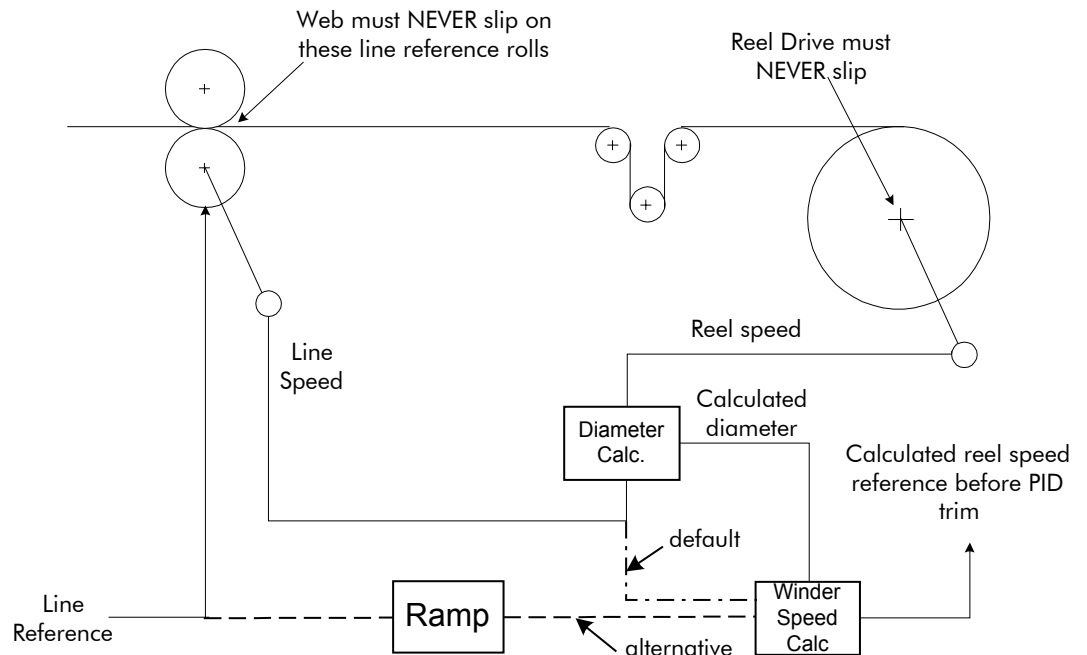
**Figure 10-4 Line Reference and Line Speed**

By default, Line Speed is connected to ANIN 1 and is used both as Line Reference and Line Speed.

Alternatively, a separate analog input for Line Reference may be used for the winder speed calculation.

If an analog tach is used for Line Speed, it must be scaled ±10V full scale.

***Note:*** *It is most important for centre wind systems that the web does not slip on the line reference rolls. Also the reel drive must never slip.*

*If slipping does occur, the diameter calculator will not be accurate, and very poor winder performance will result.*

## Basic Set-up Instruction

This section describes the operations required to set up drives containing the closed loop winder blocks.

Two different types of closed loop winders are described above, but the basic steps required to set up the drive are very similar in both cases.

If the drive is configured using the display and keys, it is important to ensure that the parameters of the drive are saved to the application on a regular basis. If this is not done, parameters adjusted during the following set-up may be lost if the auxiliary supply to the drive fails.

### Information Required

The following information is required from the winding machine manufacturer in order to set up the winder blocks:

- Absolute minimum roll diameter.

- Absolute maximum roll diameter.

- Absolute maximum line speed.

- Motor maximum speed, at smallest roll diameter and maximum line speed.

## Set-up with no Web connected to the Winder

The majority of the drive set-up should be performed without web connected to the centre winder. This allows the winding spindle to rotate freely, without being restrained by the web.

Before configuring the Closed Loop centre winder load the Winder macro, refer to the Software Product Manual, Chapter 5: "Application Macros".

### DIAMETER CALC Function Block

Set the MINIMUM DIAMETER parameter with the drive stopped.

This value can be calculated, knowing the absolute maximum and minimum roll diameters and applying the equation:

$$\text{Min Diameter} = \frac{\text{Smallest core diameter}}{\text{Maximum roll diameter}} \times 100\%$$

It is important that the absolute maximum range of diameter is used when calculating the minimum diameter parameter.

### Commission the Drive Control Loops

Since the winder blocks are equally applicable for Unwind and Rewind applications the following convention for the sign of the various set points and the direction of rotation, is useful:
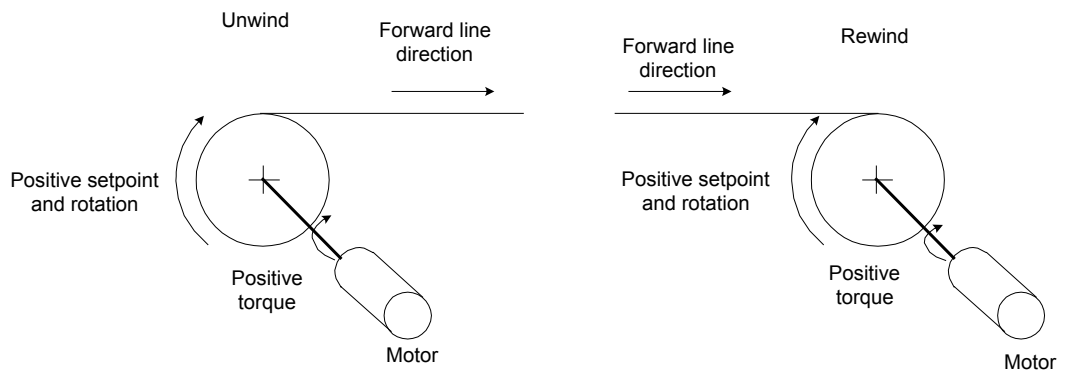


All directions are shown overwinding, with
OVERWIND set TRUE

**Figure 10-5  Conventions**

# Equations

The following equations are used to determine motor torque and power requirements.

## Simple Centre Winder Equations

It is assumed that the winders operate in constant tension mode.
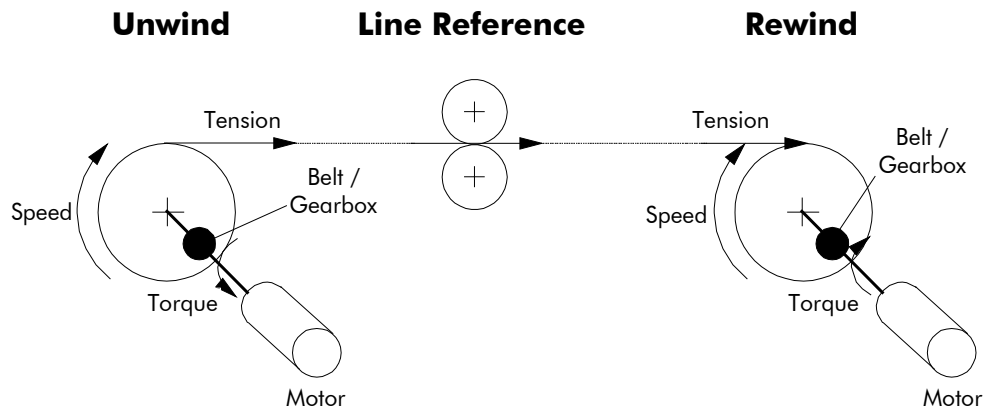


**Figure 10-6 Constant Tension Winder**

## Metric Units

The following SI units are used to produce the equations shown below.

Tension - Kilograms force (kgf)

Torque - Newton Metres (Nm)

Line Speed - Metres/Sec (MS-1)

Line accel - Metres/Sec2 (MS-2)

Rotation speed - RPM (RPM)

Roll Diameter - Metres (M)

Power - KWatt (kW)

Mass - kg (kg)

## Motor Power

The following diagram shows the motor and roll powers at maximum line speed compared to roll speed.
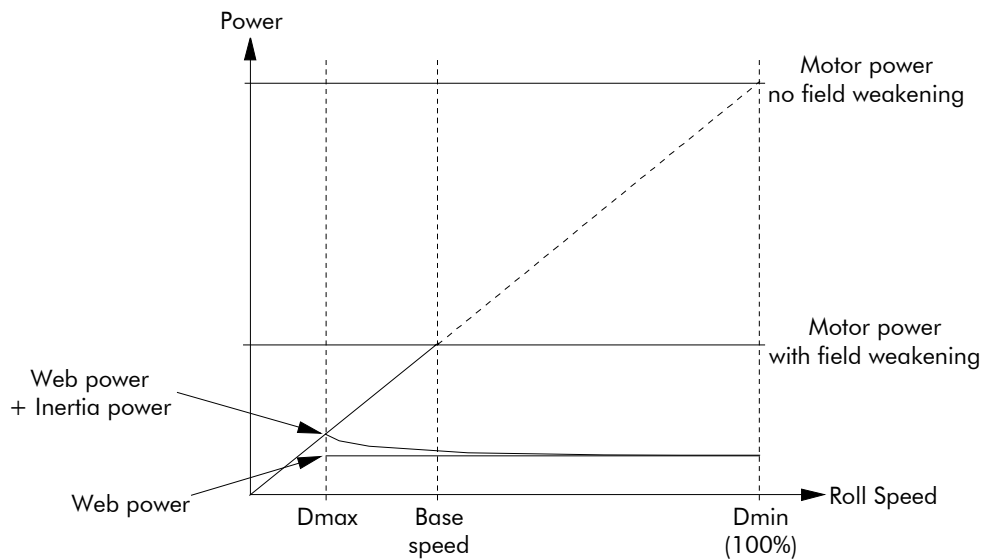


**Figure 10-7  Motor Power**

The above graph is for the case of constant tension. Friction is ignored.

$$Power_{Web} = \frac{Tension \times Max\,Line\,Speed}{101.94}\ kW$$

$$Power_{Inertia} = \frac{Roll\,Mass \times Max\,Line\,Accel \times Max\,Line\,Speed}{2000}\ kW$$

$$Power_{Friction} = \frac{Motor\,Max\,Speed}{9549} \times Motor\,Torque_{Friction}\ kW$$

Using the above individual roll powers

$$Power_{Roll} = Power_{Web} + Power_{Inertia} + Power_{Friction}\ kW$$

Referring to a motor with field weakening

$$\therefore Power_{Motor} = \left\{ (Power_{Web} + Power_{Inertia}) \times \frac{Diameter\,Build\,Up}{Cons\tan t\,Power\,Range} \right\} + Power_{Friction}\ kW$$

Here, the Constant Power Range is the motor field weakening range.

This parameter is 1 if no field weakening.

## Motor Torque

The worst case motor torque will exist for the following conditions:

Maximum roll diameter

Maximum acceleration rate

Maximum roll width

Maximum material tension

Maximum roll mass

$$\text{Torque}_{\text{Tension}} = \text{Tension} \times \text{Roll Diameter} \times 4.905$$

Assuming the roll is a solid cylinder

$$\text{Torque}_{\text{Inertia}} = \frac{\text{Roll Mass} \times \text{Line Accel} \times \text{Roll Diameter}}{4}$$

$$\text{Torque}_{\text{Roll}} = \text{Torque}_{\text{Tension}} + \text{Torque}_{\text{Inertia}}$$

$$\therefore \text{Torque}_{\text{Motor}} = \frac{\text{Torque}_{\text{Roll}}}{\text{Ratio}_{\text{Gearbox}}} + \text{Torque}_{\text{Friction}}$$

## Motor Speed

The maximum motor speed will exist under the following conditions:

Maximum line speed

Smallest core diameter

Maximum gearbox ratio

$$\text{Speed}_{\text{Roll}} = \frac{\text{Speed}_{\text{Line}}}{\text{Diameter}} \times 19.1 \text{ RPM}$$

$$\therefore \text{Speed}_{\text{Motor}} = \text{Speed}_{\text{Roll}} \times \text{Ratio}_{\text{Gearbox}} \text{ RPM}$$

# 4-Q Regen Control/Common DC Bus Applications

> *Note:* *The **4-Q REGEN** control mode is available to all units that use Software Version 5.1 or greater (4-Q Regen : 4 Quadrant Regenerative) **and** display "/007" in Block 12 of the Product Code (Europe), indicating that Special Option 7 is applied ("Y" cap disconnection).*

### MMI Menu Map

*1* | SYSTEM
*2* | RESTORE CONFIG
    | RESTORE CONFIG

### MMI Menu Map

*1* | SETUP
*2* | MOTOR CONTROL
*3* | MOTOR DATA
    | CONTROL MODE
    | LEAKAGE INDUC
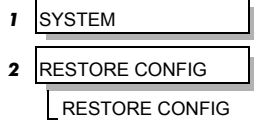
The 690+ Series AC Drive product range provides a control mode designed to simplify common DC bus applications.

Macro 8 is provided to simplify the set-up of 4-Q Regen systems by automatically configuring the drive.

**To enable this feature, simply restore Macro 8 (RESTORE CONFIG). Set the CONTROL MODE parameter (Motor Data function block) to 4-Q REGEN and the LEAKAGE INDUCTANCE parameter to the value of total line choke inductance.**
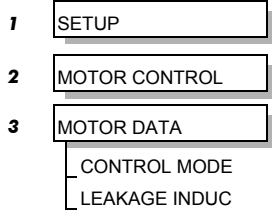
4-Q Regen control mode allows a single 690+ to act as a 4-Q power supply unit that is capable of drawing (motoring) and supplying (regenerating) sinusoidal, near-unity power factor current from the supply.

The output from the 4-Q Regen drive acts as a DC supply which is used to power other drives on a common DC Bus system.

### Advantages

Using the 690+ as a 4-Q power supply in common DC Bus schemes provides the following advantages:

- Simplified approach to Common DC Link systems
- Allows standard 690+ drive to act as 4-Q DC Link power supply unit
- Near-sinusoidal supply currents (Motoring and Regenerating)
- Near-unity power factor operation (0.99 or better)
- Low supply harmonics currents (helps to meet G5/4 and IEEE519)

**IMPORTANT:** If drives connected to the 4-Q Regen common DC Bus are being controlled in Volts/Hz motor control mode, it is essential that the VOLTAGE MODE parameter in the VOLTAGE CONTROL function block is set to FIXED. This will ensure the motor is not overfluxed by the boosted 720V DC Bus. Failure to do this may lead to motor overheating and possible burn out.

> *Note:* *If the drive is part of a common DC link/bus system set the ENABLE parameter in the SLEW RATE LIMIT function block to FALSE. This disables ramp-hold during deceleration on high link volts feature.*

## Single Motor System

The simplest configuration for 4-Q Regen control is a single 690+ acting as the unity power factor supply, connected via the DC link to another 690+ driving the application. This is shown in the diagram below.



*690+ Series AC Drive*
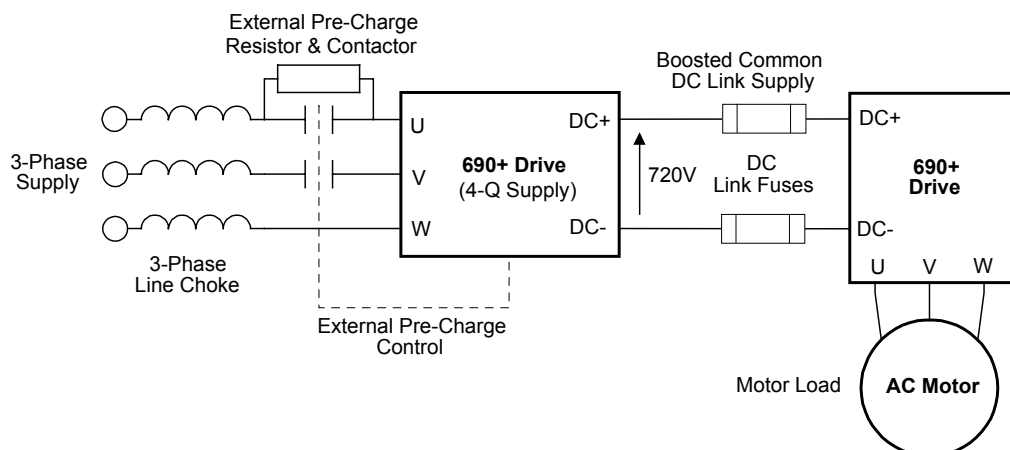
The two 690+ drives are matched in power, with the 4-Q Regen drive supplying the full motoring and regenerating requirement of the load. Additional external equipment required by the 4-Q Regen drive includes :

- 3-phase choke (typically 8 % impedance required)
- External DC link pre-charge control circuit (contactor and resistor)

No extra hardware is required to detect the rotation, frequency and phase of the mains supply. Also, no dynamic braking resistor is required.

When mains power is applied to the 4-Q Regen drive, the DC link slowly charges through the external pre-charge circuit. The regen drive's internal power supply will start in the normal way. Provided the regen drive is healthy and the Run signal is applied, synchronisation to the mains supply (phase, rotation and frequency) begins. This process takes approximately 100ms. Once synchronised, the DC link on the common bus is boosted to around 720V (on a 400V product). This high value of DC link volts is required for successful regen operation.

Applications of single motor 4-Q Regen systems include :

- Hoist and Elevators
- Dynamometer test rigs
- Unwind Stands
- Installations that would otherwise require a Harmonic Power Filter

## Multi-Motor System

In many applications, the total power consumed by the system is less than the installed power of the drives. This is because some drives are motoring (eg. winders) and some are regenerating (eg. unwinders). In these situations it is convenient to connect the drives on a common DC link. The new 690+ 4-Q Regen control mode simplifies the connection of common DC link applications as shown in the schematic below.
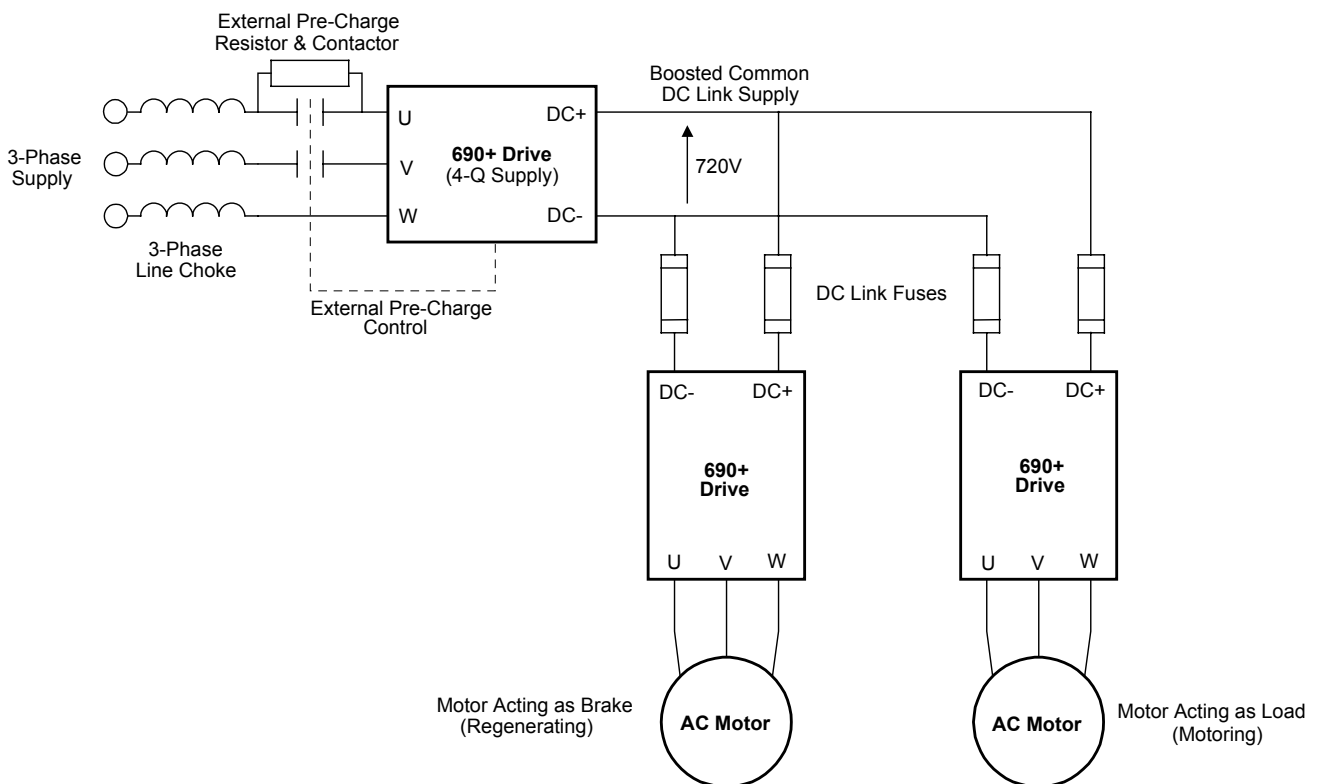


The 4-Q Regen drive draws sinusoidal, unity power factor current from the supply and only has to be rated for the net power consumed by the system or by the system braking requirements. Dynamic Braking (eg. for Emergency Stopping purposes) can still be used in this control mode if required.

## Brake Mode

The final operating mode of the 4-Q Regen drive is to act as a Smart Brake. This is selectable in software by setting the BRAKE MODE parameter in the REGEN CONTROL function block to TRUE. In this mode, the 4-Q Regen drive is connected onto a common DC link.

During motoring operation, the drives on the common link are supplied via their own internal 3-phase diode bridge. The 4-Q Regen drive tracks the mains supply but does not supply motoring power to the common DC Link.

During regeneration, the DC link will rise and trigger the 4-Q Regen drive to return the excess power to the mains (sinusoidal current, unity power factor).

Thus, the 4-Q Regen drive acts as a Smart, No Loss, Dynamic Brake. The Brake Mode allows the level of regeneration (braking) capacity in the system to be rated differently from the required motoring capacity.
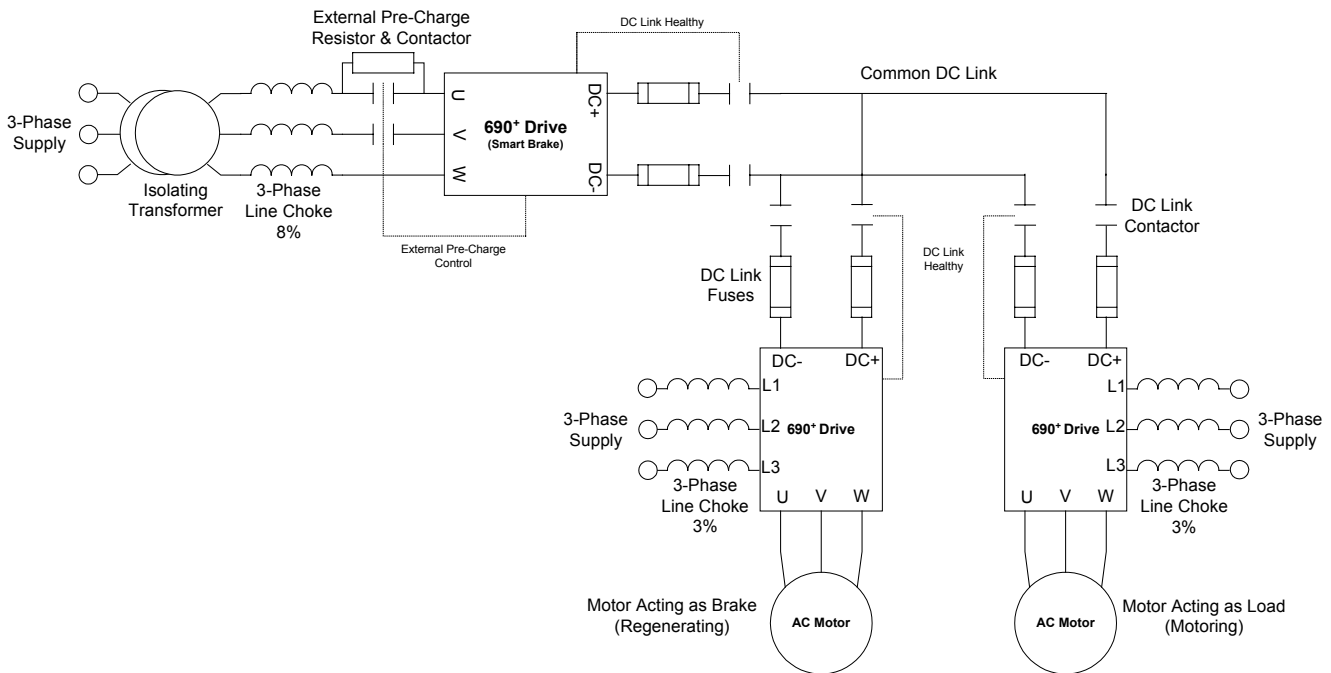


**IMPORTANT:**  It is essential to use an isolation transformer on the supply to the Smart Brake drive

When using the Brake Mode, each drive is responsible for pre-charging its own DC Link. When an individual drive is pre-charged and healthy, it connects itself on to the common DC Bus via a DC contactor. The drives disconnect from the common bus under fault conditions.
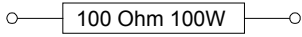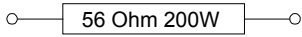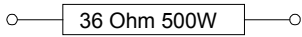
## Pre-Charge Sizing

The external pre-charge contactor is required to carry the full load current rating (including overload) of the 4-Q Regen drive. Thus, it must have an AC1 rating of the Constant Torque current rating of the drive. Refer to the rating tables in the Installation Product Manual.

We recommend that standard SSD Dynamic Braking resistors are used for the external pre-charge circuit. The continuous and peak power capabilities of these resistors are given below:

| SSD Part № | Resistance (Ω) | Continuous Power Rating (W) | Peak Power Rating (kW) |
|---|---|---|---|
| CZ389853 | 100 | 100 | 2.5 |
| CZ463068 | 56 | 200 | 5 |
| CZ388396 | 36 | 500 | 12.5 |

The recommended pre-charge resistor networks are shown in the table below. The table indicates the amount of total DC Link capacitance the network can charge for a given supply voltage.

| External Pre-Charge Network | Continuous Power Rating (W) | Impulse Joule Rating (J) | Pre-Charge Capability (µF) @ 240V$_{rms}$ +10% | Pre-Charge Capability (µF) @ 460V$_{rms}$ +10% |
|---|---|---|---|---|
| 100 Ohm 100W | 100 | 2,500 | 35,000 | 9,700 |
| 56 Ohm 200W | 200 | 5,000 | 71,000 | 19,500 |
| 36 Ohm 500W | 500 | 12,500 | 179,000 | 48,800 |

The internal DC Link Capacitance for each drive in the 690+ range is given in the table below:

| Drive Power (kW) | 400V Units | | 230V Units | |
|---|---|---|---|---|
| | Frame | µF | Frame | µF |
| 0.75 | B | 190 | B | 380 |
| 1.5 | B | 190 | B | 760 |
| 2.2 | B | 380 | B | 1140 |
| 4 | B | 380 | B | 1520 |
| 5.5 | C | 500 | C | 2000 |
| 7.5 | C | 1000 | C | 3000 |
| 11 | C | 1000 | D | 3000 |
| 15 | D | 1500 | D | 4000 |
| 18.5 | D | 2000 | D | 4000 |
| 22 | D | 2000 | E | 6000 |
| 30 | E | 2500 | F | 11200 |
| 37 | E | 3000 | F | 11200 |
| 45 | E | 3500 | F | 11200 |
| 55 | F | 5600 | | |
| 75 | F | 5600 | | |
| 90 | F | 5600 | | |
| 110 | G | 6600 | | |
| 132 | G | 9900 | | |
| 160 | G | 13500 | | |
| 180 | G | 13500 | | |
| 200 | H | 14850 | | |
| 220 | H | 14850 | | |
| 250 | H | 20250 | | |
| 280 | H | 20250 | | |
| 315 | J | 19800 | | |

Simply sum the DC Link capacitance for all the drives on the common DC Link and select the appropriate pre-charge network.

For example a system comprising 5, 30kW, 400V Frame E drives would have a total DC Link capacitance of:

$$C_{Total} = 5 \times 2500 \mu F = 12,500 \mu F$$

This is less than 19,500μF and thus a 56Ω, 200W (CZ463068) resistor will be adequate.

## 3-Phase Choke Sizing

One of the benefits of the 690+ 4-Q Regen drive is the reduction in the levels of harmonic currents drawn from the supply. The total harmonic distortion (THD) of the mains current is related to the PWM switching frequency, the supply voltage, the supply frequency and the inductance of the 3-phase line choke. The maximum allowed PWM carrier frequency in non overload conditions, for each frame size is given below:

| 690+ Frame Size | PWM Carrier Frequency |
|---|---|
| B to F | 3kHz |
| G and H | 2.5kHz |
| J | 2kHz |

The IEEE 519 standard (IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems ) requires a THD of current of 5%. The tables below show the recommended 3-phase line chokes (5% and 3% in series) and expected THD of current for 400V and 230V drives.

Suitable line chokes can be supplied from MTE Corp. The line choke must be suitable for operation with 3kHz PWM (pulse width modulation) and not significantly change inductance at 150% overload.

### 400V 690+

| Drive Power (kW) | Frame Size | Drive Current Rating (A) | 5% MTE Line Choke * | 3% MTE Line Choke * | Total Inductance (mH) | Choke Current Rating (A) | % THD @ 400V 50Hz | % THD @ 460V 60Hz | Peak Ripple Current 400V 50Hz (A) | Peak Ripple Current 460V 60Hz (A) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | B | 9.5 | RLX-0008-016 T5 | RLX-0088-015 T5 | 8 | 8 | 4.3 | 5.0 | 1.0 | 1.2 |
| 11 | C | 23 | RLX-0025-011 T5 | RLX-0025-012 T5 | 3 | 25 | 4.4 | 5.1 | 2.5 | 2.9 |
| 22 | D | 45 | RLX-0045-011 T5 | RLX-0045-012 T5 | 1.4 | 45 | 5.2 | 6.0 | 5.4 | 6.2 |
| 45 | E | 87 | RLX-0080-013 T5 | RLX-0080-014 T5 | 1.1 | 80 | 3.5 | 4.0 | 6.8 | 8.1 |
| 90 | F | 180 | RLX-0160-013 T5 | RLX-0160-014 T5 | 0.38 | 160 | 4.8 | 5.5 | 20 | 24 |
| 180 | G | 361 | RLX-0320-011 T5 | RLX-0320-010 T5 | 0.2 | 320 | 5.4 | 6.6 | 47 | 57 |
| 280 | H | 520 | RLX-0500-011 T5 | RLX-0500-010 T5 | 0.135 | 500 | 5.6 | 6.7 | 70 | 84 |
| 315 | J | 590 | RLX-0600-011 T5 | RLX-0600-010 T5 | 0.105 | 600 | 7.9 | 9.4 | 117 | 134 |

**\*** "T5" indicates the choke is fitted with a normally-closed thermal switch that opens at 185°C.

**230V 690+**

| Drive Power (kW) | Frame Size | Drive Current Rating (A) | 5% MTE Line Choke * | 3% MTE Line Choke * | Total Inductance (mH) | Choke Current Rating (A) | % THD @ 230V 50Hz | % THD @ 230V 60Hz | Peak Ripple Current 230V 50Hz (A) | Peak Ripple Current 230V 60Hz (A) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | B | 16.5 | RLX-0018-013 T5 | RLX-0018-014 T5 | 2.3 | 18 | 5.0 | 5.0 | 1.9 | 2.0 |
| 7.5 | C | 28 | RLX-0025-012 T5 | RLX-0025-013 T5 | 1.7 | 25 | 4.0 | 4.0 | 2.6 | 2.7 |
| 18.5 | D | 68 | RLX-0055-013 T5 | RLX-0055-014 T5 | 0.75 | 55 | 3.7 | 3.7 | 5.8 | 6.0 |
| 22 | E | 80 | RLX-0080-014 T5 | RLX-0080-015 T5 | 0.6 | 80 | 4.0 | 4.0 | 7.2 | 7.5 |
| 45 | F | 154 | RLX-0160-014 T5 | RLX-0160-015 T5 | 0.225 | 160 | 5.5 | 5.5 | 20 | 21 |

**\*** "T5" indicates the choke is fitted with a normally-closed thermal switch that opens at 185°C.

Lower values for THD of current can be achieved by adding extra line impedance.

*Note:* *The drive 100% current setting should never exceed the rating of the line choke.*

## Software Function Block

Refer to the Software Product Manual, Chapter 1 for a full description of the function block parameters.

**IMPORTANT:** The demanded boosted DC Link Voltage must be set appropriately for the drive voltage rating. This is given in the table below.

```
               Regen Control
        –  SYNCHRONIZING    [1641] –  FALSE
        –  SYNCHRONIZED     [1642] –  FALSE
        –  PHASE LOSS       [1643] –  FALSE
        –  CLOSE PRECHARGE  [1644] –  FALSE
        –  ENABLE DRIVE     [1645] –  FALSE
        –  STATUS           [1646]    SUPPLY FREQ LOW
 TRUE  – [1633]  PRECHARGE CLOSED  –
 720V  – [1634]  DC VOLTS DEMAND   –
 FALSE – [1678]  BRAKE MODE        –
```

| Drive Voltage Rating (V) | Under Volts Trip Level (V) | Over Volts Trip Level (V) | Recommended DC Volts Demand |
|---|---|---|---|
| 380V – 460V | 410V | 820V | 720V |
| 220V – 240V | 205V | 410V | 370V |

## Macro 8 : 4Q Regen

Macro 8 is provided to simplify the set-up of 4-Q Regen systems. A full description of Macro 8 can be found in the Software Product Manual.

*Note:* *The control mode must be set to 4-Q REGEN and the leakage inductance set to the value of total line choke inductance. Refer to page 10-10.*

Macro 8 provides the following connections:

```
                                    Regen Control
              ‒   SYNCHRONIZING    [1641] ‒  FALSE
              ‒   SYNCHRONIZED     [1642] ‒  FALSE
              ‒      PHASE LOSS    [1643] ‒  FALSE              Digital Output 3
              ‒   CLOSE PRECHARGE  [1644] ‒        software link
              ‒      ENABLE DRIVE  [1645] ‒  FALSE                  □
              ‒          STATUS    [1646]    SUPPLY FREQ LOW
Digital Input 1 ‒
      software link       [1633] PRECHARGE CLOSED ‒
          □            720V ‒ [1634] DC VOLTS DEMAND ‒
                      FALSE ‒ [1678] BRAKE MODE ‒
```
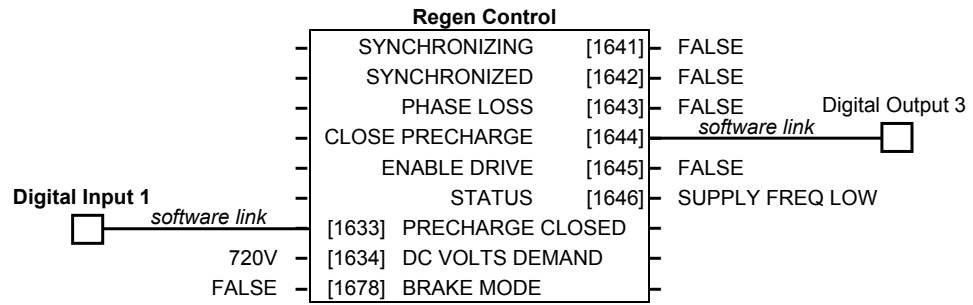
Digital Output 3 (terminals 25 & 26) controls the external pre-charge circuit. Digital input 1 (terminal 12) is used to confirm the status of the pre-charge circuit (open or closed). The 4-Q Regen drive is not allowed to synchronise to the mains unless the pre-charge relay is closed. Digital input 2 (terminal 13) is used to run the 4-Q Regen drive.

In Macro 8, the Run command is default True. Thus the drive automatically synchronises to the mains when the pre-charge relay closes. Digital input 2 (terminal 13) is used to cause a coast stop in case of emergencies.

## Connection Diagram
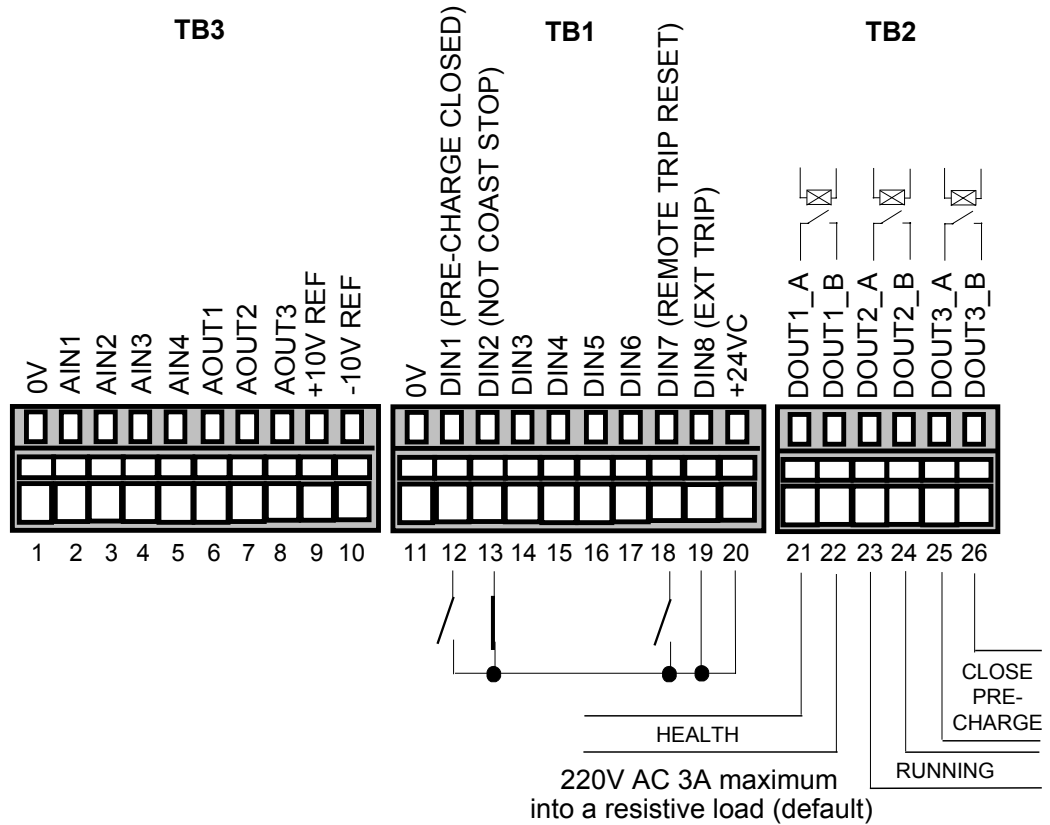


## Contactor and Fusing

The AC contactor used in the external pre-charge circuit must have an AC1 or thermal rating of the constant torque current rating of the 4-Q Regen drive.

The DC contactor used in the Brake Mode system must have an adequate thermal rating for the regen current required. Typically the regen rating of the system, and hence the rating of the DC contactor and fuses, will be less than motoring requirement.

The 4-Q Regen drive must be protected by suitable rated line fuses capable of withstanding the system AC supply voltage. These should be fast semiconductor protection fuses.

Each individual drive connected to the common DC Bus must be protected by DC Link fuses in both the DC+ and DC- lines. The fuses must be of suitable current rating and capable of

withstanding 1000Vdc . Although HRC fuses would be adequate, the high DC voltage requirement (1000Vdc) may limit the choice to semiconductor fuses.

## EMC Filtering

We recommend all 690+ Regen systems meet the EMC product specific standard EN61800-3:1997 . To achieve this, an EMC filter is required. Contact SSD Drives for details of suitable filters.

*Note:* *All drives in a common DC link scheme using a 4-Q Regen front-end must have their internal "Y" caps to earth (PE) removed. Please contact SSD Drives.*

# 2-Q Common DC Bus Applications

Using a common DC bus allows regenerative energy to be shared between the drives on the system, improving efficiency.

Two Options are shown below. Both options are single-ended, i.e. no power is returned from the control system to the mains. It is redistributed throughout the system, resulting in less drain from the supply.

*Note:* *The choice of option will depend upon the application and different quantities/powers of inverters, to provide the greatest efficiency.*

### OPTION 1

Small numbers of drives can be coupled together on both the AC supply side and DC bus side.
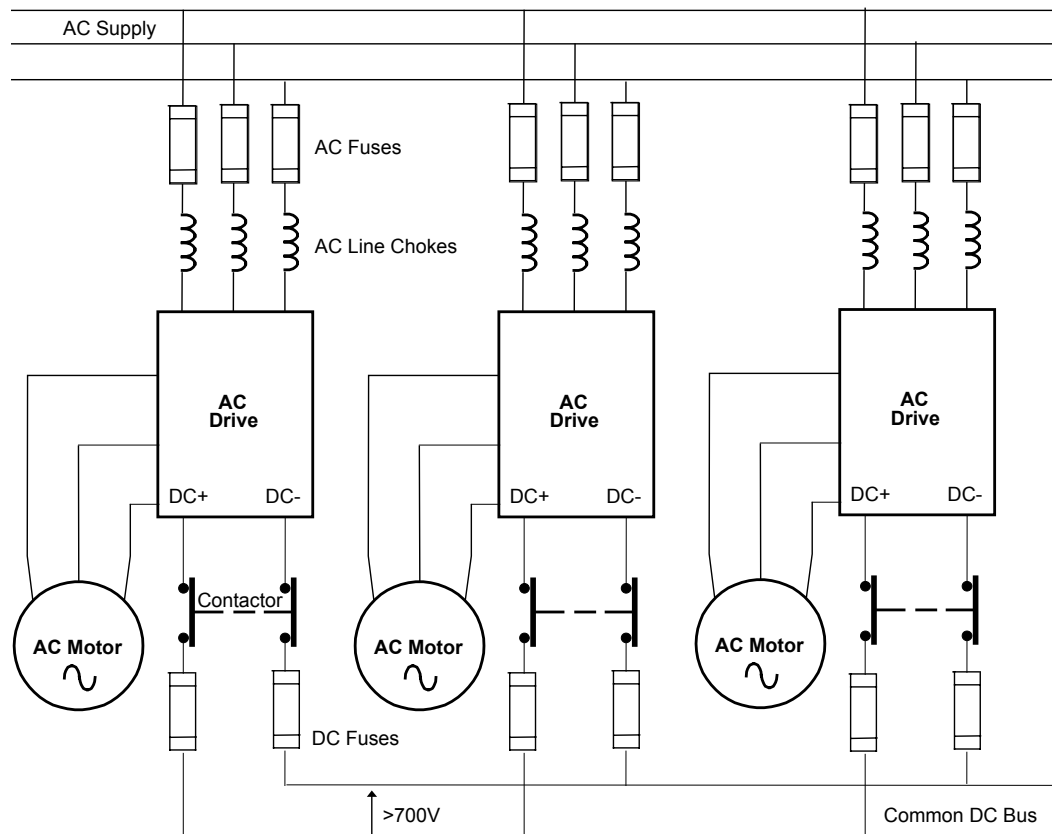


### Considerations
* AC fuses should be fast-acting. Ideally, add fuse monitoring to shut down the total system in the event of any AC fuse failure.

- AC line chokes must be fitted (minimum 3% per unit impedance). Use the following formula to derive the value of inductance required to satisfy the per unit impedance requirement:

$$\frac{\text{LINE VOLTS}}{363 \times \text{INPUT CURRENT (A)} \times \text{FREQUENCY (Hz)}} = \text{INDUCTANCE (H)}$$

*where 363 = (2 x $\pi$ x $\sqrt{3}$ x 100) / 3*

- Sequence contactors so that the AND of all the DRIVE READY signals starts a short timer which in turn closes all the contactors together. The contactors should not be opened until line stop, not even under fault conditions.

- Because the drives are fed from the AC side, clearing of the DC fuses may not present a run-threatening situation. The drives will remain functional unless the isolated drive regenerates power. Consider using indicating fuses, especially if a drive is permanently regenerating.

## OPTION 2

The drives are coupled together on the DC bus side only. The drives AC inputs are unused.
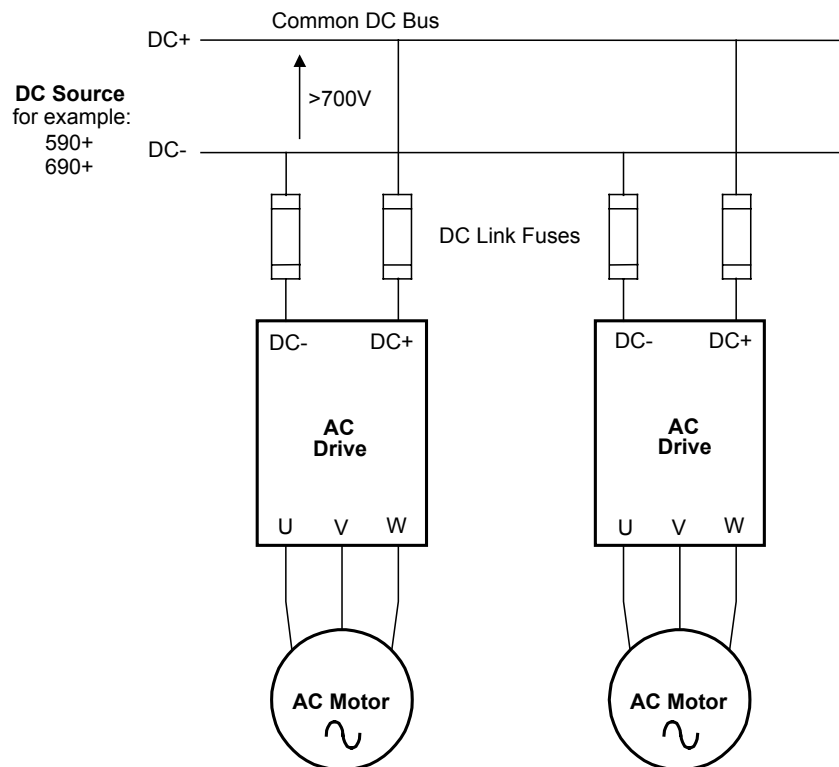


### *Considerations*

- The DC Source must be correctly rated to match the maximum power to be imported into the system. Use the following formula which takes into account form factor and efficiency:

$$\text{DC CURRENT (DC A)} >= \frac{2000 \times \text{SP}}{V_L}$$

*where: SP = Supply Power (kW)*
*$V_L$ = Supply Line Volts (V)*

- Fit DC link fusing to protect cabling to each drive.

**IMPORTANT:** Check the voltage rating of any DC link components. Voltages >700V are common.

# APPLICATION MACROS

## The Default Application

The drive is supplied with various macros. Each macro recalls a pre-programmed set of parameters when it is loaded.

- Macro 1 is the factory default macro, providing for basic speed control

*Note:* *Refer to the Software Product Manual for details of other macros.*

## Macro Descriptions

*Note:* *Parameters whose default values are product-related are indicated in the block diagrams with \* or \*\*. Refer to Chapter 2: "An Overview of the Drive" - Product-Related Default Values.*

### Macro 0

This macro will not control a motor.

It is included to document the differences between all the configurations, using this as the base-line.

Loading Macro 0 removes all internal links, and sets all parameter values to the values defined for each function block in the Software Product Manual - Chapter 1: Programming Your Application.

#### The OPERATOR Menu for Macro 0

The default OPERATOR menu is shown below.

```
┌──────────────────┐     ┬── SETPOINT (REMOTE)
│ STARTUP SCREEN   │─────┤── SPEED DEMAND
└──────────────────┘     ├── DRIVE FREQUENCY
                         ├── MOTOR CURRENT
                         ├── LOAD
                         ├── DC LINK VOLTS
                         ├── CURRENT LIMITING
                         └── ENTER PASSWORD
```

**Analog Input 1**

VALUE [ 16 ]
BREAK [ 18 ]

100.00 % — [ 14 ] SCALE
0.00 % — [ 15 ] OFFSET
0..+10 V — [ 13 ] TYPE
FALSE — [ 12 ] BREAK ENABLE
0.00 % — [ 17 ] BREAK VALUE

**Analog Input 2**

VALUE [ 25 ]
BREAK [ 27 ]

100.00 % — [ 23 ] SCALE
0.00 % — [ 24 ] OFFSET
0..+10 V — [ 22 ] TYPE
FALSE — [ 21 ] BREAK ENABLE
0.00 % — [ 26 ] BREAK VALUE

**Value Func 1**

OUTPUT [133]

[130] INPUT A
[131] INPUT B
0.00 — [132] INPUT C
A+B+C — [134] TYPE

**Skip Frequencies**

OUTPUT [346]
OUTPUT HZ [363] — 0.0 Hz
INPUT HZ [362] — 0.0 Hz

[340] INPUT
0.0 Hz — [341] BAND 1
0.0 Hz — [342] FREQUENCY 1
0.0 Hz — [680] BAND 2
0.0 Hz — [343] FREQUENCY 2
0.0 Hz — [681] BAND 3
0.0 Hz — [344] FREQUENCY 3
0.0 Hz — [682] BAND 4
0.0 Hz — [345] FREQUENCY 4

**Minimum Speed**

OUTPUT [335]

[336] INPUT
-100.00 % — [337] MINIMUM
PROP. W/MIN. — [338] MODE

**Reference**

SPEED DEMAND [255]
SPEED SETPOINT [254] — 0.00 %
REVERSE [256] — FALSE
LOCAL SETPOINT [247] — 0.00 %
LOCAL REVERSE [250] — FALSE
COMMS SETPOINT [770] — 0.00 %
[245] REMOTE SETPOINT
0.00 % — [248] SPEED TRIM
110.00 % — [252] MAX SPEED CLAMP
-110.00 % — [253] MIN SPEED CLAMP
FALSE — [243] TRIM IN LOCAL
[249] REMOTE REVERSE

**Analog Output 1**

[ 45 ] VALUE
100.00 % — [ 46 ] SCALE
0.00 % — [ 47 ] OFFSET
TRUE — [ 48 ] ABSOLUTE
0..+10 V — [ 49 ] TYPE

**Setpoint Scale**

OUTPUT [ 59 ] — 0.0 Hz
[ 58 ] INPUT
** 1500 RPM — [1032] MAX SPEED

**I/O Trips**

THERMIST [1155] — FALSE
ENCODER TB [1156] — FALSE
EXTERNAL [234] — FALSE
FALSE — [760] INVERT THERMIST
FALSE — [1154] INVERT ENC TRIP
TRIP — [233] EXT TRIP MODE
[235] INPUT 1 BREAK
[236] INPUT 2 BREAK

**Trips Status**

ACTIVE TRIPS [ 4 ] — 0000
ACTIVE TRIPS+ [740] — 0000
WARNINGS [ 5 ] — 0000
WARNINGS+ [741] — 0000
FIRST TRIP [ 6 ] — NONE
0600 — [231] DISABLED TRIPS
0040 — [742] DISABLED TRIPS+

**Reference Ramp**

RAMPING [698] — FALSE
LINEAR — [244] RAMP TYPE
10.0 s — [258] ACCEL TIME
10.0 s — [259] DECEL TIME
FALSE — [268] SYMMETRIC MODE
10.0 s — [267] SYMMETRIC TIME
10.00 /s^2 — [692] SRAMP ACCEL
10.00 /s^2 — [693] SRAMP DECEL
10.00 /s^3 — [694] SRAMP JERK 1
10.00 /s^3 — [695] SRAMP JERK 2
10.00 /s^3 — [696] SRAMP JERK 3
10.00 /s^3 — [697] SRAMP JERK 4
TRUE — [691] SRAMP CONTINUOUS
FALSE — [260] HOLD

**Digital Input 1**

VALUE [ 31 ]
FALSE — [ 30 ] INVERT

**Digital Input 2**

VALUE [ 34 ]
FALSE — [ 33 ] INVERT

**Digital Input 3**

VALUE [ 37 ]
FALSE — [ 36 ] INVERT

**Digital Input 4**

VALUE [ 40 ]
FALSE — [ 39 ] INVERT

**Digital Input 5**

VALUE [ 43 ]
FALSE — [ 42 ] INVERT

**Digital Input 6**

VALUE [726] — FALSE
FALSE — [725] INVERT

**Digital Input 7**

VALUE [728]
FALSE — [727] INVERT

**Sequencing Logic**

TRIPPED [289]
RUNNING [285]
JOGGING [302] — FALSE
STOPPING [303] — FALSE
OUTPUT CONTACTOR [286] — FALSE
SWITCH ON ENABLE [288] — FALSE
SWITCHED ON [306] — FALSE
READY [287] — FALSE
SYSTEM RESET [305] — FALSE
SEQUENCER STATE [301] — START ENABLED
REMOTE REV OUT [296]
HEALTHY [274] — TRUE
[291] RUN FORWARD
[292] RUN REVERSE
[293] NOT STOP
[280] JOG
TRUE — [1235] CONTACTOR CLOSED
TRUE — [276] DRIVE ENABLE
TRUE — [277] NOT FAST STOP
TRUE — [278] NOT COAST STOP
[294] REMOTE REVERSE
[282] REM TRIP RESET
TRUE — [290] TRIP RST BY RUN
FALSE — [283] POWER UP START

**Reference Stop**

RUN RAMP — [279] RUN STOP MODE
10.0 s — [263] STOP TIME
0.10 % — [266] STOP ZERO SPEED
0.500 s — [284] STOP DELAY
RAMPED — [304] FAST STOP MODE
30.0 s — [275] FAST STOP LIMIT
0.1 s — [264] FAST STOP TIME
1200 Hz/s — [126] FINAL STOP RATE

**Reference Jog**

10.00 % — [246] SETPOINT
1.0 s — [261] ACCEL TIME
1.0 s — [262] DECEL TIME

**Analog Output 2**

0.00 % — [731] VALUE
100.00 % — [732] SCALE
0.00 % — [733] OFFSET
FALSE — [734] ABSOLUTE
-10 .. +10 V — [735] TYPE

**Analog Output 3**

0.00 % — [800] VALUE
100.00 % — [801] SCALE
0.00 % — [802] OFFSET
FALSE — [803] ABSOLUTE
-10 .. +10 V — [804] TYPE

**Analog Input 3**

VALUE [715] — 0.00 %
BREAK [717] — FALSE
100.00 % — [713] SCALE
0.00 % — [714] OFFSET
0..+10 V — [712] TYPE
FALSE — [711] BREAK ENABLE
0.00 % — [716] BREAK VALUE

**Analog Input 4**

VALUE [722] — 0.00 %
BREAK [724] — FALSE
100.00 % — [720] SCALE
0.00 % — [721] OFFSET
0..+10 V — [719] TYPE
FALSE — [718] BREAK ENABLE
0.00 % — [723] BREAK VALUE

**Digital Output 1**

[ 52 ] VALUE
TRUE — [ 51 ] INVERT

**Digital Output 2**

[ 55 ] VALUE
FALSE — [ 54 ] INVERT

**Digital Output 3**

FALSE — [737] VALUE
FALSE — [736] INVERT

# Macro 1: Basic Speed Control (default)

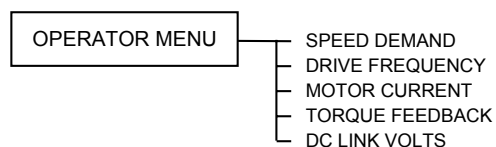## Macro 1: Basic Speed Control (default)

This macro provides standard control of the inverter.

| Control Wiring I/O | | | |
|---|---|---|---|
| Terminal | Name | Purpose | Comment |
| 2 | ANALOG INPUT 1 | Speed Setpoint | 0V = 0%, 10V = 100% |
| 3 | ANALOG INPUT 2 | Speed Trim | 0V = 0%, 10V = 100% |
| 6 | ANALOG OUTPUT 1 | Ramp Output | absolute speed demand 0V = 0%, 10V = 100% |
| 12 | DIGITAL INPUT 1 | Run Forward | 24V = run forward |
| 13 | DIGITAL INPUT 2 | Run Reverse | 24V = run reverse |
| 14 | DIGITAL INPUT 3 | Not Stop | 24V = RUN FWD and RUN REV signals latched  0V = RUN FWD and RUN REV signals not latched |
| 15 | DIGITAL INPUT 4 | Remote Reverse | 0V = remote forward 24V = remote reverse |
| 16 | DIGITAL INPUT 5 | Jog | 24V = jog |
| 18 | DIGITAL INPUT 7 | Remote Trip Reset | 24V = reset trips |
| 19 | DIGITAL INPUT 8 | External Trip | *Non-configurable* 0V = Trip (connect to terminal 20) |
| 21, 22 | DIGITAL OUTPUT 1 | Health | 0V = tripped, i.e. not healthy |
| 23, 24 | DIGITAL OUTPUT 2 | Running | 0V = stopped, 24V = running |

### The Operator Menu for Macro 1

The default Operator Menu is shown below.

```
                      ┌─ SPEED DEMAND
┌──────────────┐      ├─ DRIVE FREQUENCY
│ OPERATOR MENU├──────┼─ MOTOR CURRENT
└──────────────┘      ├─ TORQUE FEEDBACK
                      └─ DC LINK VOLTS
```

| ISS. | MODIFICATION | ECN No. | DATE | DRAWN | CHK'D |
|---|---|---|---|---|---|
| 1 | First printed release of HA465492U005. Software Version 5.x. | 17111 (17168) (16843) (17130) | 8/1/03 | CM | MP |
| 2 | New ratings information, pages 8-9, 8-12 and 8-13. Brake output values changed, pages 9-7 to 9-9. Gland plate change, page 2-1. 6901 cut-out diagram updated, page 3-22. | 17728 (17585) (16842) (17647) | 6/8/03 | CM | MP |
| 3 | New vibration information, page 8-5. New System Board I/O information, page 8-21 Variaous small amendments | 17756 (17800) | 9/1/04 | CM | MP |
| 4 | Change of company name and logo to SSD Drives Ltd. | 18354 | 2/11/04 | CM | MP |

FIRST USED ON

MODIFICATION RECORD

690+ Series AC Drive

DRAWING NUMBER

ZZ465492

SHT. 1

OF 1