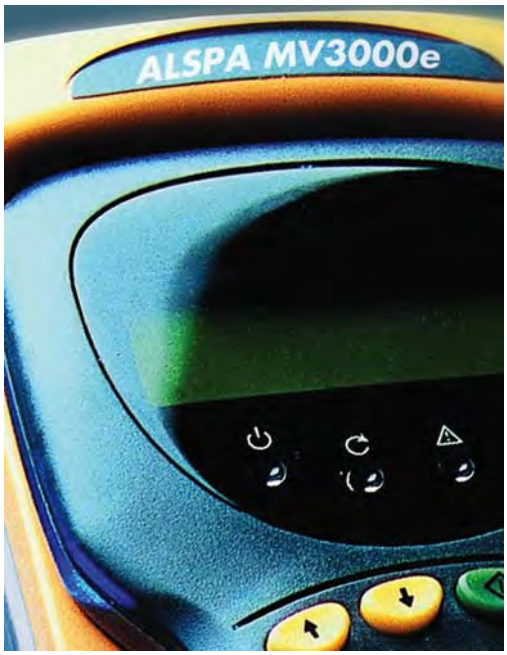


ALSPA MV3000e

Technical Manual for MVRL2100 & MVDL643-4701 690V ac Rated Products

Publication No. T1693EN Issue 0002 (08/06)

Liquid Cooled Drive System

CONVERTEAM
THE POWER CONVERSION COMPANY

Acknowledgements

"1-wire ™" is a trademark of Dallas Semiconductors of the USA.

Issue Information

Publication T1693EN Issue 1 (07/00)

Issue 1 (07/06) – Original Issue

Issue 2 (08/06) – Company name change

SAFETY INSTRUCTIONS

Care has been taken with the design of this product to ensure that it is safe. However, in common with all products of this type, misuse can result in injury or death. Therefore, it is very important that the instructions in this manual and on the product are observed during transportation, commissioning, operation, maintenance and disposal.

This technical manual should be regarded as part of the product. It should be stored with the product and passed on to any subsequent owner or user.

Local safety laws and regulations must always be observed.

Persons working on the product must be suitably skilled and should have been trained in that work for these products.

The product is a component designed for incorporation in installations, apparatus and machines.

The product must not be used as a single item safety system. In applications where maloperation of the product could cause danger, additional means must be used to prevent danger to persons.

Product approvals and certifications will be invalidated if the product is transported, used or stored outside its ratings or if the instructions in this manual are not observed.

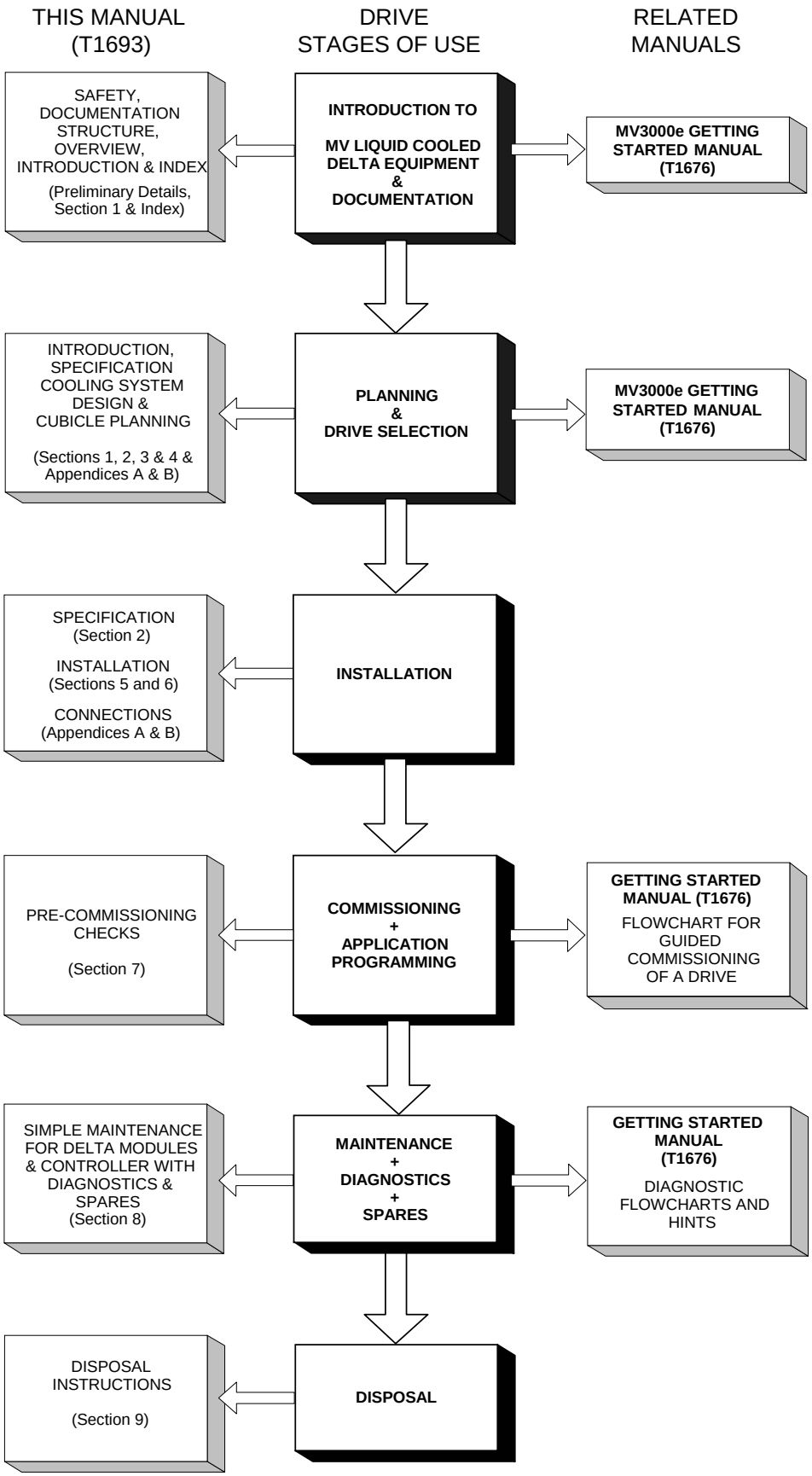
Third party approvals to safety standards UL 508C and CSA C22.2 No 14 are marked on the product.

In the European Union:

- Products within the scope of the Low Voltage Directive, 73/23/EEC as amended are CE marked.

- The product complies with the essential protection requirements of the EMC directive 89/336/EEC as amended, when installed and used as described in this manual. The requirements of the EMC Directive should be established before any installation, apparatus or machine which incorporates the product is taken into service.

- A machine should not be taken into service until the machine has been declared in conformity with the provisions of the Machinery (Safety) Directive, 98/37/EEC.


THIS MANUAL (T1693)
DRIVE STAGES OF USE
RELATED MANUALS
SAFETY, DOCUMENTATION STRUCTURE, OVERVIEW, INTRODUCTION & INDEX
(Preliminary Details, Section 1 & Index)
INTRODUCTION TO MV LIQUID COOLED DELTA EQUIPMENT & DOCUMENTATION
MV3000e GETTING STARTED MANUAL (T1676)
INTRODUCTION, SPECIFICATION COOLING SYSTEM DESIGN & CUBICLE PLANNING
(Sections 1, 2, 3 & 4 & Appendices A & B)
PLANNING & DRIVE SELECTION
MV3000e GETTING STARTED MANUAL (T1676)
SPECIFICATION (Section 2)
INSTALLATION (Sections 5 and 6)
CONNECTIONS (Appendices A & B)
INSTALLATION
PRE-COMMISSIONING CHECKS
(Section 7)
COMMISSIONING + APPLICATION PROGRAMMING
GETTING STARTED MANUAL (T1676)
FLOWCHART FOR GUIDED COMMISSIONING OF A DRIVE
SIMPLE MAINTENANCE FOR DELTA MODULES & CONTROLLER WITH DIAGNOSTICS & SPARES (Section 8)
MAINTENANCE + DIAGNOSTICS + SPARES
GETTING STARTED MANUAL (T1676)
DIAGNOSTIC FLOWCHARTS AND HINTS
DISPOSAL INSTRUCTIONS
(Section 9)
DISPOSAL

SCOPE

This publication provides assembly, installation, commissioning and maintenance instructions for MV Liquid Cooled DELTA Rectifier and Transistor power equipment when supplied in kitted form and for the associated MV3000e controller. Guidance is also given for design of the external cooling system for use with the Liquid Cooled DELTA equipment.

This publication should be read in conjunction with the appropriate MV3000e Getting Started Manual T1676. Both publications should be regarded as part of the ALSPA MV Liquid Cooled DELTA product. They should be retained for the life of the product and passed on to any subsequent owner or user.

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Units Covered:

MV LIQUID COOLED DELTA MODULES

MVDL643-4701	Transistor Module 643A, 1250V d.c.
MVRL2100-4601	Rectifier Module 2100A, 690V a.c.

MV LIQUID COOLED DELTA MOUNTING FRAMES FOR ALSTOM Q80 CUBICLE

MVDLQ80-4001	LC DELTA Mounting Kit 600W x 800D
MVDLQ80-4002	LC DELTA Mounting Kit 800W x 800D
MVDLQ80-4003	LC DELTA Mounting Kit 1000W x 800D
MVDLQ80-4004	LC DELTA Mounting Kit 1200W x 800D
MVDLQ80-4005	LC DELTA Mounting Kit 600W x 600D
MVDLQ80-4006	LC DELTA Mounting Kit 800W x 600D
MVDLQ80-4007	LC DELTA Mounting Kit 1000W x 600D
MVDLQ80-4008	LC DELTA Mounting Kit 1200W x 600D

Additional Lower Front Cross Members for ALSTOM Q80 Cubicle

50Y7585/01	For 600 mm Wide Cubicle
50Y7589/01	For 800 mm Wide Cubicle
50Y7593/01	For 1000 mm Wide Cubicle
50Y6945/01	For 1200 mm Wide Cubicle

MV LIQUID COOLED DELTA MOUNTING FRAMES FOR RITTAL PS4000 CUBICLE

MVDLRIT-4001	LC DELTA Mounting Kit 600W x 800D
MVDLRIT-4002	LC DELTA Mounting Kit 800W x 800D
MVDLRIT-4003	LC DELTA Mounting Kit 1000W x 800D
MVDLRIT-4004	LC DELTA Mounting Kit 1200W x 800D
MVDLRIT-4005	LC DELTA Mounting Kit 600W x 600D
MVDLRIT-4006	LC DELTA Mounting Kit 800W x 600D
MVDLRIT-4007	LC DELTA Mounting Kit 1000W x 600D
MVDLRIT-4008	LC DELTA Mounting Kit 1200W x 600D

Additional Lower Front Cross Members for RITTAL PS4000 Cubicle

50Y9724/01	For 600 mm Wide Cubicle
50Y9720/01	For 800 mm Wide Cubicle
50Y9728/01	For 1000 mm Wide Cubicle
50Y9732/01	For 1200 mm Wide Cubicle

UNITS ASSOCIATED WITH MV LIQUID COOLED DELTA MODULES

MVS3000-4001	Drive Data Manager™ (Keypad)
MVC3001-4001	MV3000e Controller
MVC3002-4001	User I/O Termination Panel
MVC3003-4003	MV Switched Mode Power Supply, 690 V
MVC3004-4001	Ribbon Cable Kit – 1 short length ribbon
MVC3004-4002	Ribbon Cable Kit – 1 short and 1 medium length ribbons
MVC3004-4003	Ribbon Cable Kit – 1 short, 1 medium and 1 long length ribbons
50Z0119/02	Interbridge Transformer 690 V

OVERVIEW

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1. Introduction

1.1 General Description

The ALSPA MV Liquid Cooled (LC) DELTA modular system of transistor and rectifier bridge modules, with associated components and a MV3000e DELTA Controller, covers the requirements of the a.c. variable speed drive market at high power levels. The transistor bridge range covers 691 kW to 3.9 MW (926 h.p. to 5229 h.p.) at 690 V a.c. input voltage and the rectifier bridge range covers 1.9 MW to 3.5 MW (2546 h.p. to 4693 h.p.) at 690 V a.c. Throughout the manual 'MV LCD' will be used as a prefix when referring to the MV Liquid Cooled DELTA Transistor or Rectifier Bridges, modules or associated drive systems. The term 'module' will be used extensively when referring to the mechanical assembly for the transistor and rectifier bridges.

The ALSPA MV Liquid Cooled DELTA system comprises a set of transistor bridge modules and a set of rectifier bridge modules which are the basic blocks used to construct an a.c. variable speed drive. The transistor bridges are used for inversion functions and the rectifier bridges are used for the conversion of an a.c. supply into a rectified, unsmoothed d.c. supply. The bridge modules, which are used with a range of associated components, are used as building blocks in constructing the power circuits of a.c. drives and are only suitable for installation in a cubicle or other similar enclosure. The rectifier bridges are 12 pulse modules. The block circuit diagrams, which are included in this section of the manual, are introductions to the various drive system configurations in which these bridge modules may be used.

The power range (see Section 2 - SPECIFICATION) is covered by the use of a single liquid cooled DELTA module, or by paralleling up to six liquid cooled DELTA modules.

The transistor and rectifier MV LCD modules are of a standard mechanical design, each being of a fixed height and mounted in a cubicle; 1.7 outlines the mechanical description of the modules and their mounting arrangement. All the modules are withdrawable on a simple slide system for ease of assembly and maintenance. Removal of a module from a cubicle requires suitable lifting equipment (see Section 5 - MECHANICAL INSTALLATION). Section 6 gives guidance on the electrical installation of all components required for a basic system. Design guidance for the module liquid cooling system is included at Section 3 - COOLING SYSTEM DESIGN.

1.1.1 About this Manual

This manual describes the MV LCD Modules and associated power equipment used for the MV3000e drives and common d.c. link drives over 691 kW. These components, as standard, are supplied loose as a kit of parts. This manual describes the components and how they may be assembled into a cubicle to produce a complete drive.

This T1693 manual includes references to the MV3000e Getting Started Manual (T1676) and should be used in association with it. An outline of the documentation structure and the relationship between this manual and the T1676 manual is included in preliminary information. In particular the T1676 manual includes commissioning and operating details for a MV3000e Liquid Cooled DELTA System when used as a complete drive.

The T1676 Manual should be regarded as part of the ALSPA MV LCD products. The manual(s) should be retained for the life of the products and passed to any subsequent owner or user.

1.2 Features of a MV LCD Drive System

- Wide power range covered by common modules.
- Parallel capability increases the power range.
- Modular construction making maintenance and repair work simple.
- Rapid module replacement.
- Ease of handling - smaller, lighter modules are assembled to form large drives.
- Minimum spares holding.
- Interface with the MV3000e controller.

1.3 The MV LCD Modular System

1.3.1 Introduction

A typical MV3000e DELTA modular system is shown at Figure 1-1. Interconnections between the MV3000e Controller and system components are shown at Figure 1-2.

The MV3000e Controller is capable of driving up to six MV LCD transistor bridge modules and two rectifier modules. The controller reads information from each connected module to check that the system configuration is consistent and to automatically configure itself to the appropriate current rating.

Various configurations of voltage and current rating are achieved by software control at initialisation.

1.3.2 Overview of MV LCD Drive System

The MV LCD system, which can be used to either control a motor or generate supplies from an external source, comprises one or more liquid cooled modules and a MV3000e controller. Application requirements determine the configuration of the modules, as described in this section.

Figure 1-3 shows a simple a.c. variable speed drive which uses a MV3000e Controller to control a power assembly. The power assembly has two major blocks. There is a network bridge (the Rectifier Module) that converts the a.c. supply to d.c. and a machine bridge (the Transistor Module) that chops up (inverts) this d.c. into a variable frequency, variable voltage output. These power blocks are constructed using MV LCD modules.

The network bridge may consist of an uncontrolled rectifier, a thyristor convertor, a sinusoidally controlled transistor bridge or any source of d.c. that is within the limits defined at Section 2 - SPECIFICATION. The uncontrolled rectifier network bridge is a 12 pulse bridge.

The machine bridge is a controlled transistor bridge.

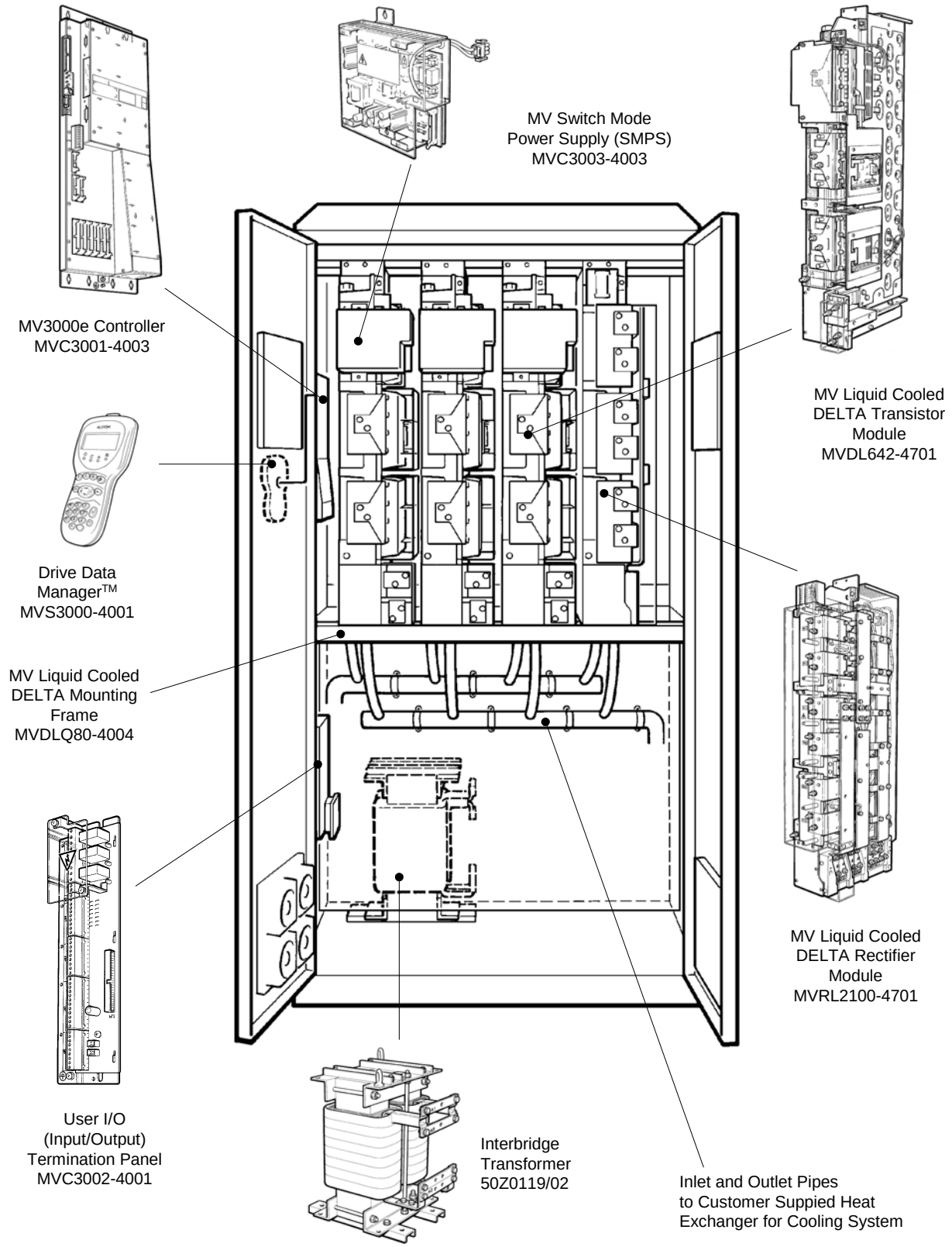


Figure 1-1 Typical Cubicle Layout for MV LCD System Component Parts

Note: A drip tray has been omitted from Figure 1-1 for clarity.

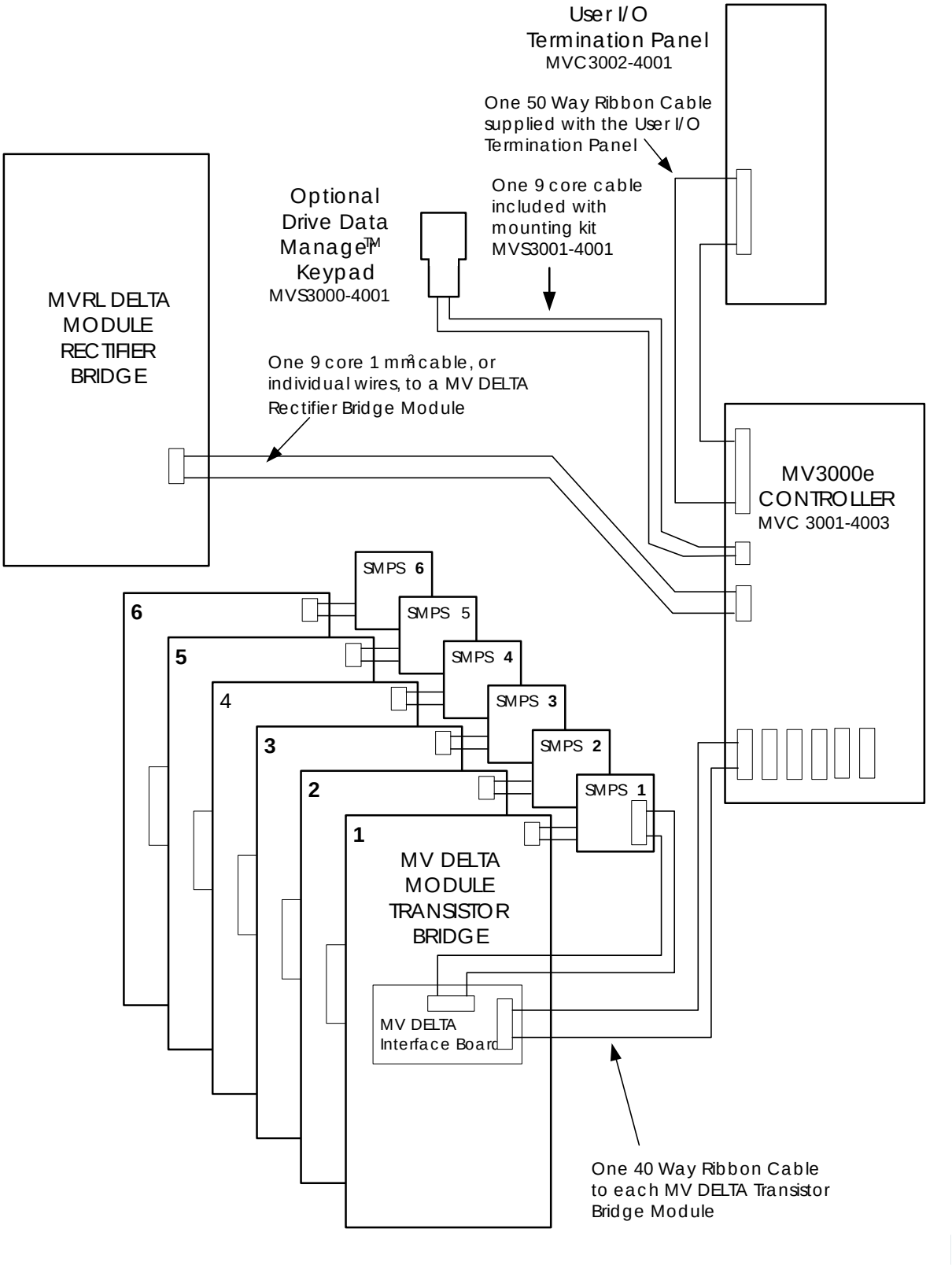


Figure 1-2 Interconnections between a MV3000e Controller and MV LCD Modules

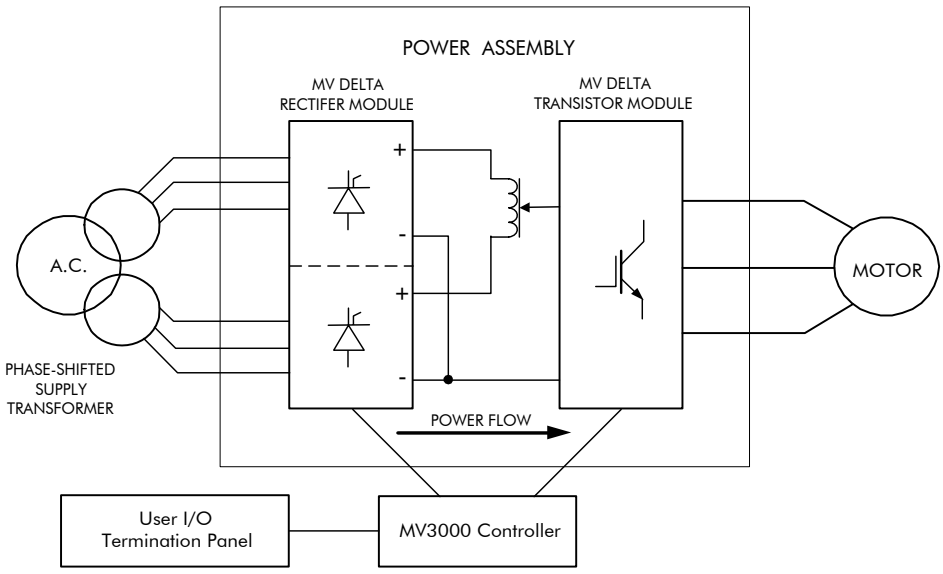


Figure 1-3 Block Diagram for an AC Variable Speed Drive showing the Functional Use of MV LCD Modules

1.3.3 12 Pulse Input Rectifier

Harmonic currents produced in the supply system by variable speed drives with uncontrolled rectifier inputs may be reduced by changing from 6 pulse (3 phase) to 12 pulse (6 phase) input.

A phase shifting transformer is used to produce the additional 3 phases which are phase shifted by 30° as shown at Figure 1-4. These two sets of three phase supplies are rectified by two rectifier bridges. Instantaneous voltage differences, between the outputs of the two rectifiers, are absorbed by an interbridge transformer connected between the two positive outputs of the rectifiers. The output to the d.c. link is taken from the centre-tap of the interbridge transformer.

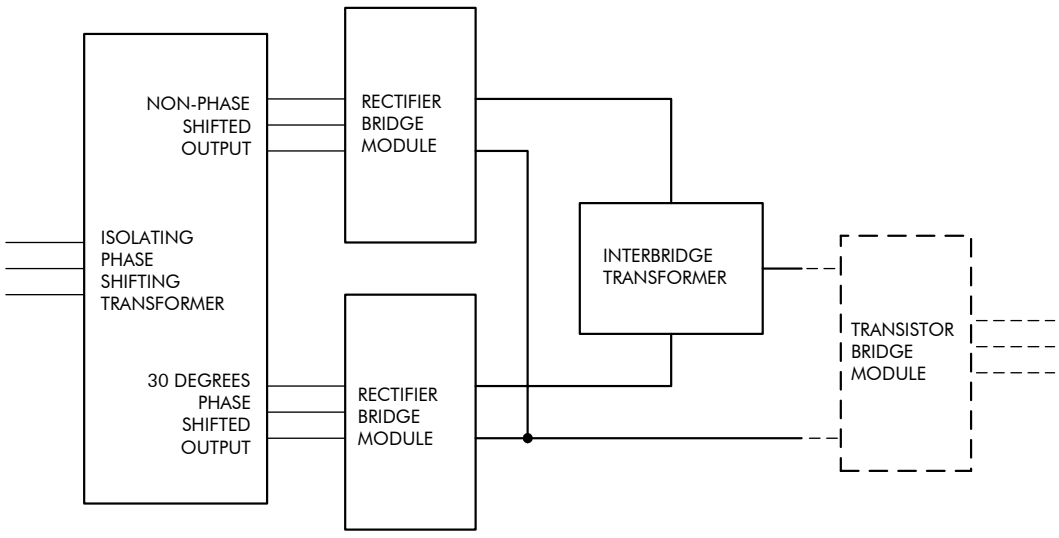


Figure 1-4 12 Pulse Input System

1.3.4 Parallel Transistor Bridges

The current rating of an individual MV LCD Transistor Bridge Module may be increased by paralleling it with another Transistor Bridge Module by the use of cabling which is star connected at the motor terminals. Figure 1-5 shows a machine bridge using parallel MV LCD transistor modules with d.c. fusing included.

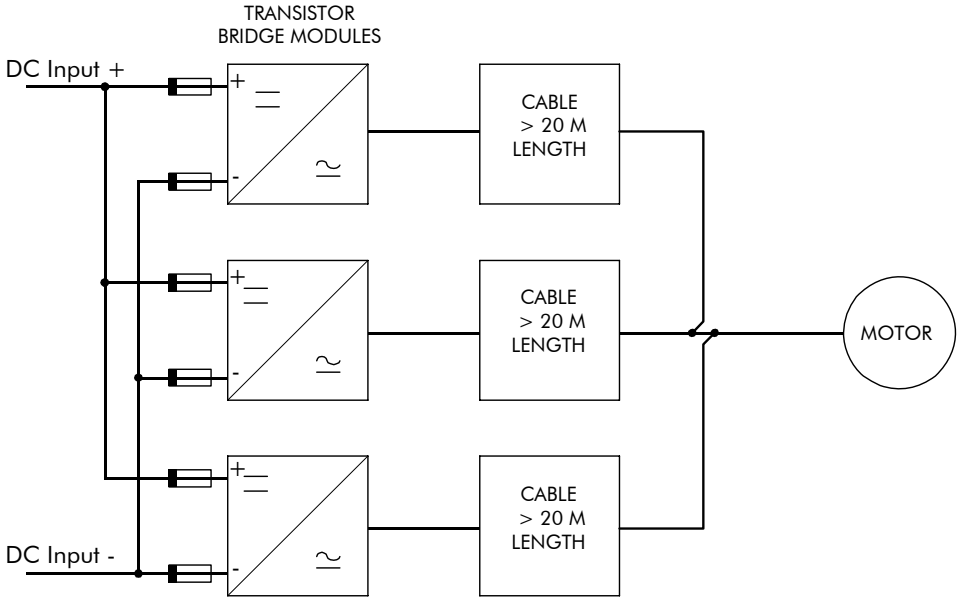


Figure 1-5 Machine Bridge using Parallel MV LCD Transistor Modules with d.c. fusing

1.4 MV LCD System Components

The basic blocks used to construct a MV3000e controlled a.c. variable speed drive, which also use MV LCD modules, are outlined at Figure 1-1 and Figure 1-2, and are:

(a) one MV3000e Controller with associated User Termination Panel and optional Drive Data Manager™ (Keypad);

(b) one to six MVDL Transistor Bridge Modules;

(c) one or two MVRL Rectifier Modules;

(d) one MV SMPS (Switched Mode Power Supply) for each MV LCD Transistor Bridge Module;

(e) Other units associated with MV LCD Systems are:

(1) interbridge transformers for the 12 pulse rectifier systems;

(2) mounting frames and module lower guide plates for use in the cubicles/ enclosures.

Each of the basic blocks is now described in more detail.

1.4.1 MV3000e Controller

The MV3000e Controller, shown at Figure 1-6, provides all the control and monitoring functions for the transistor and rectifier bridges in a MV LCD System. It is shown in a typical block diagram at Figure 1-3.

MV LCD bridge modules can be used in various input and output circuit configurations for which the circuits are included at Appendix A.

The Controller is supplied in a 'stand-alone' cassette form for mounting within an enclosure. It derives an electrical supply from an associated transistor bridge module and includes facilities for communication with both the transistor and rectifier bridge modules. Circuit interconnections for a controller and related bridge modules are shown at Figure 1-2.

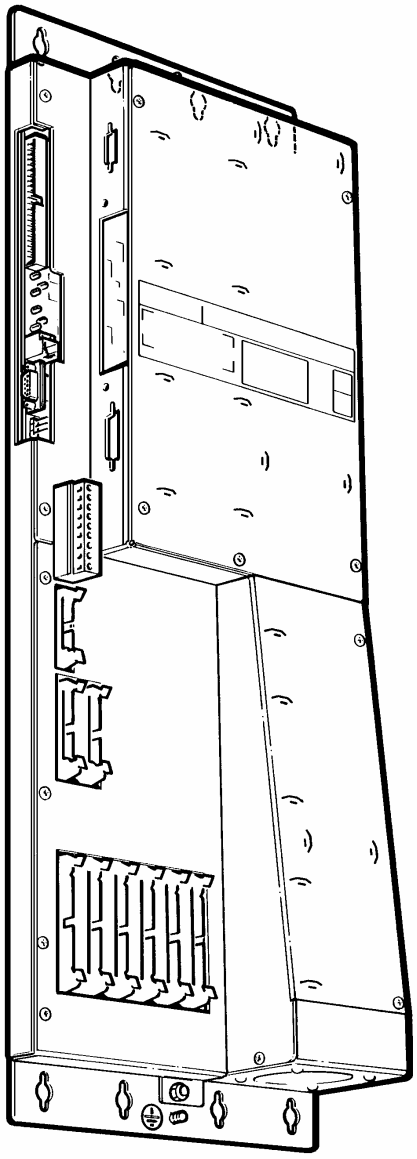


Figure 1-6 MV3000e Controller for MV LCD System

1.4.2 MV3000e User Input/Output (I/O) Termination Panel

The User Termination Panel, shown at Figure 1-7, provides the input and output termination facilities for signals to and from the MV3000e Controller. Functional details for each termination on the panel are included at Table 6-4 and a Wiring Diagram showing user circuits is included at Figure 6-10.

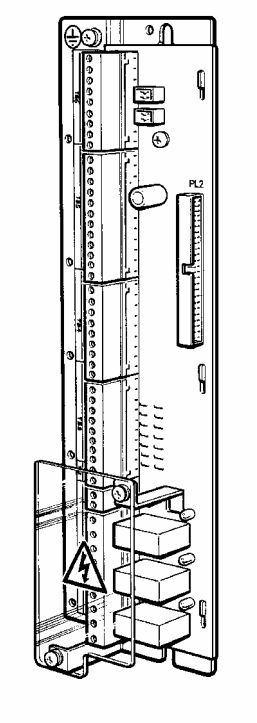


Figure 1-7 User I/O Termination Panel

1.4.3 Optional Drive Data Manager™ (Keypad)

The Drive Data Manager ™, shown at Figure 1-8, is an ergonomically designed keypad which provides the functionality to configure a drive and also provide motor control and diagnostic functions. The Drive Data Manager ™ is an optional item for use with the MV3000e Controller from where it derives its power supply. It is supplied with separate user instructions.

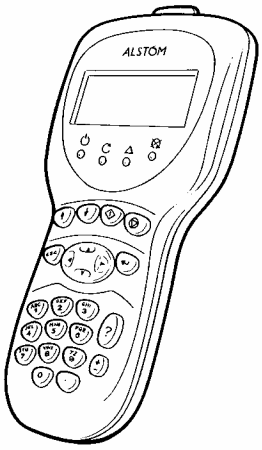


Figure 1-8 Drive Data Manager™ MVS3000-4001 for MV3000e Controller

1.5 MV LCD Modules

There are two types of MV LCD Modules, the Rectifier Bridge Module and the Transistor Bridge Module. These modules are mounted in one of two types of mounting frame for assembly into either an Converteam Q80 Cubicle or a Rittal PS4000 Series Cubicle.

A typical cubicle layout for a MV LCD system is shown at Figure 1-1.

1.5.1 Rectifier Bridge Module

1.5.1.1 Introduction

In a MV LCD System, Rectifier Bridge Modules, shown at Figure 1-9, are used as network bridges only. They convert an a.c. supply into a rectified, unsmoothed d.c. supply.

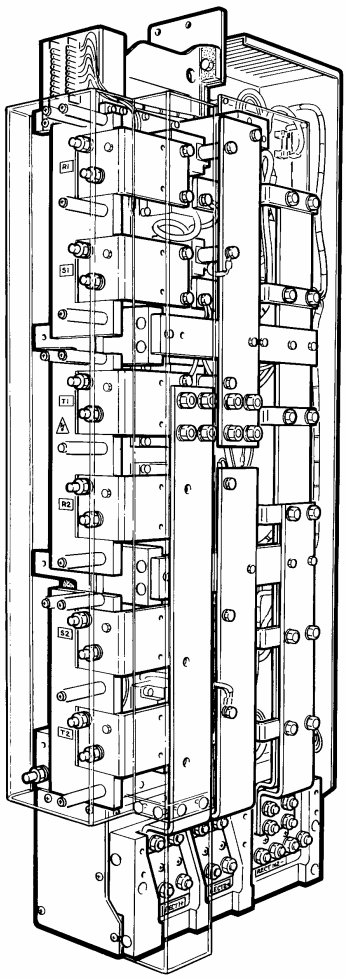


Figure 1-9 MV LCD Rectifier Bridge Module - MVRL2100

The Rectifier Bridge Module is presently available in one rating. The largest rectifier power ratings can be achieved by connecting the modules in parallel.

The Rectifier Bridge Module has two three-phase rectifier bridges with two sets of a.c. input terminals and two sets of d.c. output terminals. Two d.c. positive and a single d.c. negative output terminals are provided.

The Rectifier Bridge Module may be operated as a 12-pulse network bridge. This configuration is achieved by connecting the d.c. positive outputs together through an interbridge transformer, one a.c. input being phase-shifted in relation to the other by the external supply transformer.

The rectifier modules fit in a standard MV LCD module mounting system - see 1.7.

1.5.1.2 Features

- A Rectifier Bridge Module includes a circuit which is capable of pre-charging the Transistor Bridge Modules. This circuit charges the d.c. link capacitors of the transistor bridge via current limiting resistors in the rectifier modules.
- Modules fit in the standard MV LCD mounting frames.
- Metal oxide varistors are included to absorb surge energy from the mains. Supply impedance is necessary for this to function correctly. See 1.6 for information on reactors.
- Protection against d.c. link short circuits by the use of recommended semiconductor fuses.
- Modules carry thermostat and thermistor protection so when they are connected to the controller, the module is protected against overtemperature.

1.5.1.3 Variations

- The Rectifier Bridge Module is only available in a current rating of 2100 A (d.c. output current).
- Higher current versions are possible by paralleling the modules through reactors. As the modules will not carry equal current, some derating of the output current is necessary.
- The Rectifier Bridge Module is available for a voltage of 575 - 690 V a.c.

1.5.1.4 Interface

- Signals between the controller and the rectifier bridge module are by discrete wires, which are between 'pluggable' terminal blocks.
- The MVRL2100 power connections are designed for cable connection to stud terminals.

1.5.1.5 External Requirements

- For parallel operation of these modules, external sharing reactors must be fitted.
- For 12 pulse operation the two supplies must be phase shifted by 30° to each other and of balanced voltage. The output must be through an interbridge transformer.
- Protection of the main input rectifier devices is by the addition of external semiconductor fuses - for recommended fuses see Section 2 - SPECIFICATION.
- The a.c. terminals on the modules designed for cable connection are not suitable to support the weight of any attached cables. These cables/busbars must have additional mechanical support.
- The output from all of the Rectifier Bridge Modules must be through an interbridge transformer.

1.5.2 Transistor Bridge Module

In a MV LCD System, Transistor Bridge Modules, as shown at Figure 1-10, can be used in combinations to provide an output stage where the d.c. produced by the input stage is converted into a variable frequency and variable voltage three phase output.

A separate Switched Mode Power Supply (SMPS) is required for each Transistor Bridge Module - see Figure 1-11.

Ratings for the transistor bridge module and the SMPS are detailed in Section 2 - SPECIFICATION of this manual.

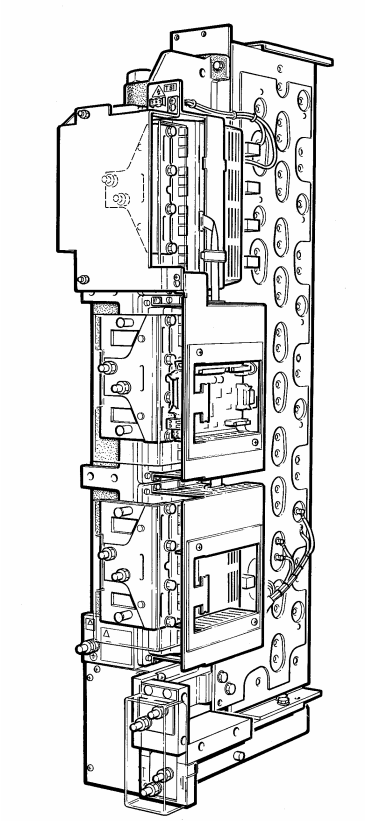


Figure 1-10 MV LCD Transistor Bridge Module - MVDL643

1.5.2.1 Introduction

In the standard MV3000e applications MV LCD Transistor Bridge Modules are used in combination to provide:

- A machine bridge where the d.c. produced by the network bridge is converted into a variable voltage variable frequency three phase output.

1.5.2.2 Features

- MV LCD Transistor Bridge Modules use the latest insulated-gate bipolar transistors (IGBT) in Integrated Intelligent Power Packs (IIP) to provide low distortion output.
- DC smoothing capacitors that provide filtering for the drive d.c. link in addition to local energy storage for transistor switching.
- Output protection against short circuits.
- Modules fit in standard MV LCD rack system.

- Auxiliary d.c. link connection plug for voltage monitoring and connection to Switch Mode Power Supply (SMPS). The appropriate MV SMPS is mounted on the Transistor Bridge Module.

- Each module carries thermistor protection. When connected to the MV3000e controller the module is protected against overtemperature.

- Each module includes fan monitoring to check the state of the cooling fans which are used to cool the d.c. link capacitors on the module.

1.5.2.3 Variations

- The Transistor Bridge Module is only available in a current rating of 643 A at 690 V.

- This version is suitable for the Network and machine bridges on MV3000e drives and as the Network or Machine power bridges in common d.c. link applications.

1.5.2.4 Interface

- Signals between the controller and Transistor Bridge Module are by a single 40 way ribbon cable per module. This cable also carries the supplies for the electronics in the controller.

- Power connections are stud terminals for the a.c. and d.c. connections.

- Auxiliary d.c. link connections.

1.5.2.5 External Requirements

- The Transistor Bridge Module contains smoothing capacitors which when used in both Network and machine bridge applications must be 'pre-charged'. These modules do not carry pre-charge circuits. Pre-charge is either via a Rectifier Bridge Module (MVRL2100-4601) or external circuitry. Refer to Converteam for recommended pre-charge rates.

- The d.c. supply to the transistor module must be within appropriate voltage, current and ripple limits and must be 'pre-charged'.

- These liquid cooled modules must be cooled by an externally derived cooling system.

- When Transistor Bridge Modules are used as network bridges it is recommended that semiconductor fuses are fitted on the a.c. supply on a per module basis.

1.5.3 MV Switched Mode Power Supply (SMPS)

The MV SMPS, shown at Figure 1-11, is mounted on a Transistor Bridge Module. It provides the electronic supplies for the Transistor Bridge Module and the MV3000e Controller. The SMPS derives a supply from the drive d.c. link; the low voltage electronics are maintained during a temporary loss of supply.

There is initially only one type of SMPS. The specification is included at Section 2 - SPECIFICATION.

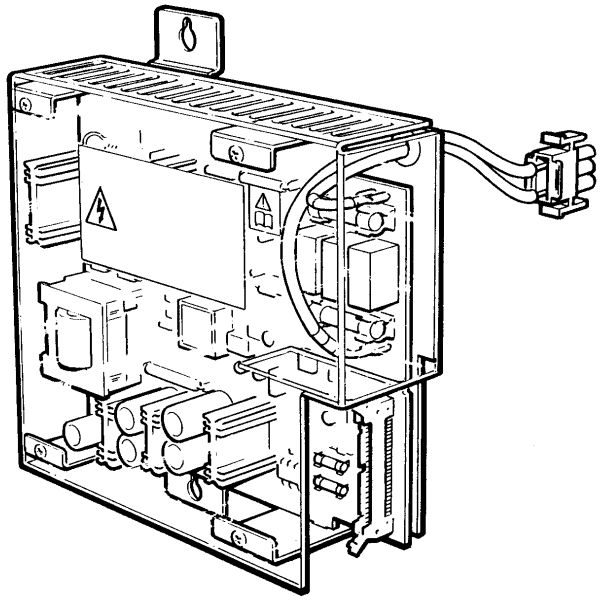


Figure 1-11 MV SMPS - MVC3003

1.6 Reactors, Inductors and Transformers

1.6.1 General Description

A variety of reactors, inductors and transformers will be available for use in conjunction with the MV LCD power modules. Different functions which these optional and mandatory components may be used for are now described.

Where a drive is supplied by an individual transformer of approximately the same rating as the drive then input line reactors are not required. However, account should be taken of the effective reactance requirements within the specification for the associated supply transformer for the drive.

It is recommended that input line reactors are fitted in the following circumstances:

(a) if there is primary switching of a transformer e.g. 13.8 kV circuit breakers, on line primary tap changing etc. and the transformer is large (i.e. greater than 17 MVA fault level);

(b) if there is power factor correction equipment on the same supply as the drive;

(c) if there is a high risk of a short circuit on the secondary of a transformer caused by other equipment with separate fuse protection;

(d) where semi-conductor fuses will not protect the input rectifiers without additional line impedance - see fuse information at Section 2 - SPECIFICATION.

1.6.2 Sharing Reactance

To allow even load sharing between Transistor Bridge Modules which are connected in parallel it is always necessary to fit additional reactance in the three-phase connection of each parallel module.

1.6.2.1 Reactors for Network Bridges

For network bridges on MV3000e applications multi-filar input reactors are recommended.

1.6.2.2 Reactors for Machine Bridges

For machine bridges sharing reactance can be obtained by use of separate motor cables of 20 m minimum length.

1.6.3 Interbridge Transformer for 12 Pulse Rectifier Systems

When using the Rectifier Bridge Modules for 12 pulse input functions the mandatory interbridge transformer replaces the d.c. link inductor. It forces sharing between the two rectifier bridges (one supply phase-shifted by 30°).

The interbridge transformers are large and heavy. They are usually mounted in the base of the drive enclosure - see Figure 1-12.

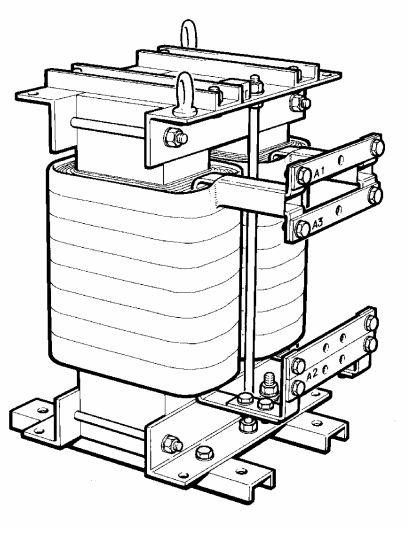


Figure 1-12 Interbridge Transformer 50Z0119/02 for 12 Pulse Rectifier Systems

1.7 Mechanical Description of MV LCD Module Mounting System

Cubicle installation of the MV LCD module is directly onto the MV LCD module mounting frame. Additional components are mounted within the cubicle. The frame consists of a set of cross members and cubicle side supports that form a ‘bookshelf’ for the modules.

The MV LCD module mounting frame consists of a set of three cross members (two at the lower position - front and rear and one at the upper position) and four cubicle side supports (two for each side). The lower cross members support the weight of a module. The upper cross member supports the top of the module. The side supports, which vary depending upon the depth of cubicle, attach the frame to the cubicle. The spacing between the upper and lower cross members is fixed by the height of the module. The overall position of the mounting frame is dependent on cubicle requirements.

The MV LCD modules are mounted between the upper and lower cross members by simple guides, two located on the lower guide plate and two on the upper cross member. The module slides between these guides and is then bolted to the cross members. When extracting a module it slides as far as the stop screw and then has to be lifted over this screw before it may be completely removed. The lower guide plate is directly attached to the cross members.

The installation of additional MV LCD modules is a step, by 250 mm (9.84 in), and repeat of the assembly up to the width of the cross members.

1.7.1 MV LCD Module Mounting Kit

1.7.1.1 Introduction

The MV LCD module mounting kit is a framework of cross members and brackets, which when installed in a cubicle, provide the support and fixings for the modules. It is suitable for installation into standard Converteam Q80 cubicles and Rittal PS4000 series cubicles - refer to Section 5 - MECHANICAL INSTALLATION for details.

1.7.1.2 Variations

- The standard kits are based on 600 mm (23.6 in) and 800 mm (31.5 in) deep cubicles. For each of these depths of cubicle there are four cross member widths available, 600 mm (23.6 in), 800 mm (31.5 in), 1000 mm (39.4 in) and 1200 mm (47.2 in).
- The 600 mm (23.6 in) and 800 mm (31.5 in) wide cross members will support up to two MV LCD modules. The 800 mm (31.5 in) wide kit is not frequently used, as it will only hold two modules.
- The 1000 mm (39.4 in) wide cross members will support up to three MV LCD modules.
- The 1200 mm (47.2 in) wide cross members will support up to four MV LCD modules.

1.7.1.3 Interface and External Requirements

- The mounting frame bolts directly into the Converteam Q80 and Rittal PS4000 series cubicles but requires a different side mounting kit for each type of cubicle.
- The mounting frame kits for Q80 and PS4000 series cubicles are available in depths of 600 and 800 mm and widths of 600, 800, 1000 and 1200 mm. For details see 2.12. For mounting in other types of enclosure see 5.4.

1.8 Cooling

1.8.1 Cooling of a MV LCD Module

Each MV LCD module is cooled principally by a liquid coolant which is pumped through it. Heat generated within a module is carried away by the coolant flow; refer to 1.8.3 for full details and Section 3 - COOLING SYSTEM DESIGN.

1.8.2 Cubicle Cooling Air

In addition to the liquid cooling system there is also a requirement for a clean cooling air flow through any cubicle/enclosure in which a MV LCD module is housed. This air flow should ensure that the modules and associated electronic circuits are operating in a clean, dust-free air which is free from corrosive vapours and cooled for operation within the temperature specification. The air flow is normally determined for each application but would typically include an air intake on a cubicle door with fan assistance and filtering as required. Factors to be considered when determining the amount of cooling air to be supplied to a cubicle and whether it should be filtered are:

(a) the amount of heat which is dissipated from the MV LCD module(s) into the cubicle - see Section 2 - SPECIFICATION for guidance;

(b) the amount of heat which is dissipated from the electronic and electrical circuits/components associated with the MV LCD module(s) - see Section 2 - SPECIFICATION for guidance;

(c) the internal and external ambient temperatures;

(d) the method of obtaining and extracting the cooling air;

(e) the type and amount of contamination in the cooling air and the need for any filtering (e.g. is the contamination conductive or corrosive?).

Note: In extreme environments the use of dual circuit heat exchangers is recommended.

1.8.3 MV LCD Module Cooling System

1.8.3.1 Introduction

The MV LCD product range is a high power rated industrial drive which uses a water-ethylene glycol coolant system to move heat away from the power electronics to a position where it can be more effectively dissipated into the environment. This dissipation is normally done with a liquid-to-air heat exchanger.

A fully integrated cooling system should comprise the following items:

(a) a liquid-to-air heat exchanger:

(b) a force ventilation fan;

(c) a pump;

(d) a header tank;

(e) a strainer;

(f) ball valves;

(g) inlet and outlet manifolds;

(h) instrumentation for coolant conditions e.g. measurement of temperature and flow rate - refer to 3.2 for more details.

The cooling system is used for all of the MV LCD modules described in this technical manual. Each module includes a precision machined casting with a cooling duct through which the liquid coolant is pumped; normally a water-ethylene glycol mixture. Additional components are required to complete the cooling system. A typical liquid-to-air cooling system for a multiple MV LCD module configuration is included at Figure 1-13.

1.8.3.2 Features

- The MV LCD module has ‘spring loaded’ couplings with ‘auto shut-off’ valves fitted to enable cooling pipes to be easily connected to, or released from it, without excessive coolant loss.
- Vent valves are included on the MV LCD module.
- The Cooling System can be designed to suit any combination of MV LCD modules.

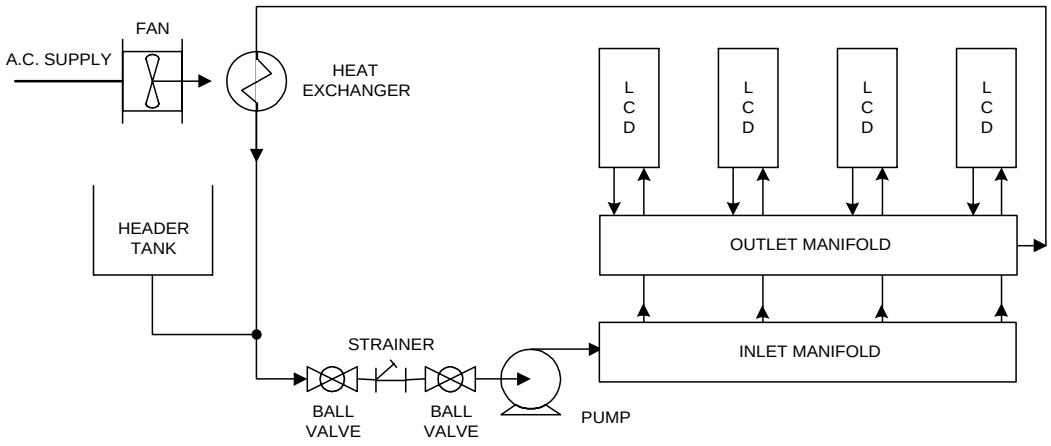


Figure 1-13 Simplified Diagram of a Cooling System for Four MV LCD Modules

1.8.3.3 Variations

- There are variations in piping to the MV LCD modules, depending on how many modules are installed in each cubicle/enclosure.
- Details for mechanical installation of all the piping and connectors at the Liquid Cooled DELTA modules are included at Section 5 - MECHANICAL INSTALLATION.
- The external cooling system should be designed to suit user requirements.

1.8.3.4 Interface

- Specification for the types of piping and connections are included at Section 3 - COOLING SYSTEM DESIGN.
- Details for the routing of piping and connections into and within a cubicle/enclosure are detailed at Section 5 - MECHANICAL INSTALLATION.

1.8.3.5 External Requirements

- Design guidance for the external cooling system is given at Section 3 - COOLING SYSTEM DESIGN.
- Additional components, to be supplied and installed by the system integrator, are required to complete a cooling system e.g. items listed at 1.8.3.1 and associated plumbing and application dependent control, protection and instrumentation.
- The additional components may be installed separately from the cubicle which houses the MV LCD modules.

1.8.4 Drip Tray

A drip tray should be used to collect any condensate from the MV LCD module casting. The method of draining condensate from the tray should be specified by the system integrator. Refer to Converteam if advice is required.

1.9 Compatibility between Converteam GD and MV DELTA Systems

Some guidance is necessary if MV LCD systems are being used for applications where GD Liquid Cooled DELTA systems are already in use - refer to Converteam for advice about compatibility.

The items which cannot be interchanged are:

MV3000e Controller;

Drive Data Manager™;

(c) Rectifier Bridge Modules;

(d) Transistor Bridge Modules;

(e) Switched Mode Power Supplies;

(f) User I/O Termination Panel;

(g) All ribbon cables;

(h) Different parts in the module mounting frames e.g. the lower guide rails.

2. Specification

2.1 Introduction

The specifications provided in this section are for the individual MV Liquid Cooled DELTA (MV LCD) power components. These components are the transistor and rectifier bridge modules and the module cooling system, the MV3000e Controller, the Switched Mode Power Supply (SMPS), the User I/O Termination Panel, associated reactors and transformers and the module mounting frames (for use in cubicles). Consideration should be given to the rating of individual components when they are included in a system as derating for parallel applications may apply.

2.2 ALSPA MV LCD Components (General Environment)

All ALSPA MV LCD components are designed to comply with the common specifications at Table 2-1 and Table 2-3 unless otherwise detailed in the individual component specification. Drive performance data for a MV3000e based Liquid Cooled DELTA drive is included at Table 2-2.

Table 2-1 Electrical Specification

Function	Specification
ELECTRICAL SUPPLY	
Network Type	TN or TT (i.e. earthed/grounded neutral). Can also be connected to IT network (i.e. isolated neutral) if IT network separated from public mains supply by an isolating transformer.
Voltage Range	575 V - 690 V (600 V nominal)
Voltage Variation (on voltage range)	±10% long term, ±15% for 0.5 to 30 cycles with loss of performance but no trip
Voltage Unbalance	Negative sequence voltage not to exceed 3%
Frequency (optimised)	50 Hz, 60 Hz
Operational Frequency Range	45 Hz to 63 Hz. With frequencies outside the optimised values, extra d.c. link ripple may be apparent and may impair motor control performance.
SWITCHING FREQUENCY	
Default Setting	1.25 kHz, 2.5 kHz, 5 kHz and 7.5 kHz for all drives (programmable by P99.02).
OUTPUT	
Overload Current	50% or 10% for one minute, as selected.
INSULATION	
Standards	UL 840, CSA C22-2 No. 0.2, EN 50178: TN or TT network : Overvoltage Category III IT network : Overvoltage Category II For full compliance with UL 508C, transient suppressers complying with UL 1449 must be fitted external to the drive.

2.2.1 Electrical Data

Table 2-1 details the specification for the electrical supply, switching frequency, output and insulation; these details apply to all units within the MV LCD system.

Other electrical parameters are included separately with each component as detailed later in this section.

Table 2-2 includes the drive performance data.

Table 2-2 Drive Performance Data

FREQUENCY			
Resolution	0.01%	Control Accuracy	0.1%
SPEED			
Resolution	0.01%	Accuracy (absolute)	0.01%
SPEED CONTROL			
	FREQUENCY CONTROL (VVVF)	**ENCODERLESS FLUX VECTOR**	**FLUX VECTOR WITH ENCODER**
Range	50 : 1	50 : 1	>1000 : 1
Bandwidth	N/A	20 rad/s	100 rad/s
Accuracy	≅ 1%	≅ 0.5%	≅ 0.02%
TORQUE CONTROL			
Bandwidth	< 1 rad/s	> 500 rad/s	> 500 rad/s
Accuracy	≅ 10%	≅ 10%	≅ 5%

2.2.2 EMC (Electromagnetic Compatibility) Compliance

The component parts of a MV3000e based drive comply with the requirements of IEC 61800-3 (EN 61800-3) providing that they are all installed and used in accordance with the instructions in this manual.

Note: Also refer to Section 4 - CUBICLE PLANNING where EMC guidelines are included.

Table 2-3 Common Specification for all MV LCD Components

Function	Specification
ENVIRONMENTAL	
Operating - Ambient Air Temperature range	0 to 50°C (32°F to 122°F)
- Relative Humidity	5 to 95% (non-condensing)
- Altitude	Normal operating altitude up to 1000m above sea level. From 1000 m (3280 ft) to a maximum of 2000 m (6551 ft) derate by 7.3% per 1000 m (3280 ft).
- Cooling air	Pollution Degree 2 (IEC 60664-1, UL 840 and CSA C22.2 No. 0.2-93) i.e. clean, free from dust, condensation and conductive or corrosive gases. If conductive pollution or condensation are expected (Pollution Degree 3), the drive must be placed in an enclosure which achieves Pollution Degree 2 by: - excluding the conductive pollution e.g. by the use of filtered air; - preventing condensation e.g. by use of anti-condensation heaters. In extreme environments dual circuit heat exchangers are recommended.
- Coolant temperature	Inlet temperature is 60°C (140°F) maximum
- Chemicals (max.)	15 ppm H_2S 25 ppm NO_2 25 ppm SO_2
Storage - emperature range	-25 to +55°C (-13°F to 131°F) – without coolant
- Relative Humidity	5 to 95% non-condensing
- Altitude	Up to 3000 m (9842 ft) above sea level
Transport - Temperature range	-25 to +70°C (-13°F to 158°F) – without coolant
- Relative Humidity	≤ 95% (non-condensing)
-Altitude	Will withstand air transport
MECHANICAL	
Enclosure - Ingress Protection	IP00 (to IEC 60529: 1989; BS EN 60529:1992) The MV DELTA modules and components must always be installed in an appropriate enclosure with restricted access.
-Vibration - operational	To IEC 61800-2 which specifies 'Class 3M1' of IEC 60721-3-3 and to the vibration requirements of EN 50178. The products comply with the more severe requirements from both standards - this is given as the 'Composite' data represented in the following table.

Frequency	IEC 61800-2	EN 50178	Composite
2 Hz to 9 Hz	0.3 mm amplitude		0.3 mm amplitude
9 Hz to 18.4 Hz	1 m/s^2	0.075 mm from 10 Hz	1 m/s^2
18.4 Hz to 57 Hz	1 m/s^2	0.075 mm amplitude	0.075 mm amplitude
57 Hz to 150 Hz	1 m/s^2	9.81 m/s^2	9.81 m/s^2
150 Hz to 200 Hz	1 m/s^2		1 m/s^2

-Vibration - storage and transport	To IEC 61800-2 which specifies Class 2M1 of IEC 60721-3-2 when equipment is packed for transport: 2 to 9 Hz 3.5 mm amplitude 9 to 200 Hz 10 m/s^2 200 to 500 Hz 15 m/s^2
- Drop - transport	To IEC 61800-2 which specifies Class 2M1 of IEC60721-3-2 when equipment is packed for transport: mass < 100 kg 0.25 m; 100 kg ≤ mass 0.10 m

2.3 MV3000e Controller

2.3.1 Terminations

The terminations from the MV3000e Controller to other equipment in the MV LCD system are as follows:

(a) One 40 way ribbon cable to each Transistor Bridge Module - see Table 6-1;

(b) One 9 way connector for wiring* to the Rectifier Bridge Module.

Note: * Wiring should have a cross sectional area between limits of:

Minimum	0.5 mm^2 or 20 AWG (use a consolidating crimp)
Maximum	2.5 mm^2 or 14 AWG

(c) One screened cable to an optional Drive Data Manager™ Keypad - see Table 6-3;

(d) One 50 Way ribbon cable to the User I/O Termination Panel - supplied with the User I/O Termination Panel.

2.3.2 Weight

The MV3000e Controller weighs 4 kg (8.8 lb).

2.4 User I/O Termination Panel

The user connectors on the User I/O Termination Panel are suitable for 0.5 mm^2 - 2.5 mm2 (20 to 14 AWG) single core or flexible cable*. A consolidating crimp should be used for the minimum size. Refer to Table 6-4 for a specification of each terminal function. A 50 way ribbon cable, supplied with the panel, connects to the controller.

Note: ***** UL/CSA Approval requires cable in the range No. 22 - 12 AWG.

2.5 MV3000e Drive Data Manager™ (Keypad)

The specification for the Drive Data Manager™ is included at the T1915 Instruction Sheet which is supplied with it.

2.6 Rectifier Bridge Module

Unit covered: MVRL2100-4601.

2.6.1 Current Ratings

Overloads are for 60 seconds, 6 times per hour equally spaced.

All ratings assume standard drive configurations using interbridge transformers.

If two separate Rectifier Bridge Modules are paralleled derate the output current by 10% to allow for current imbalance between the bridges.

To protect a Rectifier Bridge Module from d.c. link side short circuits it is recommended that a.c. supply semi-conductor fuses be fitted. The current rating of the Rectifier Bridge Module with the recommended fuses, from Le Carbone (Ferraz Shawmut), is given at Table 2-4.

Table 2-4 Rectifier Bridge Module Current Rating when using Recommended Fuses

Module	Voltage (V) a.c.	Fuse For 1.1 Overload	DC Current Rating (A) For 1.1 Overload
MVRL2100-4601	575 - 690	12.5 URD 73 TTF 700	2100

Notes:

(1) Semi-conductor fuses of the correct rating must be fitted to each of the three phases of the a.c. supply input to protect against catastrophic failure of the input rectifiers; refer to 6.11 for additional fuse details.

(2) The fuses should be fitted remotely from the rectifier; refer to 6.11.3 for mounting details.

(3) All ratings are calculated assuming a 31 MVA supply (fault level), no added impedance.

(4) All incoming mains cables should be protected with fuses according to local wiring regulations, for example, in Europe (or any other countries that use IEC standards) using fuses type gG and in USA and Canada using Class L fuses.

2.6.2 Phase Rotation

Rectifier modules are not sensitive to phase rotation.

2.6.3 Input Phase Voltage

The Input Phase Voltage is detailed at Table 2-5.

Nominal voltage is a.c. rms, 3 phase, 3-wire and earth/ground.

The equipment will operate with a variation of ±10% of the nominal supply voltage. For supply voltages below the nominal, there will be a corresponding reduction in maximum output power. The equipment can operate up to a maximum of +15% variation on the nominal supplies for a maximum of 30 cycles duration without the equipment tripping though reduced performance may be observed.

Supply frequency : 45 Hz to 63 Hz.

Table 2-5 Input AC Voltage and Output DC Link Voltage Ratings

Module	Input AC Voltage	Output DC Link Voltage	
	Nominal AC Input Voltage (Vrms)	Maximum Output (Vd.c.)	Maximum Allowed Regenerative Voltage (Vd.c.)
MVRL2100-4601	575 - 690	1122	1250

2.6.4 Output DC Link Voltage

The Output DC Link Voltage is detailed at Table 2-5.

Typical d.c. output : 1.35 x supply voltage (rms).

2.6.5 Pre-charge

Pre-charge requirements are listed at Table 2-6. The pre-charge control signal switches in the main rectifiers when d.c. link has finished pre-charging. The drive MV3000e Controller determines when the charging period is complete.

The rectifier pre-charge acknowledge signal must be connected to the MV3000e Controller at PL12 to allow drive operation.

Table 2-6 Pre-charge Requirements

Module	Internal Pre-charge Resistor (Ohm)	Control Signal Voltage (Vd.c.)	Control Signal Load (mA)
MVRL2100-4601	72	24 V	10 mA

2.6.6 Heat Dissipation

The heat dissipation for a MV LCD rectifier module will vary depending upon the drive system in which it is used (a typical dissipation from module to coolant is 6000 W). The total heat dissipation will include heat dissipated from the module into the coolant and into the cubicle. Additionally heat will be dissipated from the module electronics into the cubicle. As these dissipation figures are all application dependent refer to Converteam for advice.

2.6.7 Thermal Protection

Thermal protection is provided on each rectifier bridge module by a thermistor on the upper heatplate and a thermostat located on each heatplate. The thermistor and thermostat specifications are:

(a) Thermistor

Type : Microtherm TC25P5KAT (600)

Rating : 5 k Ω ±1%

(b) Thermostat

Type : Microtherm 54N-111034 90/75

Rating : 10 A at 250 Va.c., 50/60 Hz

8.5 A at 24 Vd.c.

7 A at 48 Vd.c.

normally closed contact opens at 90°C ±3°C.

2.6.8 Terminations

(a) Power Terminations

Terminations for the 3-phase supply, the d.c. output and earth/ground are detailed at Table 2-7.

Table 2-7 Terminations for 3-phase Supply and DC Output on MVRL2100-4601

Termination	Stud Size	Crimp Size
A.C. Terminals	2 x M10 stud connections per phase	M10 (or 3/8 in) ring crimps
D.C. Terminals	2 x M10 stud connections for each positive output and 4 x M10 stud connections for the single negative output	M10 (or 3/8 in) ring crimps
Earth Terminal 1 x	1 x M10 stud	M10 (or 3/8 in) ring crimps

Notes:

(1) The a.c. terminals are suitable for a maximum of 2 x 150 mm^2 cables (2 x 300 MCM in North America).

(2) Do not allow the temperature of the cable to exceed 130°C (266 °F).

(3) To achieve the full current rating of the product, it may be necessary to use high temperature cable, e.g. Von Roll Isola silicon rubber type SIWO-KUL.

Von Roll Isola is available in the UK from Von Roll Isola Ltd., Wharfdale Road, Euroway Estate, Bradford, West Yorkshire, BD4 6SG; Tel. 01274 687777; Fax. 01274 689095).

For other distributors, contact the Head Office in Switzerland, at Schweizerische Isola-Werke Ltd, Passwangstrasse 20, CH-4226, Breitenbach, Switzerland, Tel: ++41 61 785 51 11; Fax: ++41 61 781 20 78.

(4) The a.c. terminals are not intended for incoming cables from the plant which should be terminated appropriately at the cubicle/enclosure boundary.

(5) The d.c. positive terminals are suitable for a maximum size of busbar at 76 mm x 6.3 mm wide (≈ 3 in x 1/4 in). Ratings and sizes of busbars are application dependent.

(6) The d.c. negative terminals are suitable for a maximum size of busbar at 140 mm x 6.3 mm wide (≈ 5.1/2 in x 1/4 in). Ratings and sizes of busbars are application dependent.

(b) Control Terminations

The control terminations for the Rectifier Bridge Module, which are made via TB1, are suitable for 0.5 mm^2 to 2.5 mm^2 size wire (20 -14 AWG). Functional details for each termination are included at Table 2-8.

2.6.9 Weight

The weight of each basic MVRL2100 MV LCD Rectifier Module, without coolant, is 83 kg (183 lb). Each module increases in weight by 1.5 kg (3.3 lb) when filled with coolant.

2.6.10 Acoustic Noise

Acoustic noise is negligible for the MV LCD Rectifier. The majority of any noise generated will be from the heat exchanger system.

Table 2-8 Control Terminations on TB1 on MVRL2100-4601

Termination Number	Function	Termination Number	Function
1	NTC Temperature Sensor - Thermistor	6	0 V
2	NTC Temperature Sensor - Thermistor	7	+24 V
3	Thermostat (24 V = HEALTHY)	8	Pre-charge Signal 24 V
4	Thermostat +24 V	9	Pre-charge Acknowledge +24 V
5	No connection	10	No connection

2.7 Transistor Bridge Module

Unit covered: MVDL643-4701.

The values given in this section are the Absolute Maximum Ratings for the Transistor Bridge Module. As other components (i.e. controller) are required to form a complete drive circuit, then the ratings arising from the combined components should be used when sizing a drive.

2.7.1 AC Phase Current Ratings

The AC Phase Current Ratings, detailed at Table 2-9, are limited by the system design. The cooling system, number of paralleled Transistor Bridge Modules, type and configuration of controller will limit the system rating. It is NOT possible to achieve these absolute ratings under all operating conditions. Most combinations of ambient temperature, supply voltage, and switching frequencies will result in a reduced rating. Refer to the Converteam factory or agent for specific ratings for different configurations.

Table 2-9 Absolute Maximum AC Phase Current Ratings (Network or Machine Mode)

Conditions	MVDL643
Peak instantaneous current	1000 A
Continuous a.c. rms current allowing for a 1.5 x overload	471 A
Continuous a.c. rms current allowing for a 1.1 x overload	643 A
Continuous a.c. rms current with no allowance for overloads	707 A

2.7.2 Phase Voltage

The maximum phase to phase rms voltage is Vdc/√2 for sinusoidal waveforms.

2.7.3 DC Link Voltage

Table 2-10 lists the DC Link Voltage and the DC Link Overvoltage Trip Level. When a motor is braked, power is returned to the drive and the d.c. link voltage rises. The drive is programmed to trip if the d.c. link voltage rises to an excessive level to protect the MV LCD Transistor Module. The trip level, which is set at the controller for a nominal supply voltage of 690 V, is given at Table 2-10.

Table 2-10 DC Link Voltage and Overvoltage Trip Level

Module	Maximum Continuous Working Voltage	Maximum Voltage* (Surge)	Maximum Silicon Voltage (V_{CES})	Overvoltage Trip Level for 600 V & 690 V Nominal Supply Voltage
MVDL 643-4701	1165 V	1250 V	1700 V	1172 V

Notes: (1) * : the maximum surge level is the lesser of the d.c. link capacitor rating and the short circuit test rating for the IGBT (Insulated-gate Bipolar Transistor).

(2) Refer to 6.11 for additional fuse details for the d.c. link protection.

2.7.4 DC Link Capacitors

Refer to Table 2-11 for Transistor module d.c. link capacitors (for one module).

Table 2-11 DC Link Capacitors for one MV LCD Transistor Module

Product Type	Voltage (V)	Value of Capacitor (μF)	Number in Series	Total Quantity	Total Capacitance (μF)
MVDL643-4701	450	2900	3	36	11 600

2.7.5 Heat Dissipation

The heat dissipation for a MV LCD transistor module will vary depending upon a number of factors which include the type of module and the drive in which it is used (a typical dissipation from module to coolant is 8900 W). The total heat dissipation will include heat dissipated from the MV LCD module into the coolant and into the cubicle. Additionally heat will be dissipated from the module electronics into the cubicle. As these dissipation figures are all application dependent refer to Converteam for advice.

2.7.6 Thermal Protection

Thermal protection is provided on each transistor bridge module by a thermistor located within each IGBT Module. The thermistor is embedded within the module.

2.7.7 Terminations

(a) Power Terminations

Terminations for 3-phase, d.c. outputs and earth/ground are detailed at Table 2-12.

Table 2-12 Terminations for 3-phase and DC on MVDL643-4701

Termination	Stud Size	Crimp Size
A.C. Terminals	2 x M10 stud connections per phase	M10 (or 3/8 in) ring crimps
D.C. Terminals	2 x M10 stud connections per position	M10 (or 3/8 in) ring crimps
Earth Terminal	1 x M10 stud	M10 (or 3/8 in) ring crimps

Notes:

(1) The a.c. terminals are suitable for a maximum of 2 x 120 mm^2 cables (250 MCM in North America).

(2) Do not allow the temperature of the cable to exceed 130 ^{o}C (266 ^{o}F).

(3) To achieve the full current rating of the product, it may be necessary to use high temperature cable, e.g. Von Roll Isola silicon rubber type SIWO-KUL.

Von Roll Isola is available in the UK from Von Roll Isola Ltd., Wharfdale Road, Euroway Estate, Bradford, West Yorkshire, BD4 6SG; Tel. 01274 687777; Fax. 01274 689095).

For other distributors, contact the Head Office in Switzerland, at Schweizerische Isola-Werke Ltd, Passwangstrasse 20, CH-4226, Breitenbach, Switzerland, Tel: ++41 61 785 51 11; Fax: ++41 61 781 20 78.

(4) The a.c. terminals are not intended for incoming cables from the plant which should be terminated appropriately at the cubicle/enclosure boundary.

(5) The d.c. terminals are suitable for a maximum size of busbar at 6.3 mm x 70 mm wide (≈ 1/4 in x 2. 3/4 in). Ratings and sizes of busbars are application dependent.

(b) Control Terminations

The control terminations for the Transistor Bridge Module are detailed at Table 2-13. The connectors are supplied with the product.

Table 2-13 Terminations for Control Circuits on Transistor Bridge Module MVDL643-4701 (excluding ribbon cables)

Termination	Connector Type
DC Feedback/ SMPS supply	AMP Mate-n-Lok (2way)
Control signals	1 x 40 way ribbon connector

2.7.8 Weight

The weight of the MVDL643 Transistor Module, without coolant, is 95 kg (210 lb). The module increases in weight by 1.5 kg (3.3 lb) when filled with coolant.

2.7.9 Acoustic Noise

Acoustic noise is negligible for the MV LCD Transistor Bridge Module. There will be a small amount of noise from the fan assembly which houses the cooling fans for the d.c. link capacitors and this will be 52 dB(A). However, the majority of any noise generated will be from the heat exchanger system and this will be specific to each application.

2.8 Switched Mode Power Supplies (SMPS) for MV LCD Systems

One MV SMPS unit, detailed at Table 2-14, must be fitted to each Transistor Bridge Module.

Table 2-14 MV SMPS Power Supply Specification

Order Number	MVC3003-4003
Nominal Drive Supply Voltage (Va.c.)	575 - 690 V (600 V nominal)
SMPS Supply	Fed from d.c. link of MV LCD Transistor Module
Start Up Voltage (Vd.c.)	550
Overvoltage Trip (V)	1172
Undervoltage Trip (V)	560
Output Power (W)	110
Maximum Ambient (°C)	50
Weight in kg (lb)	1.5 kg (3.3 lb)

2.9 Three-phase Sharing Reactors

2.9.1 Network Bridge

For MV3000e applications, network bridge sharing reactors have been implemented within the network line reactor (see Table 2-15) as necessary. The network line reactor is suitable for use with a maximum of two parallel DELTA transistor modules.

Table 2-15 Sinusoidal Network/Sharing Reactor

Drive	Nominal Supply Voltage (V)	Reactor Current Rating $I_{a.c.}$ (A) (rms)	Phase Inductance (mH)	$R_{reactor}$ (mΩ)	Weight (kg)	Order No.
MVDL643-4701	690	986	0.385	0.85	1050	50Z0081/01

2.9.2 Machine Bridge

To ensure current sharing between multiple transistor bridges it is recommended that the cabling to the machine is star connected at the motor terminals. A minimum cable length of 20 metres must be maintained to achieve sufficient inductance for the sharing function.

2.10 Interbridge Transformer

2.10.1 Weight and Resistance

These naturally ventilated transformers are used with 12 pulse input rectifier systems - see Table 2-16.

Table 2-16 Interbridge Transformer - Weight and Resistance

Reactor Order Number	Nominal Supply Voltage (V)	Approx. Weight (kg)	(lb)	$R_{reactor}$ (mΩ)
50Z0119/02	690	160	352	0.27

2.10.2 Terminations

Customer connections at A1, A2 and A3 on the Interbridge Transformer 50Z0119/02 should be with M12 bolts (or 1/2 in) with cable ring crimps.

2.10.3 Losses

Power loss = I_{dc}^2 x $R_{reactor}$ x 0.325 Watts

where $R_{reactor}$ is in ohms and I_{dc} is in Amperes

2.11 MV LCD Module Cooling System

The cooling system for the MV LCD rectifier and transistor modules uses an ethylene glycol type of liquid coolant (full specification is at Section 3). There are particular requirements for specification of the:

(a) cooling system - including all the requirements external to the liquid cooled modules;

(b) control, protection and instrumentation for the cooling system;

(c) compatibility rules for liquids and materials which may come into contact with the coolant or the cooling system.

Because these are all important aspects of the specification, which involve the user in the design of a cooling system, all the specification requirements are included at Section 3 - COOLING SYSTEM DESIGN. However, those details which relate specifically to the Liquid Cooled modules, are specified in this Section 2.

2.11.1 Type and Concentration of Coolant

The recommended coolant type is an ethylene glycol water mixture with a minimum concentration of 33% for the ethylene glycol. Refer to 3.7.2 and 3.7.3 for additional details.

2.11.2 Volume and Weight of Coolant in each MV LCD Module

The volume of coolant in each MV LCD module, Rectifier and Transistor, is 1.75 litres (≈ 0.38 UK gallon or ≈ 0.46 US gallon); weight of coolant is 1.75 kg (4 lb).

2.11.3 Coolant Flow Rate

The recommended flow rate, per module, for the coolant is 25 litres/minute (5.5 UK gallons/minute or 6.6 US gallons/minute).

2.11.4 Pressure Drop across a MV LCD Module

The pressure drop measured across a single MV LCD module, including the couplings, is typically 0.3 bar (30 kPa) at a flow rate of 25 litres/minute (5.5 UK gallons/minute or 6.6 US gallons/minute); variation of glycol concentration does not affect this pressure drop.

2.11.5 Cooling System Working Pressure

The maximum working pressure for the cooling system is 3 bar (0.3 MPa). The maximum pressure for testing purposes only is 6 bar (0.6 MPa) for short durations.

2.11.6 Coolant Inlet Temperature

The maximum coolant inlet temperature is 60 ^{o}C (140 ^{o}F) - measured at the inlet to the cooling duct.

2.11.7 Material Compatibility in Cooling Path

It is important that all materials in the cooling path are compatible with each other and with the type of ethylene glycol coolant in use (see 3.7.2). Because the external cooling path is specified by a system integrator and the equipment is not normally supplied with the MV LCD module it is important that material compatibility is maintained. The materials which are used in the MV LCD Cooling Path, and those which are acceptable for the external cooling path, are listed in this specification at Tables 2-17 and 2-18 respectively. Table 2-19 lists materials which are known to be incompatible with other materials in the MV LCD cooling path. This list is not fully inclusive and therefore system integrators must check intercompatibility.

Table 2-17 Materials Used in the MV LCD Cooling Path

COMPONENT	MATERIAL AND SPECIFICATION
Staubli Quick Release Hose Couplings RMI16 N007 117 96 - SKT and RMI16 N007 153 98 - PLG	Main Parts in brass CuZn40Pb3 - Nickel plated Release Sleeve in Stainless Steel Z30 CF13 Plug Body in hardened Chromium Steel Z30 CF13 Locking Balls in Stainless Steel Z2 CN18.09 Seals in EPDM Ethylene Propylene Springs in Stainless Steel Z10 CN18.09
Drain Plug - Converteam Part No. 51Y0653/01	Main Body - Stainless Steel Grade 316 Washer - Stainless Steel Grade 316 'O' ring for washer - EPDM Ethylene Propylene
Bleed Plug Assembly - Converteam Bleed Plug Part No. 51Y0651/01 Bleed Screw Part No. 51Y0652/01	Bleed Plug Main Body - Stainless Steel Grade 316 Washer - Stainless Steel Grade 316 'O' ring for washer - EPDM Ethylene Propylene Bleed Screw - Brass (grade unspecified)
Coolant Duct	Aluminium LM25 to BS 1490
Heatplate	Aluminium LM25 to BS 1490
Heatplate 'O' ring	Nitrile Rubber NI 70 (008-N70)

Table 2-18 Typical Materials (and Coolant) Suitable for Use in the External Cooling Path

COMPONENT	MATERIAL AND SPECIFICATION
Flexible Pipework from Staubli Couplings to Manifold	Codan Water Hose Type 4801 with: EPDM Lining, Polyester reinforcement and EPDM cover
Rigid Pipework from Manifold to External Cooling System	Light Carbon Steel Tube to BS 1387
Manifold	Brass or Carbon Steel
Header Tank	Polypropylene or Stainless Steel
Heat Exchanger	tube material - copper
Coolant Pump	brass body and bronze impeller
Coolant	Ethylene glycol (better than BS 6580) and water mixture, with inhibitors (see 3.7.2 for details).

Table 2-19 Non-compatible Materials for the Cooling Path

TYPE	MATERIAL
non-compatible non-metals	polyurethane

2.12 Mechanical Assemblies

2.12.1 MV LCD Module Mounting Frames

The MV LCD module mounting frames include four side supports and three cross members complete with fixing screws. Four frame widths are listed. The frames are supplied in a kit form. Lower guide plates are also included with the kits.

The detailed part references for the MV LCD module mounting frames for installation in Q80 and Rittal Cubicles are listed at Table 2-20.

Table 2-20 MV LCD Module Mounting Frame Specifications

Order Number	Number of MV LCD Modules	Cubicle Width (mm)	Cubicle Depth (mm)	Frame Weight	
				kg	lb
Q80 Cubicle - Module Mounting Frames					
MVDLQ80-4001	2	600	800	15	33
MVDLQ80-4002	2	800	800	17	37
MVDLQ80-4003	3	1000	800	19	43
MVDLQ80-4004	4	1200	800	22	48
MVDLQ80-4005	2	600	600	13	29
MVDLQ80-4006	2	800	600	15	33
MVDLQ80-4007	3	1000	600	17	38
MVDLQ80-4008	4	1200	600	20	44
RITTAL PS4000 Series Cubicle - Module Mounting Frames					
MVDLRIT-4001	2	600	800	15	32
MVDLRIT-4002	2	800	800	17	37
MVDLRIT-4003	3	1000	800	19	43
MVDLRIT-4004	4	1200	800	22	48
MVDLRIT-4005	2	600	600	13	29
MVDLRIT-4006	2	800	600	15	33
MVDLRIT-4007	3	1000	600	17	38
MVDLRIT-4008	4	1200	600	20	44

3. Cooling System Design

WARNING

Health Hazards of Liquid Coolants

The coolant used in this equipment may be hazardous to health if not stored, handled and disposed of in accordance with the manufacturer's instructions.

3.1 Introduction

The MV Liquid Cooled DELTA (MV LCD) module liquid cooling system depends upon specific requirements for each particular application and therefore requires separate consideration of its design at the system integration stage. This section, which includes details relating specifically to the Cooling System Design, should also be read in conjunction with Section 2 - SPECIFICATION which includes all the specifications for the MV LCD modules. The details included in this Section 3, for Cooling System Design, include integration of the cooling system control, protection and instrumentation features within the drive system and outline specifications for the hardware and coolant required for a complete cooling system. Outline specifications are included for the heat exchanger, the coolant pump, the header tanks and associated fittings and all piping and couplings. A detailed specification is included for the coolant and guidance is given about safe use, handling and disposal of the recommended coolants. A typical cooling system is shown at Figure 3-1.

Throughout this section of the manual reference to a MV LCD Module should be read as applying to either a Rectifier Module or a Transistor Module unless a type of module is specifically stated.

3.2 Cooling System Integration Requirements

Requirements for integration of the control, protection and instrumentation features of the cooling system with the drive controller depend upon each particular application. Some of these features are included as standard on a MV LCD module, e.g. measurement of heatsink temperature by thermistor, and inputs for the related control and protection circuits are already available within the MV3000e controller. However, other features which are not included as standard on the module, may also be considered at the system integration stage. Both standard and non-standard features for control, protection and instrumentation are now listed. The lists are not fully inclusive and special application conditions may include more extensive requirements.

3.2.1 Control

Control, and interlocking with system design, may be required for the following:

(a) co-ordination of coolant pump and heat exchanger operation;

(b) coolant pump 'switch off' when coolant temperature is low;

(c) economic use of the heat exchanger fan by controlled intermittent operation;

(d) drive start not permitted because the coolant temperature is too low.

3.2.2 Protection

Protection for the following conditions may be required:

(a) pump not running;

(b) coolant not flowing;

(c) coolant level too low;

(d) low pressure in cooling system

(e) coolant temperature too low for drive to start;

(f) coolant temperature too high for safe operation;

(g) module overtemperature;

(h) heat exchanger in thermal overload;

(i) heat exchanger fan not running therefore coolant temperature too high.

3.2.3 Instrumentation

Instrumentation for measuring or indicating the following coolant conditions may be required:

(a) inlet temperature;

(b) outlet temperature;

(c) pressure;

(d) level;

(e) flow rate;

(f) pump not running.

3.3 Heat Exchanger - Requirement Specification

The heat exchanger, which is not included with the MV LCD module, should be specified by the system integrator. To assist with that specification Table 3-1 lists those features which should be considered and specified at the system integration stage for a liquid-to-air heat exchanger; liquid-to-liquid types may also be used. The exact details will depend upon each particular application, including, for example, the number of MV LCD modules which have to be cooled.

When designing the heat exchanger please refer to Section 2 - SPECIFICATION, in this manual, which includes details of typical heat dissipation from the MV LCD modules and their associated electronics. These heat dissipation figures should provide a basis for calculations of the heat exchanger size for each particular application. The specification for material compatibility in the cooling system is also included at Section 2 and this should be implemented.

Detailed consideration should be given to the operating altitude whereby de-rating may be required for the heat exchanger.

Protection of the heat exchanger for thermal overload conditions may also be required and this should also be specified during system design.

Table 3-1 Liquid-to-air Heat Exchanger Specification

Feature	Units	Feature	Units
cooler type		design pressure	kPa
cooler reference		fluid density	kg/m^3
number required		fluid specific heat	J/kg/K
capacity	kW	fluid thermal conductivity	W/m/K
air flow rate	m^3/s	fluid viscosity	Ns/m^2
max. ambient temperature	^oC	weight net	kg
ambient relative humidity	%	total surface area	m^2
altitude	m	internal volume	litres
coolant type	recommended as ethylene glycol/water mixture with inhibitors	coupling size inlet/outlet vent/drain	 inches bsp* inches bsp*
glycol mix	% by volume	tube material	
lowest operational storage temperature	^oC	fin material	
coolant flow	litres/s	other external materials	
inlet temperature	^oC	overall dimensions: length depth height	 mm mm mm
outlet temperature (maximum of 60 ^oC)	^oC	number of fans	
fluid pressure drop	kPa	motor data (rating for inverter or supply driven as appropriate): installed full load current voltage phases	 kW A V
working pressure	kPa	noise level at 1 m	dB (A)

Note: ***** National standard pipe threads may be used as alternatives to bsp.

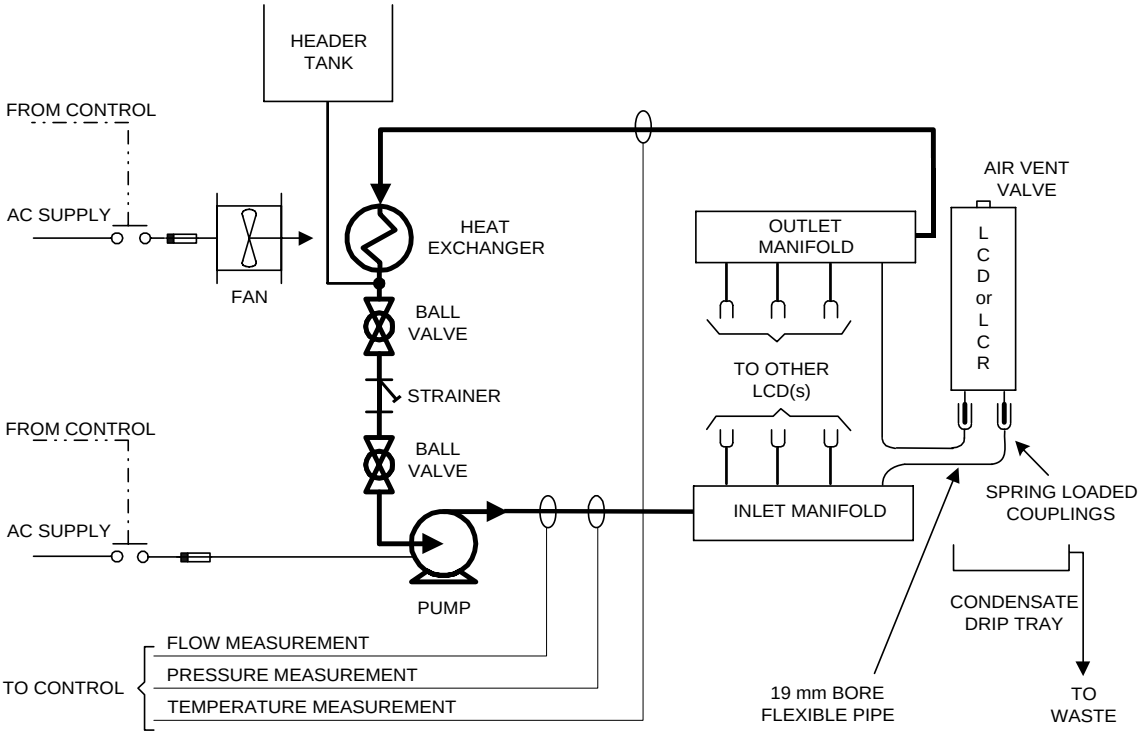


Figure 3-1 A Typical MV LCD Cooling System

3.4 Coolant Pump - Requirement Specification

Before specifying a coolant pump refer to Section 2 - SPECIFICATION for details of the module cooling requirements and compatible materials. Specification of the coolant pump should include the following:

(a) type;

(b) rating - power, voltage, current, flow rate, pressure etc;

(c) temperature - operating and storage;

(d) size/capacity - consider rate of flow and associated pressure drops (see 2.11.4);

(e) IP category;

(f) any protection required e.g. thermal overload by either thermostat or thermistor and feedback requirements into drive system;

(g) requirement for a second (standby) pump.

3.5 Header/Expansion Tank - Requirement Specification

Before specifying a header/expansion tank refer to Section 2 - SPECIFICATION for details of the module cooling requirements, including volume of coolant required for each module and material compatibility specifications.

Specification of the tank should include consideration of the following:

(a) whether a fully sealed system is required;

(b) type of header tank;

(c) size of tank - when determining the size allow for the volume of coolant in all modules, all pipework, pumps, manifolds and header tank;

(d) material for tank should be compatible with the module material specification (see Section 2);

(e) position of tank in relation to cubicle housing the modules.

3.6 Piping, Couplings and Fittings - Requirement Specification

There are several important factors to consider when specifying the piping, couplings and fittings for the MV LCD Cooling System. These factors relate to the number of modules, the materials used in the cooling system, their temperature and environmental specifications. Refer to Section 2 - SPECIFICATION for details of those requirements. All materials for piping and couplings should be compatible with the module material specification at Section 2. Specification of the piping, couplings and fittings for a multiple arrangement of modules (i.e. more than one) should include the following:

(a) possible use of a cooling system design that includes a by-pass around the heat exchanger to minimise the possibility of condensation occurring on those parts of the cooling system enclosed in the cubicle;

(b) the flow and return pipes should be positioned to ensure equalisation of coolant flow when piping to multiple modules e.g. the first connection from the inlet manifold connects to the FLOW coupling of the first liquid cooled product. The RETURN coupling from this module would connect to the last (end) connection of the outlet manifold - see Figure 3-1;

(c) each liquid cooled module is fitted with two ‘spring loaded’, ‘auto shut-off’ couplings - one for FLOW and one for RETURN. Two mating parts, Staubli Unimation Part RMI 16 type N00711796 socket hose couplings, are supplied loose with each module. These hose couplings are suitable for 19 mm (3/4 in) internal bore hose;

(d) pipes (flexible) - specification of flexible pipes from the MV LCD module to the cubicle manifold are included at Table 3-2 where typical, flexible high quality rubber pipes, manufactured, for example, by Codan Gummi A/S of Denmark are detailed – adequate fixings should also be specified to ensure that the pipes are fully located onto the coupling and firmly held in place by a clamp;

Note: Suitable clamps are Oetiker 2-Ear-Clamps available in the U.K. from Oetiker U.K. Ltd – Tel. +44(0) 1403 26 04 78 and also available internationally from the same company.

(e) pipes (rigid) - specification of rigid pipes recommended for couplings from the cubicle manifold to heat exchanger/pump are detailed at Table 3-3, based on BS 21;

(f) strainer - type and specification are user determined - recommended position is before the pump in the flow line;

(g) ball valves - type, specification and position are user determined;

(h) stop cocks - type, specification and position are user determined;

(i) vent valves - type, specification and position are user determined - note that if an automatic air eliminator valve is used, e.g. for a sealed system, it should be at the highest point in the cooling system i.e. higher than the vent valve which is positioned in the module;

(j) connection to manifold(s) - design for equal fluid flow through the system with separate feed and outflow pipes - ensure that there are no significant pressure drops across the manifold(s) by the use of suitably sized pipework for the main feed/outlet and individual feeds/outlets for the modules;

Table 3-2 Specification for Flexible Coolant Pipe

Size (internal diameter) (mm & in)	Type	Temperature Range	Working Pressure bar	psi	MPa	Minimum Bending Radius (mm & in)
19.1 (3/4 in)	Codan 4801	+110 °C to -40 °C	6	87	0.6	100 (3.9 in)
19.0 (3/4 in)	Alfagomma FLEXOR 6 (T-800)	+100 °C to -40 °C	21	300	2.1	178 (7.0 in)

(k) routing of pipework external to a drive enclosure - this pipework will be at high temperature and so measures should be taken to prevent accidental contact by personnel also **WARNINGS** for high temperatures should be placed on, or near to, all coolant piping and associated valves etc. which may be accessed by personnel.

Table 3-3 Specification for Minimum Size of Light Carbon Steel Coolant Pipes

Size (in) (internal diameter)	Type	Temperature Range	Working Pressure (bar)
1 (DN25)	BS 1387	+100 °C to -40 °C	10
1.25 (DN32)	BS 1387	+100 °C to -40 °C	10
1.5 (DN40)	BS 1387	+100 °C to -40 °C	10

Notes: (1) The minimum bending radius for carbon steel pipes depends upon several factors including pipe diameter and finish. Refer to BS 1387 in the UK, or other appropriate national standards, for details.

(2) Stainless steel pipe is also an acceptable alternative to the carbon steel pipe. Thick wall and thin wall stainless steel pipe should be specified against BS 4127 for UK use or other appropriate national standard.

3.7 Coolant

WARNINGS

- **Type of Liquid Coolant**
  Only use a recommended coolant with corrosion inhibitors.
- **Mixing Liquid Coolants**
  Do not mix coolants of different types or from different manufacturers.
- **Water without Corrosion Inhibitors**
  Do not use water as the only coolant. Mix water with corrosion inhibitor or ethylene glycol containing corrosion inhibitor.

3.7.1 Coolant Inlet Temperature at the Module Cooling Duct

The maximum cooling system inlet temperature, measured at the entry point of the coolant into the module cooling duct on the module, is 60°C.

The ambient temperature of the coolant is application dependent and should include consideration of heat from all the pumps, heat exchangers and pipework etc.

The inlet temperature should always be qualified as either that for the coolant duct or that for the total cooling system. The latter will be feeding several modules and possibly other equipment as determined by the application and the temperature will therefore differ from that measured at the entry point to a single module.

3.7.2 Coolant Type

The coolant mixture recommended for use with the MV LCD modules is an Ethylene Glycol and Water mixture.

The coolant should meet the performance specification of BS 6580 or the equivalent national standard. It must provide:

(a) corrosion protection;

(b) frost protection;

(c) scale inhibitors (against hard water);

(d) all year usage.

Two types of recommended coolant are detailed below. A local supplier of coolant (antifreeze) can be used providing that it complies with the requirements in (a) to (d) and is compatible with the materials specified at Table 2-17 and Table 2-18. However, it is important that these coolants, or any others from different manufacturers, are NOT MIXED in the cooling system.

Note: Ethylene Glycol based coolants are NOT normally compatible with polyurethane which should therefore not be included in the cooling system.

Recommended U.K. based coolant suppliers are:

(1) ESKIMO UNIVERSAL ANTIFREEZE from:

FUCHS LUBRICANTS (UK) PLC
SILKOLENE OIL REFINERY
BELPER
DERBYSHIRE
DE56 1WF
U.K.
Tel. +44(0)1773 824151 Fax. +44(0)1773 823659

(2) COMMA SUPERCOLDMASTER ANTIFREEZE from:

COMMA OIL & CHEMICALS LIMITED
LOWER GRANGE ROAD
GRAVESEND
KENT
DA12 2QX
U.K.
Tel. +44(0)1474 564311 Fax. +44(0)1474 333000

3.7.3 Coolant Mixture and Concentration

Coolant and pure or de-mineralised water should be used to prepare the coolant mixture.

The coolant mixture concentration depends upon the minimum external ambient temperature to avoid the possibility of freezing - refer to the manufacturer's recommendations for a coolant concentration to meet your requirements. There are four particular conditions which must be noted when determining the concentration of coolant viz:

(a) as the percentage of ethylene glycol within a coolant mixture increases, the efficiency of the coolant to remove heat from a module reduces slightly;

(b) .concentrations of ethylene glycol above approximately 50% offer no further protection against low temperatures.

(c) concentrations of ethylene glycol above approximately 75% provide less low temperature protection.

(d) a minimum concentration of 33% Ethylene Glycol must be included with the cooling system to ensure adequate corrosion protection.

3.7.4 Volume of Coolant in a System

The volume of coolant required for a cooling system depends upon the particular application and should consider the volumes of coolant required for:

(a) all the modules;

(b) all the cooling pipes;

(c) header/expansion tank;

(d) manifold(s);

(e) evaporation loss between planned maintenance.

Refer to Section 2 - SPECIFICATION for the capacity of coolant in each module.

3.7.5 Separation of Different Coolant Types

It is recommended that the coolant used for MV LCD modules be kept separate from any other coolants used at the same location. It is also important that different manufacturer's types of coolant are not mixed in the same MV LCD cooling system.

3.7.6 Rate of Flow and Cooling Rate

Before specifying the rate of flow for cooling requirements refer to Section 2 - SPECIFICATION for the cooling rates and heat dissipation figures for each module. Because cooling rates are affected by heat dissipation, ambient temperatures, coolant volumes etc. calculations for the required cooling rate and flow rate will depend upon each particular application.

The rate of flow, which is application dependent, should typically be 25 litres/minute.

3.7.7 Renewal of Coolant

Renewal of coolant is described at Section 8 - MAINTENANCE.

3.7.8 Handling, Storage and Disposal of Coolant

The coolant is subject to particular conditions during handling, storage and disposal. Refer to the manufacturer's instructions for the particular coolant in use. It is recommended that the instructions be retained with this manual. Detailed advice for safe handling, storage and disposal is included at Section 8 - MAINTENANCE. Disposal of the coolant and/or its container should be done in accordance with the manufacturer's instructions to ensure compliance with local and national Health, Safety and Environmental legislation.

4. Cubicle Planning

WARNING

Local Safety Regulations

Follow all local safety regulations for electrical equipment when planning and installing Liquid Cooled DELTA based systems.

4.1 Introduction

This section gives guidance for the selection, planning and installation of MV Liquid Cooled DELTA (MV LCD) Drive Systems. As each application has different requirements, this section only gives general rules and information. Requirements for Electromagnetic Compatibility are included at 4.4 and these should be implemented during the Cubicle Planning stage.

4.2 Guidance for the Selection of MV LCD Products

If the drive is non-standard the following selection procedure is included for guidance when confirming that the products ordered for a particular application are suitable:

1. Calculate the application current rating based on a 1.1 times (variable torque) overload for 60 seconds, 6 times per hour.

2. Select the appropriate MV LCD configuration. The standard supply voltage range is 575 - 690 V. Apply de-rating factors (ambient temperature and altitude etc.). Select the appropriate number of MVDL643-4701s to achieve the current rating for the application.

3. Select one ALSPA MV3000e DELTA Controller.

4. One MV DELTA User I/O Termination Panel is required.

5. Choose a quantity of Switch Mode Power Supplies (SMPS(s)) - one per MV LCD Inverter Module.

6. Corresponding to the required DELTA rating select the appropriate MVRL rectifier module.

   The rectifier designation is in d.c. current in Amps, i.e.

   MVRL2100 = 2100 A d.c..

   To relate rectifier rating to inverter module rating the conversion factor is:

   a.c. current = 0.85 x d.c. current

   Note: It is important to note that when two MV LCD rectifier modules are paralleled a 10% derate should be applied for load sharing reasons.

   As with MV LCD inverter modules, extra care should be taken with calculations when required current ratings are very close to (i.e. just under) the module rating.

7. Rectifier module MVRL2100 is designed for cable connection.

8. For multiple MV LCD Inverter Modules output sharing is achieved by independent cabling from the inverter to a star point at the motor.

9. Choose the appropriate interbridge reactor for 12-pulse rectifier configurations.

10. Choose the appropriate Cable Assembly Kit.

11. Choose the size and quantity of MV LCD module mounting frames to cover the number of modules i.e. rectifiers and inverters, and also to suit the desired cubicle width(s) and depth(s).

12. Select Technical Manuals.

13. End of selection procedure.

4.3 General Considerations for the Enclosure of MV LCD Drives

When planning for the installation of MV LCD components into a cubicle there are some general design considerations which have an effect on the overall performance of the drive system and also affect its compliance with various standards and approvals.

4.3.1 Enclosure Type

Essential requirements for the enclosure are that:

(a) The MV LCD modules must be enclosed in a steel (conductive) enclosure for:

- electrical safety - all doors must be closed and all unnecessary apertures avoided;
- reduction of radiated emissions from the drive and protection of the drive from radiating sources.

(b) The enclosure must provide a Pollution Degree 2 Environment, in accordance with IEC 60664-1, UL 840 and CSA 22.2 No. 0.2, for the MV LCD system components.

Note: Refer to Section 2 for the specification of an enclosure to meet a Pollution Degree 2 Environment.

(c) The assembly and connection of all parts should be done using the torque settings at Appendix B.

4.3.2 Enclosure Sizes

4.3.2.1 600 mm (23.6 in) Deep Enclosure

The MV LCD modules and components may be mounted in a range of different sized enclosures - see Table 2-19 for cubicle/enclosure widths and depths. However, when a 600 mm (23.6 in) deep enclosure is used, careful planning is required because some components use the full enclosure depth.

Also on 600 mm wide enclosures the horizontal mounting position of a module is offset 20 mm further to the left on the 600 mm cross rails than on all other versions.

4.3.2.2 800 mm (31.5 in) Deep Enclosure

The side supports for the 800 mm deep cubicles allow for two variations in the fitting of the MV LCD modules viz:

(a) modules mounted at the back of the cubicle - pipework and manifolds must then be fitted either above and below the cross members or located outside the cubicle.

(b) modules mounted forward of the rear face of the cubicle - this will allow for pipework and manifolds to be mounted on the rear wall of the cubicle behind the modules.

Note: To implement variation (b) the user must purchase an additional lower front cross member which fixes onto the side supports. The reference depends upon the cubicle type, quantity of modules and cubicle width; these are listed at Table 4-1.

Table 4-1 Details of Additional Lower Front Cross Member

Cubicle Width (mm)	Cubicle Manufacturer and Type	
	Converteam Q80	RITTAL PS4000
600	50Y7585/01	50Y9724/01
800	50Y7589/01	50Y9720/01
1000	50Y7593/01	50Y9728/01
1200	50Y6945/01	50Y9732/01

4.3.3 Position of Rectifier Bridge Module

It is recommended that the Rectifier Bridge Module be mounted on the right hand side of a cubicle (front view), with space to the right of the module, for the following reasons:

(a) access to d.c. positive and negative cable connections on the right hand side of the module;

(b) access to the d.c. link pre-charge fuses which are located on the printed circuit board at the rear of the module;

(c) access for tidy routing of cables from the d.c. connections;

(d) most cubicle doors are hinged on the left, so door interlocked isolators are mounted on the right of the cubicle.

4.3.4 Position of MV3000e Controller

The MV3000e controller is designed for mounting on the left or right hand side sheets of a cubicle housing MV LCD modules. There are certain constraints which apply to the position of the controller, and its associated modules, and User I/O Termination Panel and these are:

(a) wherever the controller is mounted allow a 50 mm (2 in) ventilation space above and below the controller;

(b) arrange for the controller to be mounted with front access for the LED(s) and sufficient space for access to all the connecting plugs, sockets and terminations;

(c) allow sufficient space around the controller for the routing and retention of all associated cables;

(d) arrange for User I/O Termination Panel to be mounted on the same side of the cubicle as the controller to minimise any EMC problems (refer to 6.8 for details) - ensure that the cable routing distance for the 50 way ribbon cable from PL20, at the controller, to the User I/O Termination Panel does not exceed 2 m (6.5 ft);

(e) ensure that the cable routing distance for each of the six 40 way ribbon cables from the controller to each module does not exceed the lengths supplied - refer to 6.3.1 for details of cable lengths;

(f) ensure that the cable routing distance for the cable from PL12 to a Network Bridge Rectifier does not exceed 25 m (82 ft);

(g) ensure that the optional Drive Data Manager™ (Keypad), when used, is mounted in a position which is within the 3 m (9.8 ft) cable length for connection to the controller at SK5 - this dimension will influence controller position;

(h) ensure that the cable routing distance for the 50 way ribbon cable from PL20, at the controller, to the User I/O Termination Panel does not exceed 2 m (6.5 ft).

4.3.5 Position of MV Switched Mode Power Supply (SMPS)

There is one SMPS for each MV LCD Transistor Bridge Module. It is mounted on the upper front face of the module from which it derives a d.c. power supply.

4.4 Electromagnetic Compatibility (EMC) Requirements

There are particular requirements for Electromagnetic Compatibility (EMC) compliance. These requirements are determined, to some extent, by the application for which the MV LCD system is being used. However, there are some general guidelines which can be used to ensure that the equipment is EMC compliant. These guidelines are listed at 4.4.1 to 4.4.5.

4.4.1 General Application Guidance

There is some general application guidance for the MV LCD equipment as follows:

(a) When the equipment is being used in a 'second environment' (industrial environment) in accordance with IEC 61800-3 then EMC filters are not normally required.

(b) If the equipment is installed on a public low voltage supply which also supplies domestic premises ('first environment' according to IEC 61800-3) then EMC filtering will be required.

(c) Filtering will also be required if other items connected to the same supply are sensitive to radio frequency interference or would normally be used in domestic environments.

(d) EMC filters may only be used if the supply neutral is connected to earth/ground at the source of the supply (also known as TN or TT network).

(e) If EMC filters are to be used and there are also thyristor converters (e.g. d.c. drives) on the same supply, any commutation notches from these converters must not exceed 40%,

(f) If an EMC filter is fitted, it must be mounted on to a metal panel which is directly bolted to the metal framework of the cubicle.

4.4.2 EMC Requirements for The Enclosure

There are particular EMC requirements that apply to an enclosure housing MV LCD equipment as follows:

(a) Clean air cooling apertures in the enclosure should be fitted with EMC screen filters.

(b) The gland plate for input/output cables must be bolted directly to the enclosure walls, or to metal framework to which the outer walls are electrically bonded. Gland plates should not to be spaced off, even on metal pillars or bars and direct metal-to-metal contact must be achieved for earth continuity and low electrical noise purposes.

(c) Module mounting rails must be secured to the metal frame of the enclosure, to achieve high mechanical strength and good earth bonding for electrical safety and EMC.

(d) If more than one enclosure is used for the MV LCD module system, bond these securely together making a 'continuous enclosure'. This bonding should be by direct metal-to-metal contact, not by braids or cables. If it is not practical to have these enclosures adjacent, use armoured cable or conduit, glanded to each enclosure.

4.4.3 Reactors and other Iron-cored Components

Wound components (e.g. reactors, transformers, interbridge transformers etc.) emit magnetic fields and protection is required. The following guidance is given for such magnetic components in the MV LCD equipment:

(a) wound components must be installed in a steel enclosure to prevent emission of radiation - for electrical safety, all terminals should be shrouded to prevent accidental contact.

Note: These components will usually be mounted on the floor of the enclosure as they are large and heavy.

(b) Additionally air-cored reactors must have a minimum segregation of 300 mm (12 in).

4.4.4 Routing and Segregation of Cables

The routing and segregation of cables, including separation distances and directions of cable routing, can all contribute to the performance of the equipment. The following guidance is given for cables in the MV LCD equipment:

(a) Wiring between the mains input and an RFI (Radio Frequency Interference) filter must be segregated by a minimum of 300 mm (12 in) from all other drive and drive output components, i.e. modules, inductors and motor cable.

(b) Control and power wiring must cross at 90° and be separated by a minimum of 300 mm (12 in).

(c) Ribbon cables supplied with MV LCD kits should be run along earthed metal and not through mid-air. Use the ribbons supplied, do not extend these ribbons. If the ribbons are too long, fold the excess length backward and forward (do not roll) to make a low-inductance bundle (see Table 6-1 and Figure 6-5).

(d) The MV3000e controller should be mounted in the same enclosure, or suite of enclosures as the MV LCD modules.
If the controller is fitted to a hinged gate, this should be mounted directly to the metal frame of the enclosure. There are length restrictions from the controller to the furthest module, due to the ribbon cable lengths as detailed in Section 6 - ELECTRICAL INSTALLATION.

(e) The User I/O Termination Panel should be mounted in the same enclosure as the controller and with a 'metal-to-metal' contact with the enclosure frame.

The Ribbon Cable from the User I/O Termination Panel to the controller should be run along earthed metal and not through mid-air. Again, there are distance restrictions, check that the ribbon cables will reach - cable length is 2 m (6.5 ft). These ribbons should be segregated by approximately 300 mm (12 in) from power cables and from external plant wiring.

4.4.5 Protection of Cables Routed Outside the Enclosure

All cables which are routed outside the MV LCD enclosure - e.g. plant wiring where there is a requirement for screening, segregation, terminations etc. - require protection which would normally be determined by the application but generally follow the rules already described in this section.

4.5 Cubicle Planning

4.5.1 General Guidance

The Cubicle Planning details are intended for users who have been supplied with a kit of MV LCD components for which an enclosure has to be provided. Guidance is given for planning of that enclosure for assembly of the components.

(a) List the items to be installed - a typical component list is included, as an example, at Table 4-2.

(b) Assess the approximate size and weight of the individual items.

(c) Understand how the items are supported and mechanically interact - refer to the appropriate assembly details at Section 5 - MECHANICAL INSTALLATION.

Note: The horizontal mounting position of the modules is offset 20 mm further to the left on the 600 mm wide cross rails than on all other versions for Q80 and Rittal PS4000 Series Cubicles.

(d) If the equipment is to be mounted in an 800 mm deep enclosure, with space allowed at the back of the modules for coolant manifolds and/or pipework, then ensure that the upper and the lower front cross members are positioned appropriately. Note that an additional front cross member is required in the rear location.

(e) Decide on the positions of the network and machine bridge modules as follows:

refer to guidance at 4.3.3 for the rectifier module position;

allow a 50 mm (2 in) ventilation space above the upper cross member;

(f) Ensure that the cooling requirements are adequate, in particular, that:

- a clean air supply is available for the electronics;
- minimum clearances are complied with for ventilation above and below the controller - see 5.10 and Figure 5-11.
- the external cooling system has been designed in accordance with the guidance at Section 3 - COOLING SYSTEM DESIGN;
- all the piping and connectors for each MV Liquid Cooled module are installed in the cubicle in accordance with the recommendations at Section 5 – MECHANICAL INSTALLATION;

(g) Cabling - consider:

- cable sizes and routing - ensure that the modules can be cabled together;
- access to main and control connections of the modules;

(h) Detail the mechanical interfaces required for installation of the drive - these should include:

- any additional brackets required to locate the module mounting frame within the cubicle;
- air inlet on cubicle door;
- mounting of the controller;
- the main cabling glanding/ terminals in/out of the cubicle.

(i) Ensure that any additional contract dependent components have been included e.g. fuses, isolator, circuit breakers.

(j) Ensure that all components are assembled in the sequence given at 4.6 and that:

- sufficient clearance is allowed to fit those components;
- additional components are fitted in positions that do not obstruct the removal and replacement of any modules.

4.5.2 Example of a MV31929 12 Pulse Input Drive

4.5.2.1 Component List

The list of components required for the drive should be discussed with Convrteam at the time of ordering. Table 4-2 lists typical components that are required for a MV LCD drive. Mounting details for the components are included at Section 5 - MECHANICAL INSTALLATION.

Figure 4-1 shows a typical cubicle layout for the components included in this example.

4.5.2.2 MV31929 Cubicle Layout

The drive components listed at Table 4-1 may be mounted in an Converteam Q80 Cubicle, a Rittal PS4000 Series cubicle or another equivalent cubicle for which the mounting frames are described at Section 5 - MECHANICAL INSTALLATION.

The lower guide plates, cross members and side supports are all attached together and so form a sub-assembly (the dimensions of these are shown at Figure 5-1). The MV LCD modules slide into this sub-assembly.

The horizontal position of the modules within the cubicle is set by their position on the lower cross members. This spacing is defined by the pitch required between the modules. The front to back location of the cross members, and hence the modules, is set by the side supports. The default location is with the module at the back of the cubicle. For the 800 mm deep cubicle, however, the module can be moved forward to allow for pipework and coolant manifolds to be located behind the module - refer to 4.3.2.2 and Table 4-1 for details.

The vertical position is determined by the cubicle planner and is dependent on any components that are to be fitted, either underneath or above the modules, and also the position of manifolds.

The enclosure shown at Figure 4-1 represents a MV31929 drive installed in a 2200 mm high, 1200 mm wide, 800 mm deep cubicle. The components shown are those that are mandatory for this size of drive.

In addition to the mandatory components (see Table 4-2) other optional and user supplied components, as listed at the table, may also be specified by the user.

The interbridge transformer should be mounted on the cubicle floor as it is large and heavy.

The controller should be attached to a side panel and positioned towards the front of the cubicle; refer to 4.3.4 for general information about positioning the controller.

Cooling requirements should be considered. Fans for cubicle ventilation, and their position, should also be specified by the user.

4.5.3 Cubicle Access

If cubicle access is required, either at rear or side, for auxiliary components then the modules must be fully enclosed to prevent accidental contact with potentially live voltages.

4.6 Installation Sequence

Guidance is given for a recommended sequence of installing the MV LCD components. Some pre-assembly checks are also included to minimise any delays during assembly.

4.6.1 Checks prior to Assembly

The following checks should be made before starting the assembly of any MV LCD components:

(a) all required items are available - check against a list of parts for the drive system;

(b) module mounting frames - note particularly the details as follows:

- width of frames to be assembled (2, 3 or 4 module);
- module types to be fitted in each frame and their positions;
- positions and types of reactor required;
- cooling requirements & equipment;

(c) cubicle layout includes sufficient clearance to fit each component and, to later gain access if required for servicing.

4.6.2 Sequence of Assembly

The MV LCD components and cooling system pipework should be assembled in the following sequence:

- module mounting frames - assemble into the selected cubicle;
- lower guide plates;
- cooling system pipework;
- drip tray;
- modules;
- Switched Mode Power Supply to the Transistor Bridge Module;
- d.c. link fuses, when required;
- a.c. input fuses and isolators;
- User I/O Termination Panel;
- MV3000e Controller;
- Drive Data Manager™ ;
- cubicle ventilation fans;
- other ancillary components.

4.7 Module Mounting Frame Sizes

Sizes of the module mounting frames for a range of cubicle sizes are included at Section 2 - SPECIFICATION.

4.8 Drip Tray

It is recommended that a suitable drip tray be selected for fitting in the cubicle beneath the liquid cooled modules to catch any coolant drips which may occur during servicing operations. The system integrator should specify the method of draining condensate from the tray. Refer to Converteam if advice is required.

Table 4-2 List of Components for Example of MV31929 Drive

Ref. on Fig. 4-1	Required Components	Quantity	Remarks
A	MVDL 643 Transistor Bridge Module	3	MVDL643-4701
B	MVRL 2100 Rectifier Bridge Module	1	MVRL2100-4601
C	MV DELTA Switched Mode Power Supply	3	MVC3003-4003
D	MV3000e Controller	1	MVC3001-4001
E	MV3000e User I/O Termination Panel	1	MVC3002-4001
F	Interbridge Transformer	1	50Z0119/02
G	MV LCD Module Mounting Frame Kit	1	MVDLQ80-4004
-	Ribbon Cable Kit(s)	2	MVC3004-4003
	Optional Components		
H	Drive Data Manager™ (Keypad)	1	MVS3000-4001
	User Supplied Components		
	Input fuses D.C. protection fuses		
	Power Cables		User defined
	A.C. Output Sharing Reactance		Use of cables > 20 m in length
	Control wiring (other than ribbons)		User defined
	External Cooling System e.g. heat exchanger		User defined
	Enclosure (cubicle)		User defined
	Enclosure (cubicle) Ventilation Fans		User defined

Note: The list of components at Table 4-2 does not include any auxiliary components e.g. isolators and contactors.

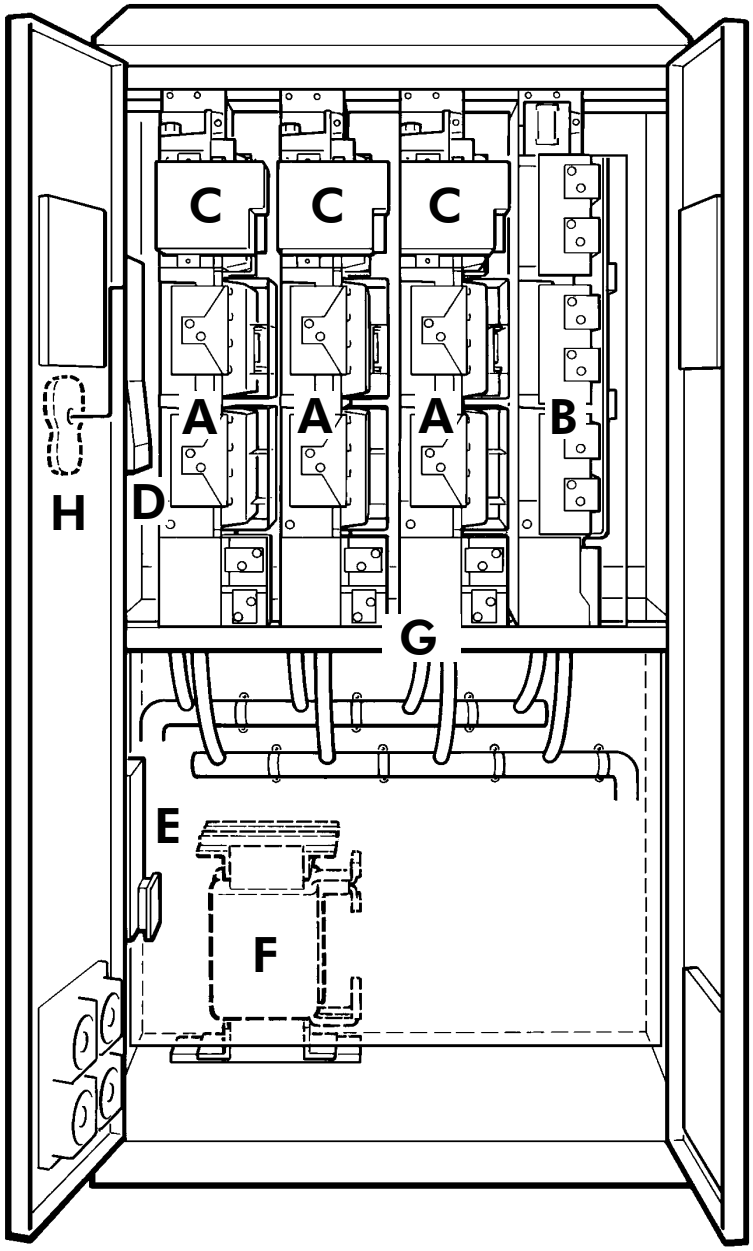


Figure 4-1 Typical Layout for a MV LCD System Cubicle

5. Mechanical Installation

WARNINGS

- **Heavy Weights**

  Items marked with weights greater than 20 kg should only be moved with lifting apparatus.

- **Exposed High Voltages**

  Enclose all items exposing high voltage before the equipment is energised.

5.1 Introduction

This section of the manual describes the mechanical installation of the items which are specific to an ALSPA MV Liquid Cooled DELTA (MV LCD) system.

Before starting any installation work reference should be made to Sections 4 and 6 of this manual. Section 4 - CUBICLE PLANNING includes details about preparation and planning for installation and Section 6 - ELECTRICAL INSTALLATION includes guidance for the electrical installation of components.

Note: References in this section to 'left' and 'right' should be taken to mean the viewer's left and right when facing the front of a module.

5.2 Receipt and Storage of Equipment

Before starting work the contents of the kit supplied should be carefully unpacked and inspected. Check the complete assignment against the delivery note for any shortages or loss in transit.

Damaged or missing parts must be reported immediately to the supplier and the following details quoted:

(a) list of damaged or missing items with names and part numbers;

(b) description of damage;

(c) delivery/advice note numbers and dates, and order and item numbers.

If the equipment delivered to site is not to be installed immediately:

(1) re-pack it in its original packaging material - if this is not possible it should be enclosed in polythene sheet to protect it from the ingress of dust;

(2) store it in a clean dry atmosphere, preferably at room temperature - DO NOT EXCEED the storage temperature limits referred to in 2.2;

(3) ensure that, if the equipment is stored for a long period of time, usually greater than two years, the equipment supplier is contacted for advice about reforming the d.c. link capacitors before the equipment is put into service;

(4) if the equipment is unpacked in a warm environment condensation may occur - if condensation is seen do not use the equipment until its temperature has stabilised to that of the working environment;

(5) ensure that a liquid cooled module, i.e. rectifier or inverter, is stored without any coolant loaded in it.

Note: Whenever possible retain and store the original packing materials for use if a product has to be returned for repair to an Converteam factory or service centre.

5.3 Cooling Requirements

To ensure cooling efficiency for the power devices in the modules it is important that the following checks be carried out prior to coolant being loaded into the cooling system:

(a) all modules have been assembled in the appropriate module mounting frame;

(b) all couplings for the cooling fluid pipes are correctly made and the external cooling system has been appropriately designed (see Section 3 - COOLING SYSTEM DESIGN);

(c) all flexible pipes are securely fastened within the cubicle/enclosure which houses the modules;

(d) all materials used in the external cooling system are compatible with the materials in the module cooling path (see Section 2 - SPECIFICATION for details of the compatible materials);

(e) the cooling system, external to the module(s), has been checked for integrity.

The general cubicle/enclosure environment must dissipate the heat generated by the control equipment and all ancillary devices. The maximum heat dissipation into the general cubicle/enclosure from the MV LCD equipment varies for each application. The maximum heat dissipation is given in Section 2 - SPECIFICATION. The enclosure internal temperature must always remain within the equipment operating limits as specified at Section 2. If fans are used to cool the general enclosure environment it may also be necessary for the air inlet to be filtered, depending on the local atmospheric conditions.

5.4 Module Mounting Frame Dimensions

The standard kit of parts includes a mounting frame for installing the equipment into standard Converteam Q80 style cubicles, or Rittal PS4000 series cubicles (see 2.12). The kit however, does not include the cubicles. If another style of enclosure is to be used it will be necessary to construct suitable brackets to mimic the Q80 mounting points to support the MV LCD frame inside the selected cubicle. Advice should be obtained from Converteam prior to designing any mounting steelwork.

Figure 5-1 shows the relative positions of the upper and lower cross members and four side supports (and fixing hole centres) of the frame which must be interfaced with an enclosure (e.g. Q80 type). The mountings of the lower side supports and rear cross member must be strong enough to support the total weight of the MV LCD modules with the frame and cabling/busbars. The weights of the modules and these components are listed at Section 2 - SPECIFICATION.

There is an option to mount the modules in one of two positions of depth in an 800 mm deep cubicle - see 5.5.2 and 5.6.2.

5.5 Assembling Module Mounting Frames for Q80 Cubicles

5.5.1 General

The frames are available in two cubicle depths and four cubicle widths for mounting up to two, three, or four modules side-by-side. The eight frames are all of similar construction, with the lengths of the cross members that determine the overall frame width, and the side supports which determine the cubicle depth varying for each cubicle size. These instructions may be used for any frame.

Prepare suitable mounting arrangements for the frames as described at 5.4. All fixing holes for mounting the frames should be drilled 7 mm (9/32 in) to clear the M6 Taptite screws supplied. Taptites are self-tapping and may be driven in by hand using pozi-drive screwdrivers.

5.5.2 Side Supports for 600 or 800 mm (23.6 in or 31.5 in) Deep Cubicles

There are four identical side supports that may be fitted to the left or right sides of the cubicle. The top of each of these supports may be identified by either two holes (in 600 mm deep side support) or six holes (in 800 mm deep side support), in the top flange - see Figure 5-2 item **1**.

Note: Front to back orientation is not important as all of the fixing holes have been mirrored about the centre line.

Each side support has two fixing holes at each end which accept the M6 Taptite screws supplied in the kit. Use four M6 x 12 mm hexagon head earthed-nib Taptite screws to mount each of the four side supports as shown at Figure 5-2 - item **A**.

For 800 mm deep cubicles, the module can be mounted either flush against the rear of the cubicle or brought forward by approximately 100 mm (4 in) to allow for pipework to be fitted inside the cubicle. Refer to 4.3.2 and 4.5.1 for details.

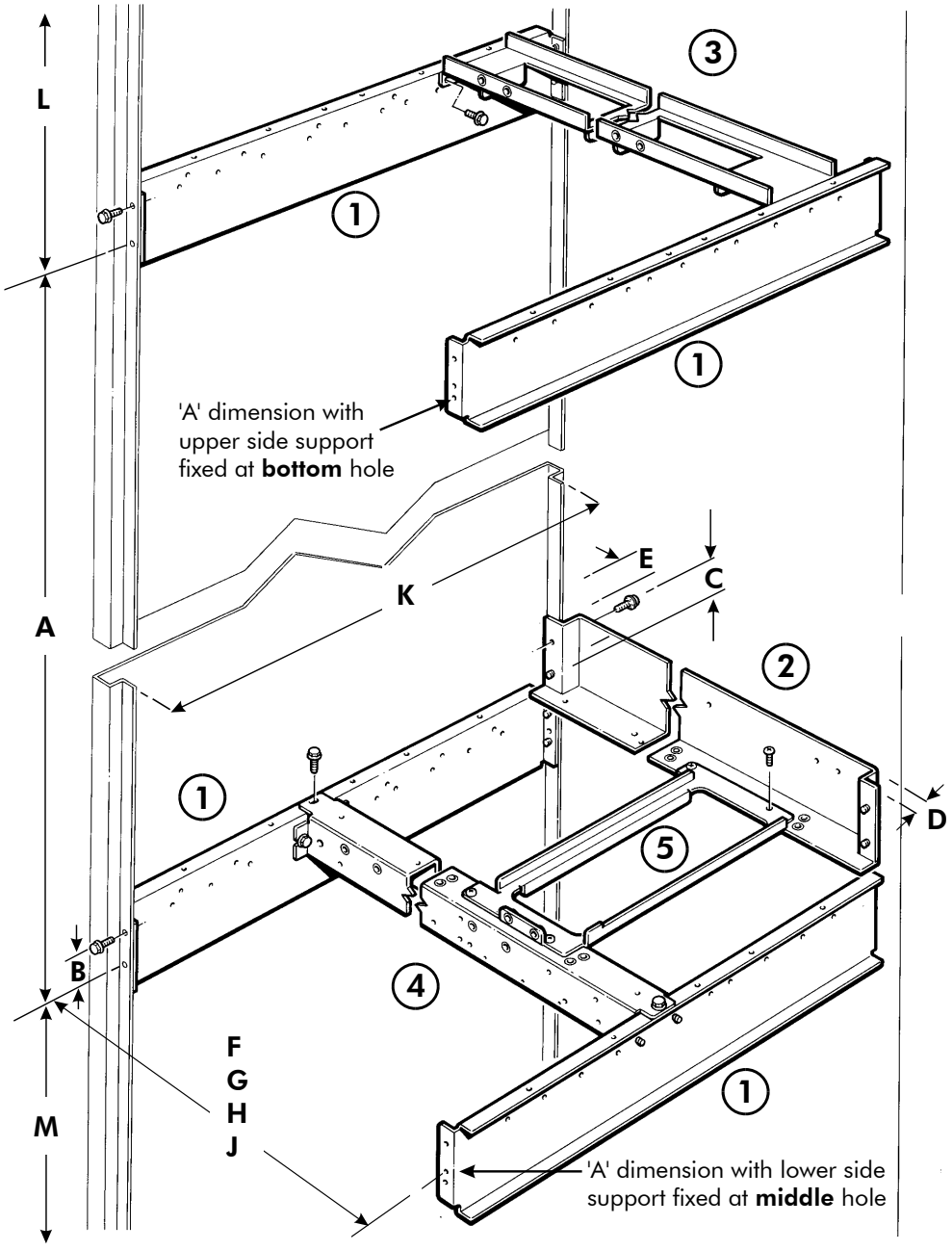
5.5.3 Cross Members

Refer to Figure 5-2, for details and part item numbers, and install the three cross members as follows:

(a) Identify the lower rear cross member - item **2**. Use four M6 x 12 mm hexagon head earthed-nib Taptite screws - item **B** - to mount it to the cubicle steelwork.

(b) Identify the upper cross member - item **3**. Use four M6 x 12 mm hexagon head earthed-nib Taptite screws - item **C** - to mount it between the two upper side-supports. Check that the end flanges are at the bottom.

(c) Identify the lower front cross member - item **4**. Use six M6 x 12 mm hexagon head earthed-nib Taptite screws - item **D** - to mount it between the two lower side-supports. The threaded inserts should be in the top and front flanges - item **E**.



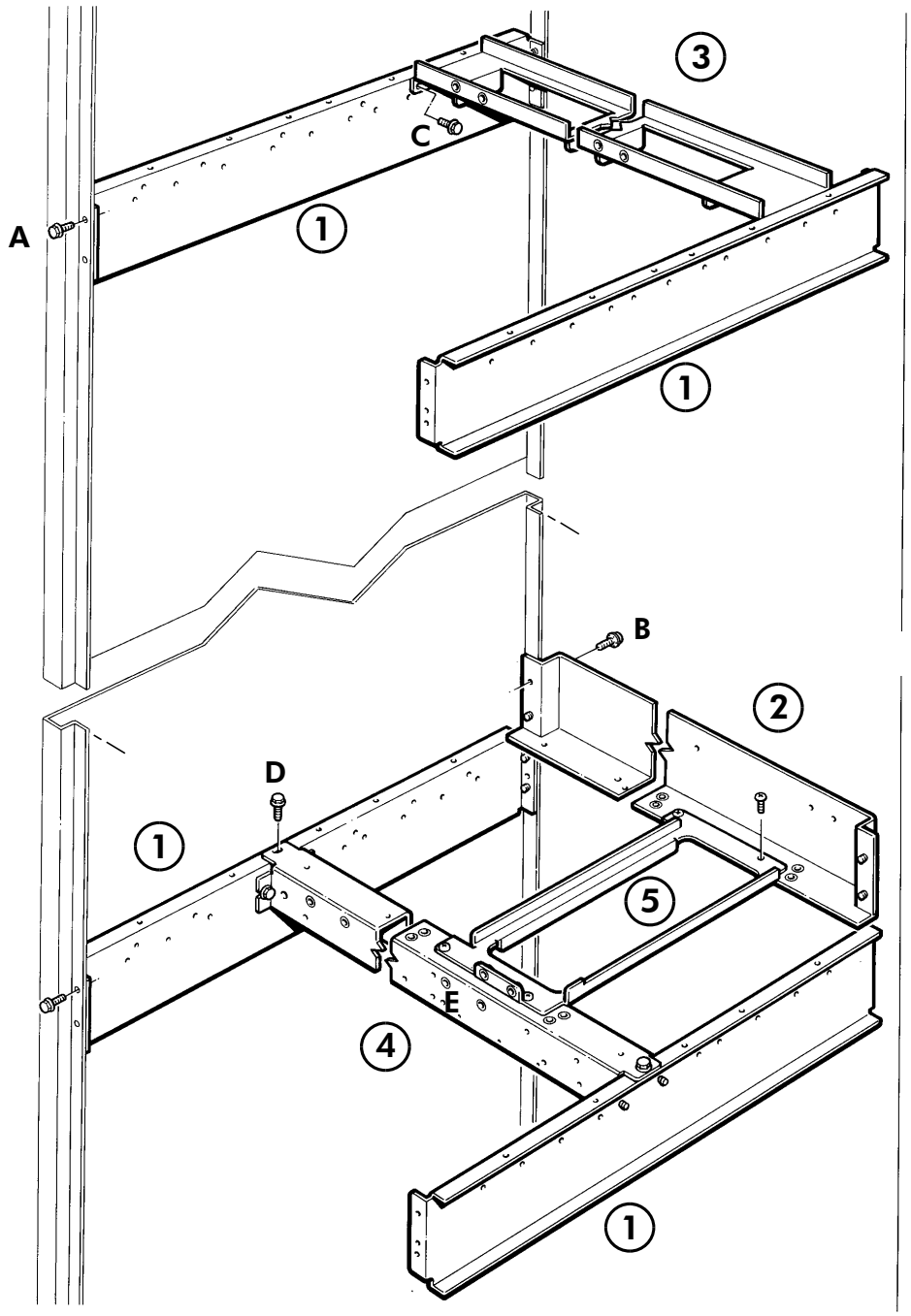
KEY: (1) Side Support (2) Lower Rear Cross Member (3) Upper Cross Member (4) Lower Front Cross Member (5) Lower Guide Plate

Key for dimensions (mm):

A	1244	D	30	G	704 (800 Wide)	K	742 (800 Deep); 542 (600 deep)
B	44.4	E	35	H	904 (1000 Wide	L	Cubicle dependent but minimum of 100
C	100	F	504 (600 Wide)	J	1104 (1200 Wide)	M	Cubicle dependent but minimum of 250

Note: Dimension 'A', at 1244 mm, is with the lower side support fixed with the middle hole on the front facing flange and the upper side supports fixed with the bottom hole.

Figure 5-1 Converteam Q80 Cubicle Dimensions for Module Mounting Frame



KEY: (1) Side Support (2) Lower Rear Cross Member (3) Upper Cross Member (4) Lower Front Cross Member (5) Lower Guide Plate

Figure 5-2 Converteam Q80 Cubicle - Fitting Supports and Cross Members for a Module Mounting Frame

5.6 Assembling Module Mounting Frames for Rittal PS4000 Cubicles

5.6.1 General

The module mounting frames are available in two cubicle depths and four cubicle widths for mounting up to two, three, or four modules side-by-side. The eight frames are all of similar construction, with the lengths of cross members that determine the overall frame width, and the side supports which determine cubicle depth varying for each cubicle size. These instructions may be used for any frame.

Prior to installing the side supports in the cubicle, insert the Rittal M6 spring captive nuts RIT/PS4614 (4 per side support and 4 for lower rear cross member) into the framework at the desired distance L or M and side rail fixing centres 'B' as shown at Figures 5-1 and 5-3. Other positional dimensions are generally as the Q80 Cubicle.

Earth continuity through the cubicle steelwork cannot be guaranteed because of the method of fixing the framework into the cubicle. To improve earth continuity, fit four M5 x 10 mm pozi-head Taptite screws to secure each side support to the Rittal cubicle as described at 5.6.2. The cubicle steelwork must always be separately bonded to earth/ground. Also refer to 6.4 for earthing/grounding requirements.

5.6.2 Side Supports for 600 or 800 mm (23.6 in or 31.5 in) Deep Cubicles

There are four identical side supports that may be fitted to the left or right sides of the cubicle. The top of each of these supports may be identified by either two holes (in 600 mm deep side support) or six holes (in 800 mm deep side support), in the top flange - see Figure 5-3 - item **1**.

Note: Front to back orientation is not important as all of the fixing holes have been mirrored about the centre line.

Each side support has four fixing holes at each end; the outer two accept the M6 x 12 mm hexagon head screws supplied in the kit. Use four M6 x 12 mm hexagon head screws, each with a spring washer, to mount each side support as shown at Figure 5-3 - item **A**. The inner two holes at each flange of the side support accept M5 x 10 mm pozi-head Taptite screws - item **G** which mechanically bond the side supports to the cubicle .

For 800 mm deep cubicles, the module can be mounted either flush against the rear of the cubicle or brought forward by approximately 100 mm (4 in) to allow for pipework to be fitted inside the cubicle. Refer to 4.3.2 and 4.5.1 for details.

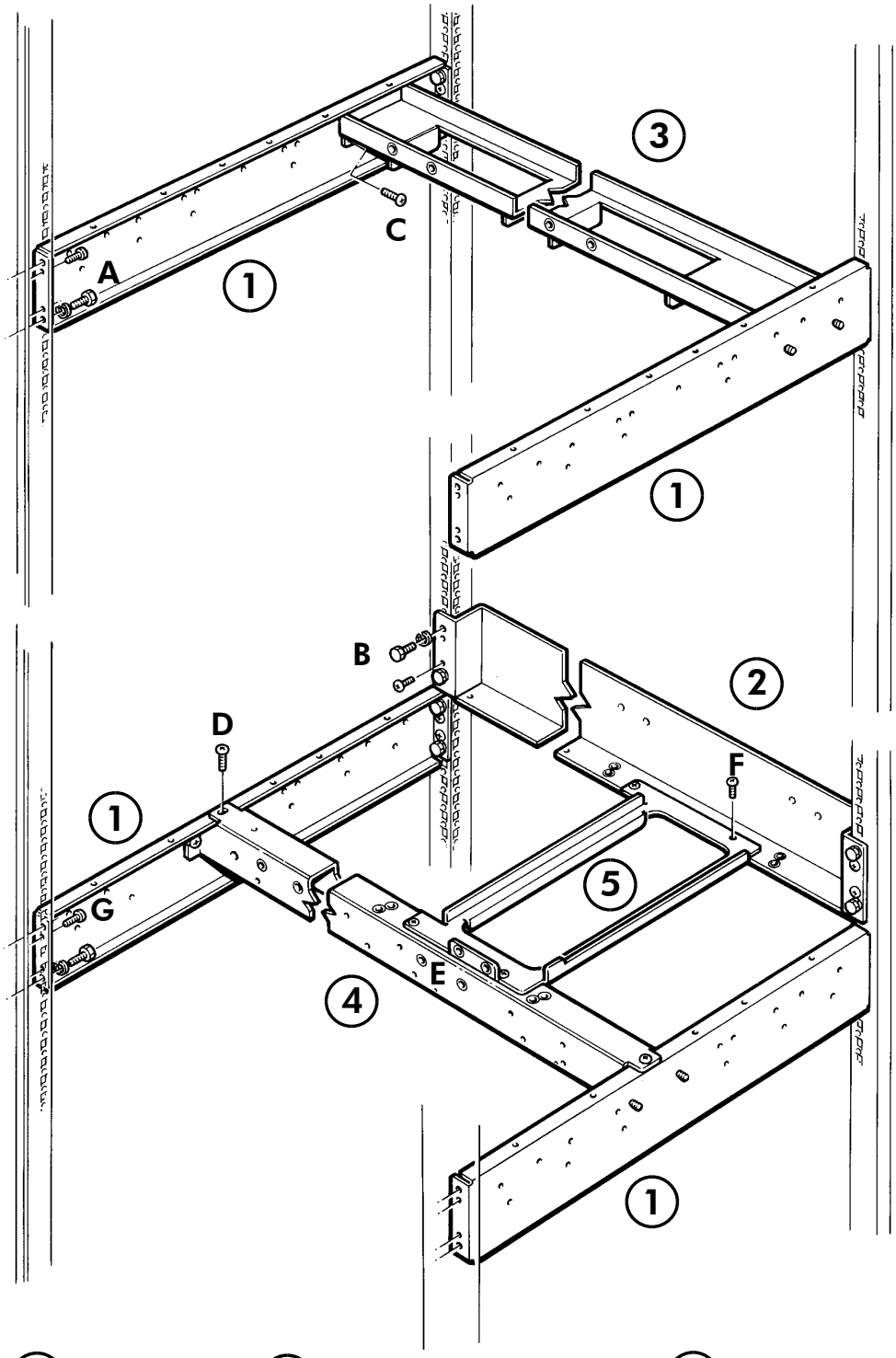
5.6.3 Cross Members

Refer to Figure 5-3 and install the three cross members as follows:

(a) Identify the lower rear cross member - item **2**. Use four M6 x 12 mm hexagon head screws, each with a spring washer- item **B**, to mount the rear cross member to the cubicle steelwork.

(b) Identify the upper cross member - item **3**. Use four M6 x 12 mm pozi-head Taptite screws - item **C** - to mount it between the two upper side-supports. Check that the end flanges are at the bottom and face downwards.

(c) Identify the lower front cross member - item **4**. Use six M6 x 12 mm pozi-head Taptite screws - item **D** - to mount it between the two lower side-supports. The threaded inserts should be in the top and front flanges - item **E**.



KEY: (1) Side Support (2) Lower Rear Cross Member (3) Upper Cross Member (4) Lower Front Cross Member (5) Lower Guide Plate

Figure 5-3 Rittal PS4000 Cubicle - Fitting Supports and Cross Members for a Module Mounting Frame

5.7 Lower Guide Plates

Figures 5-1 to 5-3 show a lower guide plate in position in a module mounting frame, for Converteam Q80 and Rittal PS4000 Cubicles - item **5**. One lower guide plate is required for each module mounted in the module frame. It should be installed with four M5 x 10 mm pozi-head Taptite screws - item **F**.

5.8 Drip Tray

It is recommended that a drip tray be fitted in the cubicle beneath the liquid cooled modules to catch any coolant drips which may occur during servicing operations. The method of draining condensate from the tray should be specified by the system integrator. Refer to Converteam if advice is required.

5.9 Modules (Transistor and Rectifier Bridges)

CAUTION

The modules are delicate and vulnerable to damage - handle carefully.

Only lift or move them by use of the lifting point.

Lay them down on the plain left-hand face when not fitted in a frame.

Do not leave modules unsupported in the upright position.

5.9.1 Guidance for Handling

The MV LCD modules require particular care and attention during handling to ensure that personnel are not injured or the modules damaged. Figure 5-4 and Figure 5-5 show typical Rectifier and Transistor Modules respectively and Figure 5-6 and Figure 5-7 show the outline and fixing dimensions. The lifting arrangement is the same for each type of module. They should only be lifted with a crane rated for the module weights, as detailed at Section 2 - SPECIFICATION, and suitable for cubicle access. The modules should be handled without any pipes attached. All preparatory work should be done in the cubicle/enclosure prior to any module being lifted.

5.9.2 Module Lifting Procedure

(a) Attach the lifting shackle to the module lifting hole, 20 mm (3/4 in) diameter, at the top of the module - see Figures 5-4 and 5-5.

(b) Lift the module to the appropriate height and move it into position to insert into the frame - see Figures 5-8 and 5-9.

(c) Tilt the module as it is moved into its slot so that it clears the withdrawal ‘STOP SCREW’ which is built into the bottom right-hand guide - see Figures 5-4, 5-5 & 5-10.

(d) When the rear of the module is located between the guides, lower and push the module back until it sits on the frame.

(e) Remove the lifting shackle and then push the module firmly into position.

(f) The top and bottom front flanges should now lie against the upper and front lower cross members and the four fixing holes in the flanges should align with the holes in the cross members.

(g) Use four M6 x 12 mm pozi-head screws with plain and spring washers, supplied with the mounting frame kits, to secure the module in place - see Figure 5-8.

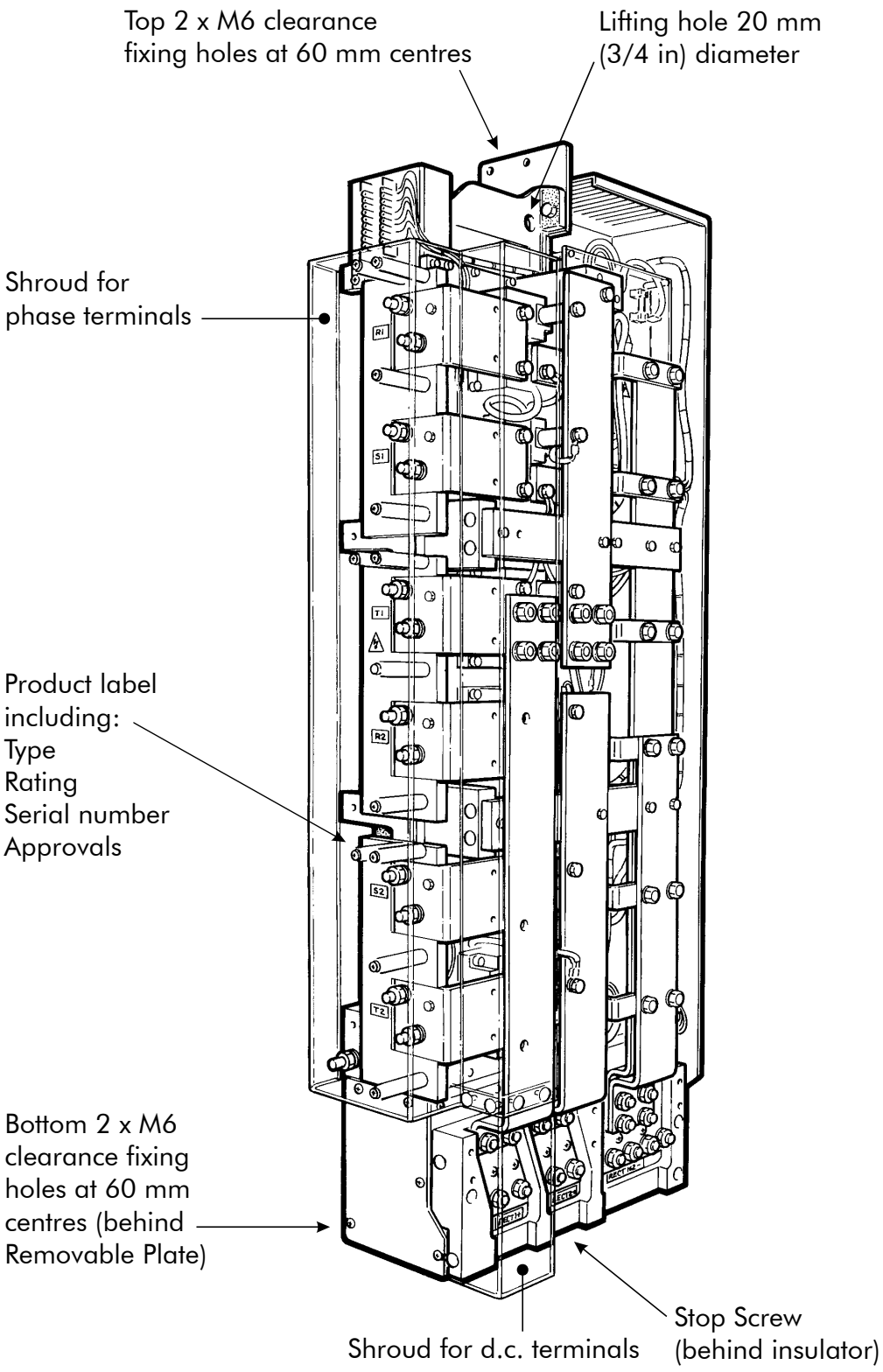


Figure 5-4 Typical View of a MV LCD Rectifier Bridge Module showing Mechanical Details

Note : Figure 5-4 does not show details of coolant piping couplings and valves which are shown at Figure 5-15. Refer to Figure 6-1 for details of electrical connections on the module.

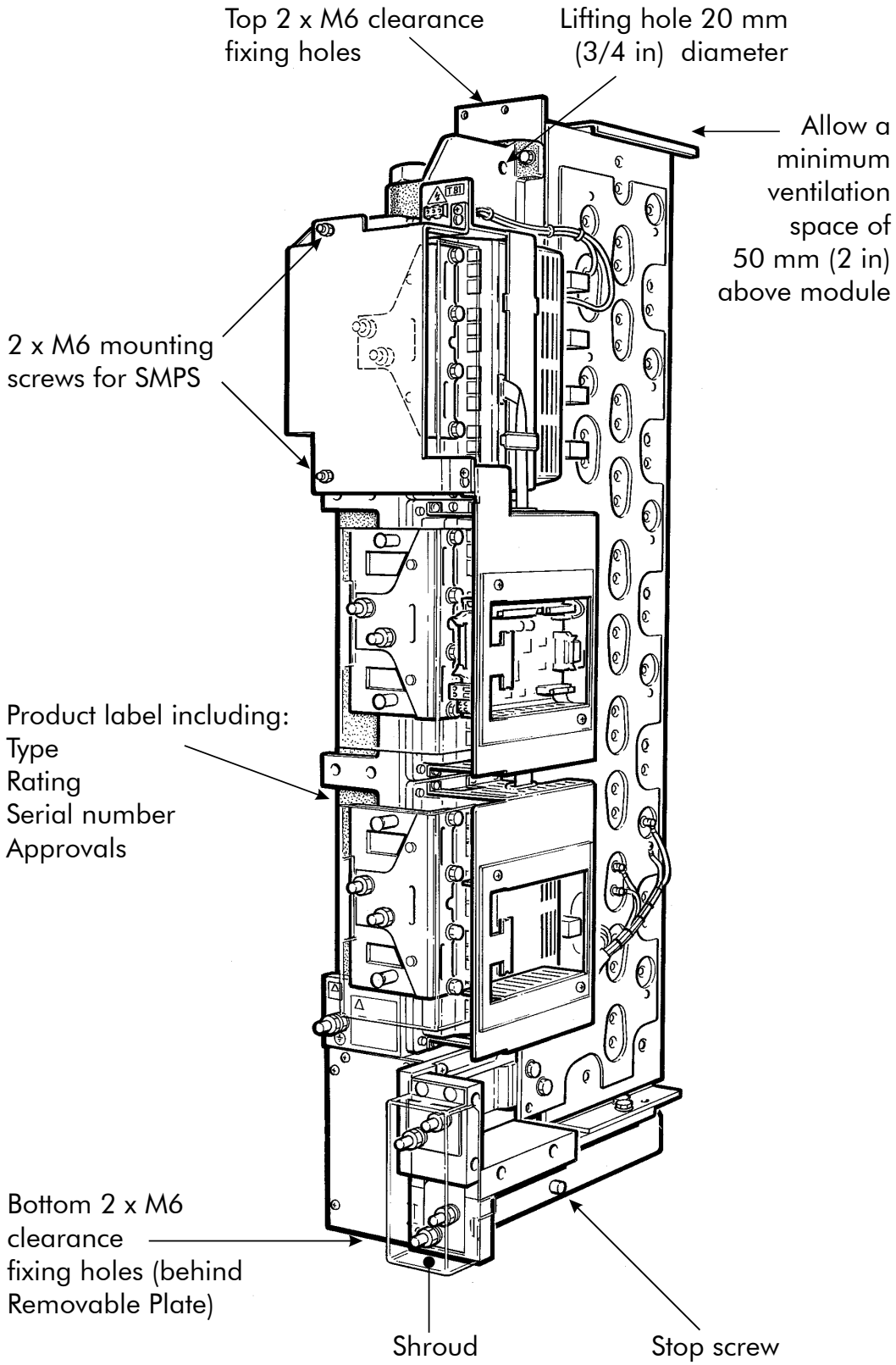


Figure 5-5 Typical View of a MV LCD Transistor Bridge Module showing Mechanical Details

Note : Figure 5-5 does not show details of coolant piping couplings and valves which are shown at Figure 5-15. Refer to Figure 6-4 for details of electrical connections, and diagnostic LEDs, on the module.

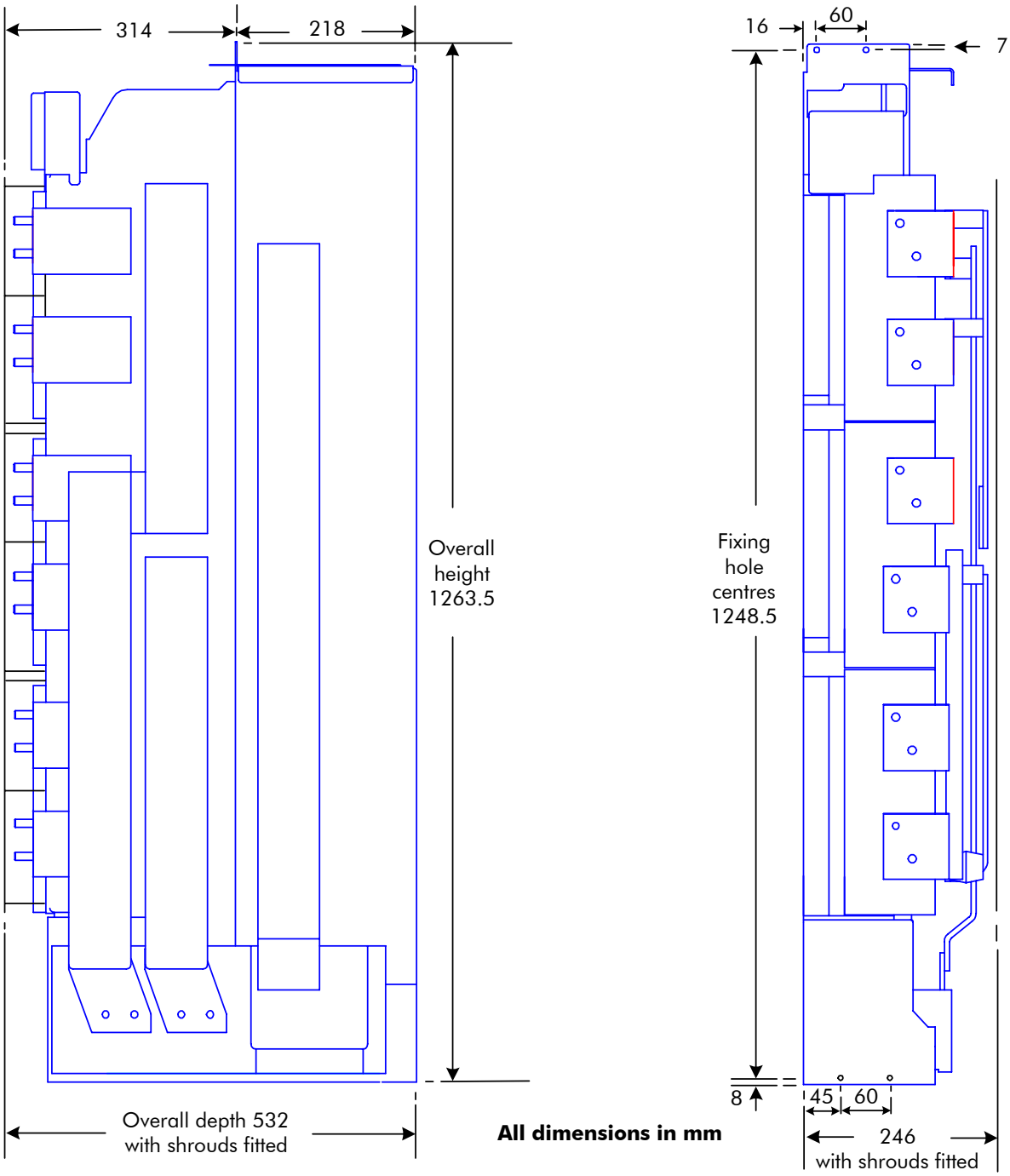


Figure 5-6 Outline and Fixing Dimensions for a Rectifier Bridge Module

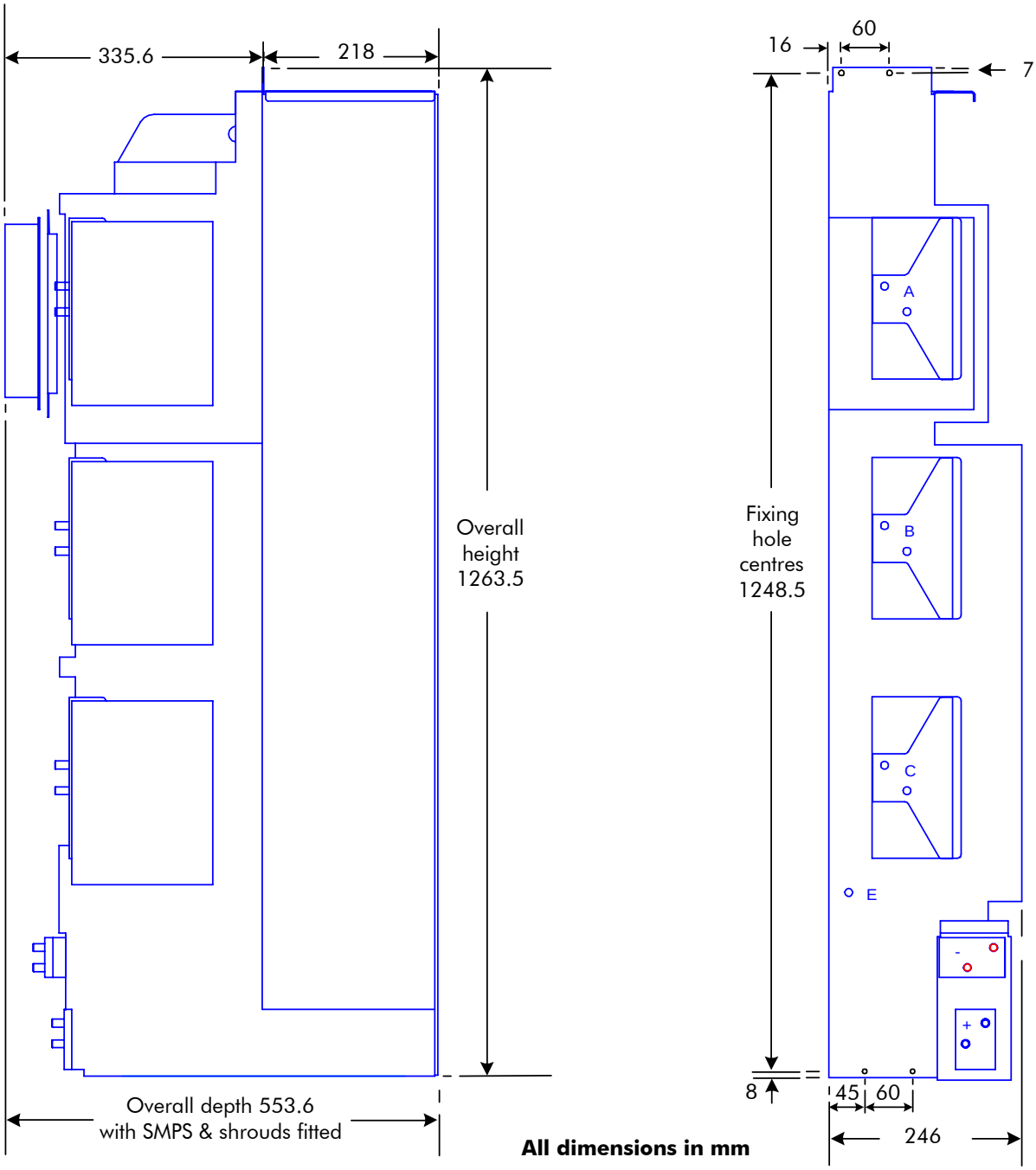


Figure 5-7 Outline and Fixing Dimensions for a Transistor Bridge Module

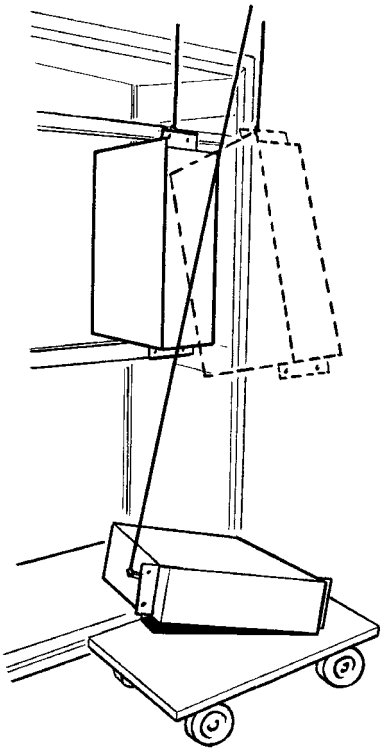


Figure 5-8 Lifting a Module

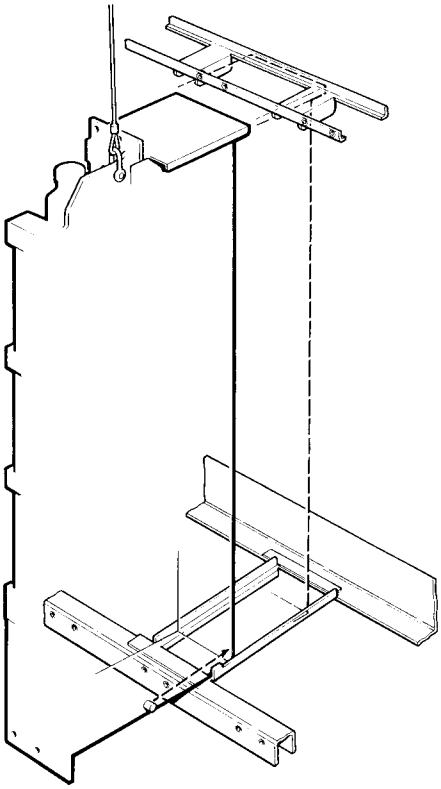


Figure 5-9 Positioning a Module between Guides

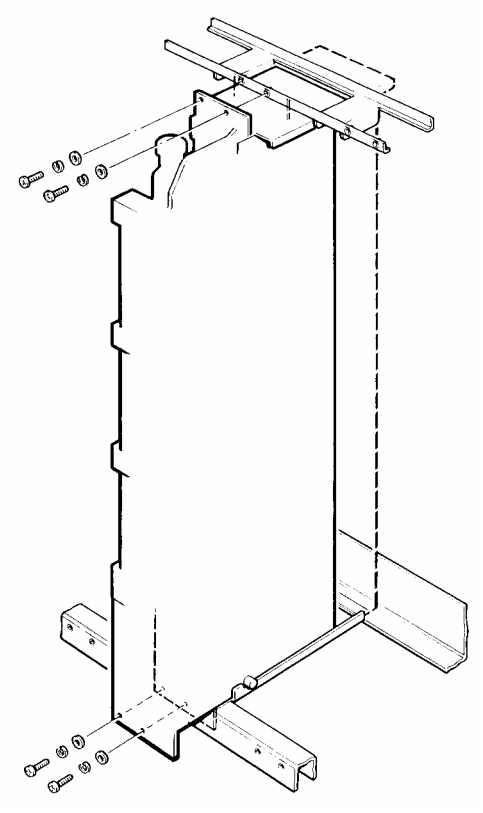


Figure 5-10 Moving and Securing a Module in Position beyond the STOP SCREW

5.9.3 Transistor Modules – fitting a busbar

In some applications the transistor modules may be connected together with a single busbar across the d.c. terminals. In these situations it is very important that the modules are fully inserted into the module mounting frame and are correctly aligned across the front faces of the modules to avoid stressing any of the connections.

5.9.4 Fitting of Shrouds

The Rectifier and Transistor modules each have shrouds for the live terminals. The fitting arrangement for these shrouds is included at Section 6 - ELECTRICAL INSTALLATION. The shrouds should always be replaced after fitting cables.

5.10 Mounting a MV3000e Controller in a Cubicle

The MV3000e Controller, shown at Figure 5-11, can be mounted at various locations in a Cubicle. The recommended position is on the left hand side panel, when viewed from the front. Cubicle Planning details, which include the requirements determining the position of a controller in a cubicle, are included at Section 4 - CUBICLE PLANNING. Wherever it is mounted there are certain requirements which are applicable to the location as follows:

(a) plan the cubicle layout to receive a MV3000e controller as detailed at 4.3.4;

(b) ensure that the operating environment and cooling requirements comply with the specification in Section 2 - SPECIFICATION;

(c) mount the controller with four M5 Taptite screws to the fixing dimensions at Figure 5-11 and torque setting as detailed in Appendix B - the orientation of the controller will depend upon the mounting position within the cubicle.

5.11 Installation of the Drive Data Manager™ (Keypad)

CAUTION

When drilling a panel or cubicle door to fit a Drive Data Manager™ (Keypad) do not allow any swarf from the drilling operation to enter the enclosure - it may cause component malfunction.

A Drive Data Manager™ (Keypad) is available, as an optional item, for use with the MV3000e Controller. The MV3000e Keypad, part number MVS3000-4001, is supplied separately from its associated waterproof gasket and lead, part number MVS3001-4001. The lead, for connection from the Keypad to the MV3000e Controller, has a maximum length of 3 m (9.8 ft). This lead length determines the relative positions of the Keypad and the controller.

The Keypad can be mounted in a separate location from the controller within the cubicle. When supplied with a waterproof gasket, it can be mounted on a cubicle door to meet IP 65 enclosure protection. It should be retained by the six M4 x 8 mm fixing screws and washers supplied. Refer to the Instruction Sheets T1915 and T1916 respectively (supplied with the kit) for details of the keypad and mounting.

5.12 Installation of the User I/O Termination Panel

The User I/O Termination Panel, shown at Figure 5-12, can be mounted wherever it is most convenient in a cubicle for a particular application, within the 2 m length limits of the ribbon cable (for connection to the controller), and complying with the segregation requirements. The outline dimensions, including fixing dimensions, are also shown at Figure 5-12. Guidance for positioning of the termination panel is given in Section 4 - CUBICLE PLANNING and guidance for the routing and separation of associated cabling is given in Section 6 - ELECTRICAL INSTALLATION.

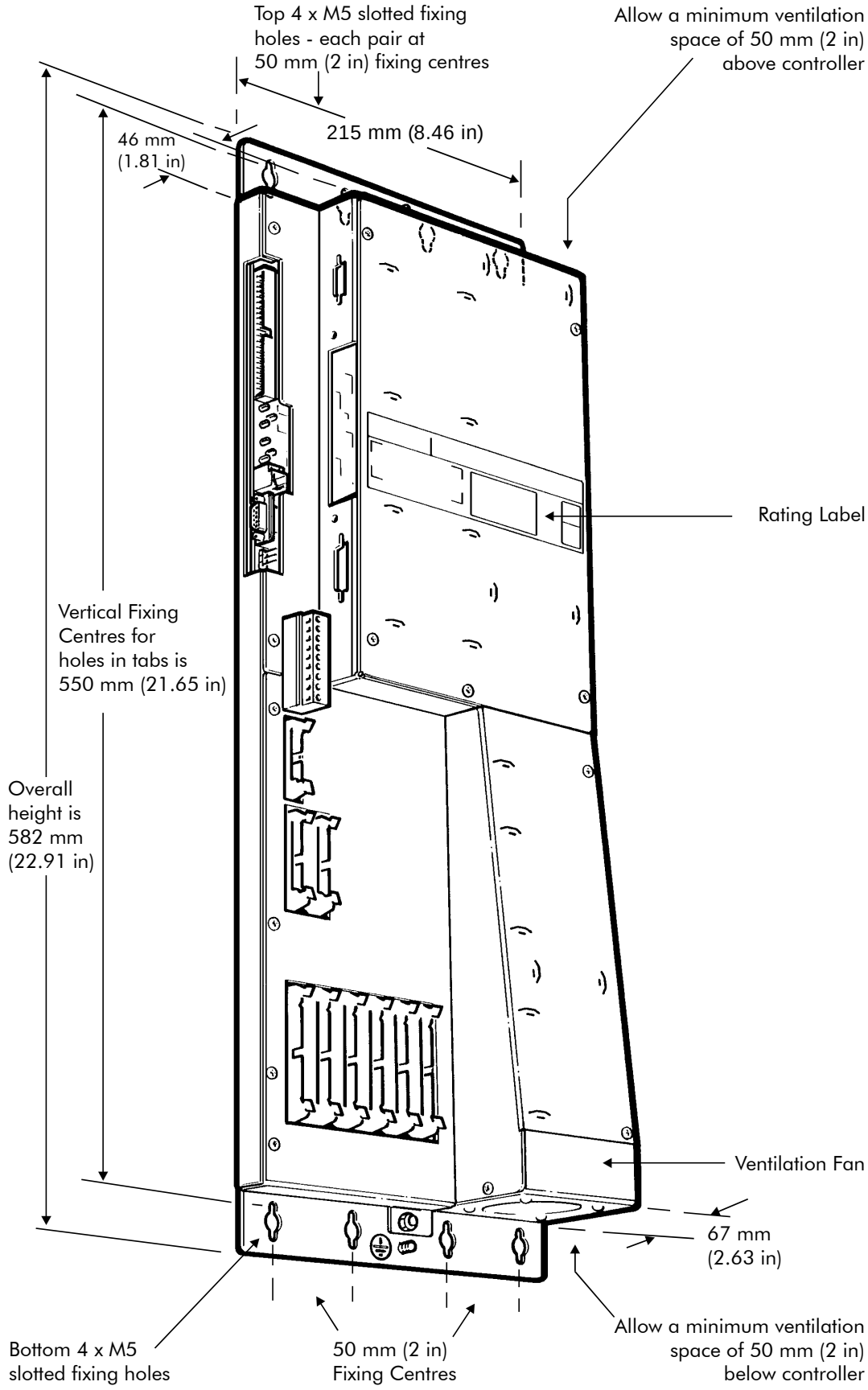


Figure 5-11 MVM3000e Controller – Mechanical Details

Note: Figure 5-11 does not identify electrical connections, or diagnostic LED functions, which are shown at Figure 6-8.

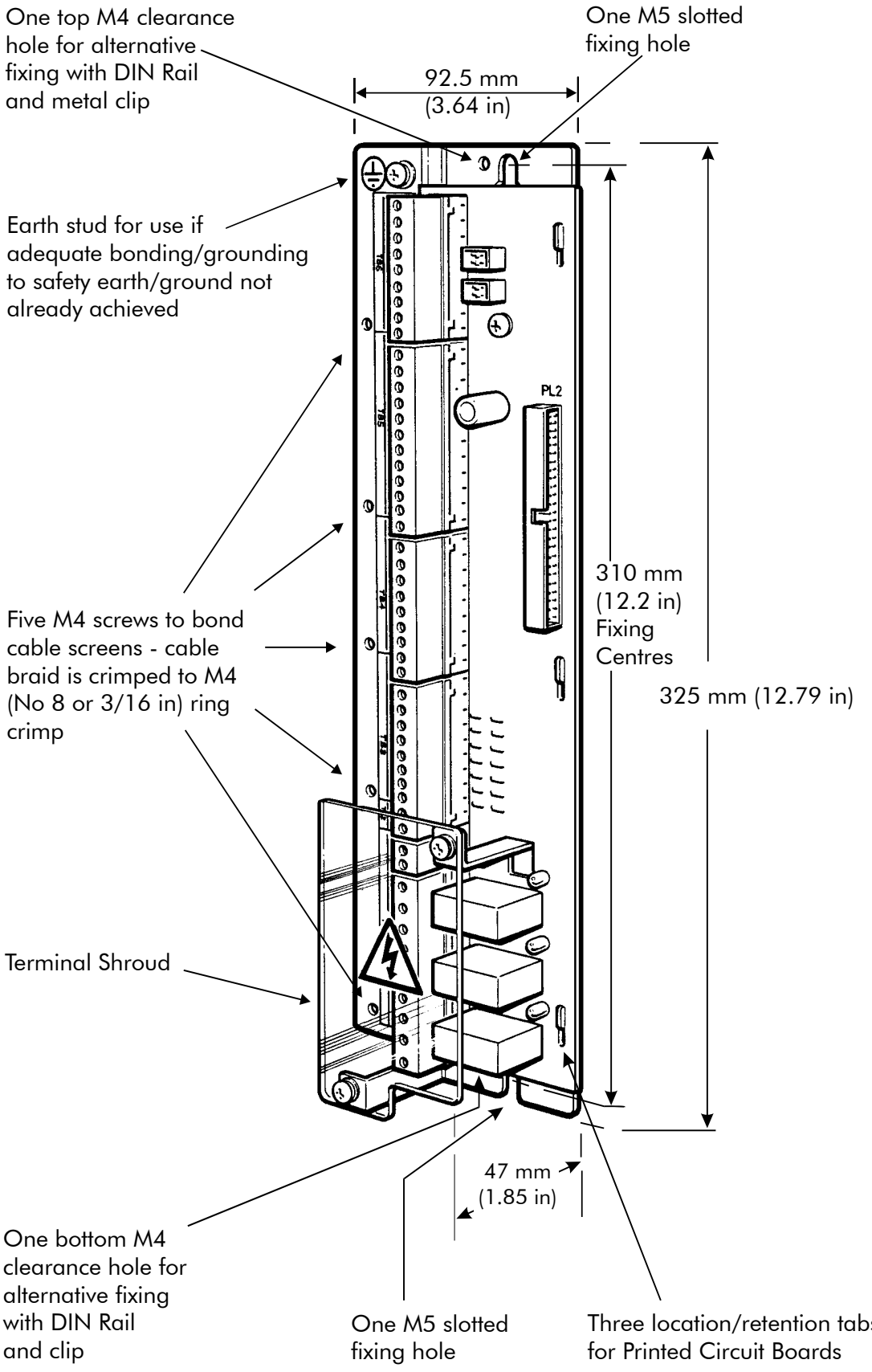


Figure 5-12 User Input/Output Termination Panel - Mechanical Details

5.13 Installation of a MV3000e Switched Mode Power Supply (SMPS)

One MV SMPS fits directly onto the front of each MV LCD Transistor Bridge Module.

Proceed to fit the SMPS, as follows, with reference to Figure 5-13:

(a) Remove the back plate from the module and retain all M6 and M4 fixings;

(b) Fit all the power cabling to the module before fitting the SMPS.

(c) Fix the back plate with the two M6 and two M4 pozi-head fixing screws with plain and spring washers.

(d) Mount the SMPS assembly, using the two locating tabs on the left hand side, and secure with two M4 Nyloc nuts, supplied, onto the M4 studs.

(e) Remove the blanking plug from TB1 on the Transistor Bridge Module and connect the DC cable assembly to TB1.

(f) Connect the 40 way ribbon cable from PL3 on the MV DELTA Transistor Bridge Module to PL22 on the SMPS.

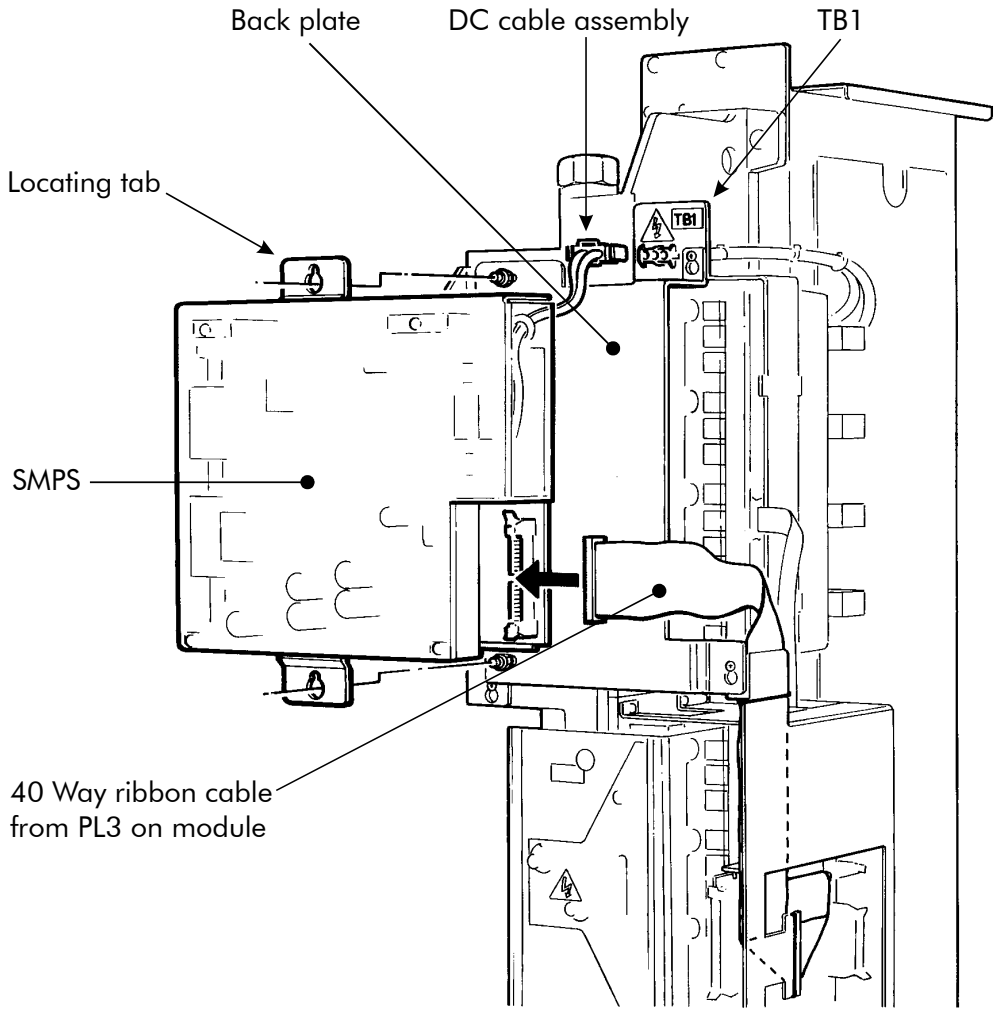


Figure 5-13 Fitting a SMPS to a MV LCD Transistor Bridge Module

5.14 Mounting the Interbridge Transformer (50Z0119/02)

The Interbridge Transformer is a heavy item of equipment and is normally mounted in the base of a cubicle. Figure 5-14 shows the transformer with its lifting eyes and terminations. Refer to Section 2 - SPECIFICATION for technical details, including weight, and Appendix A for connection details.

The transformer should be lifted into position, by its M12 lifting eye bolts, with suitable lifting equipment. It should be fixed through the four 13 mm (1/2 in) fixing holes.

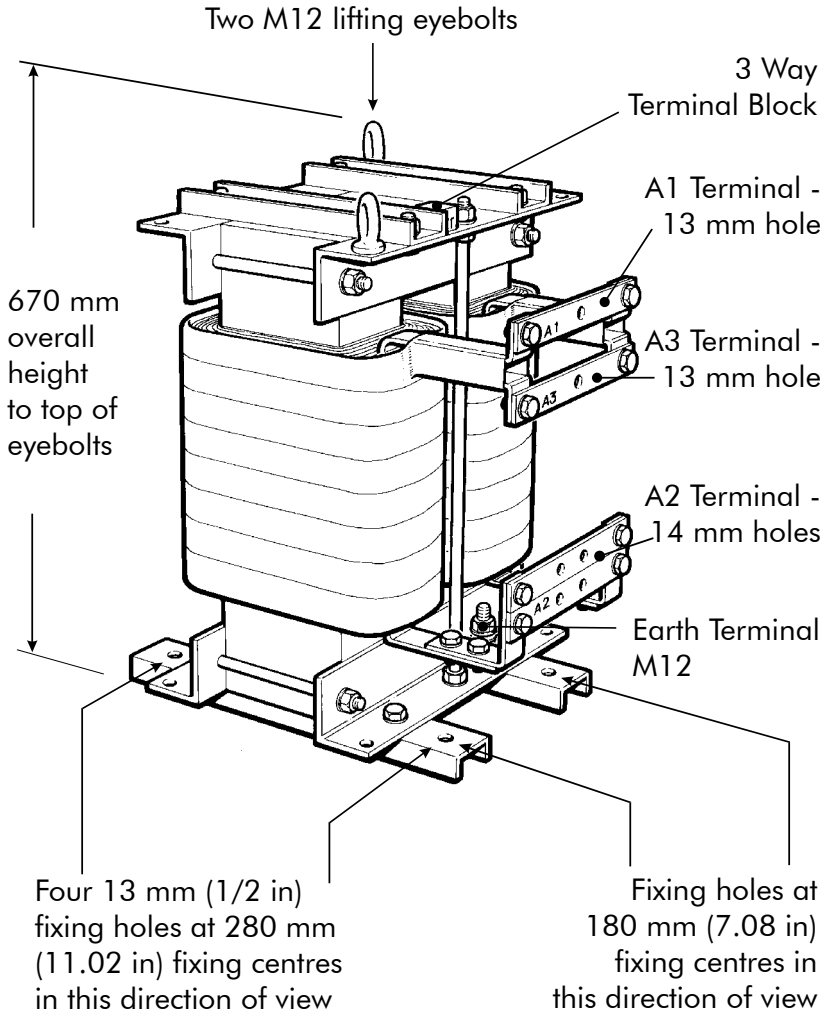


Figure 5-14 Interbridge Transformer 50Z0119/02

5.15 Cable Connections between MV LCD Modules and MV3000e Controller

Connections between the Rectifier Module and the MV3000e Controller are made by nine individual cables; refer to Figures 6-2 and 6-8.

Connections between the Transistor Module and the MV3000e Controller are made with a 40-way ribbon cable; refer to Figures 6-4 and 6-8. More details for routing of the ribbon cables is included at Section 6 - ELECTRICAL INSTALLATION.

5.16 Piping Connections for Cooling System

The following notes provide general guidance for the cooling system piping connections to single and multi-cubicle suits. The guidance given must be interpreted for each particular application; it cannot be specific for all applications.

5.16.1 Piping and Couplings

When the MV LCD module has been securely placed in position in its mounting frame it is recommended that the coolant piping from the module to a cubicle manifold, and from the manifold to the external cooling system, should be installed.

The type of pipe and couplings for internal and external connections are detailed at Section 3 - COOLING SYSTEM DESIGN. The internal piping from the module to the manifold should be of a flexible type and it is recommended that the external piping from the manifold to the external cooling system should be of a rigid type.

A module is shown at Figure 5-15 with the positions for piping, couplings and valves.

The procedure for filling the cooling system when all the piping and couplings are in place is described at 7.5.

5.16.2 Recommendations for Routing Pipes into a Cubicle

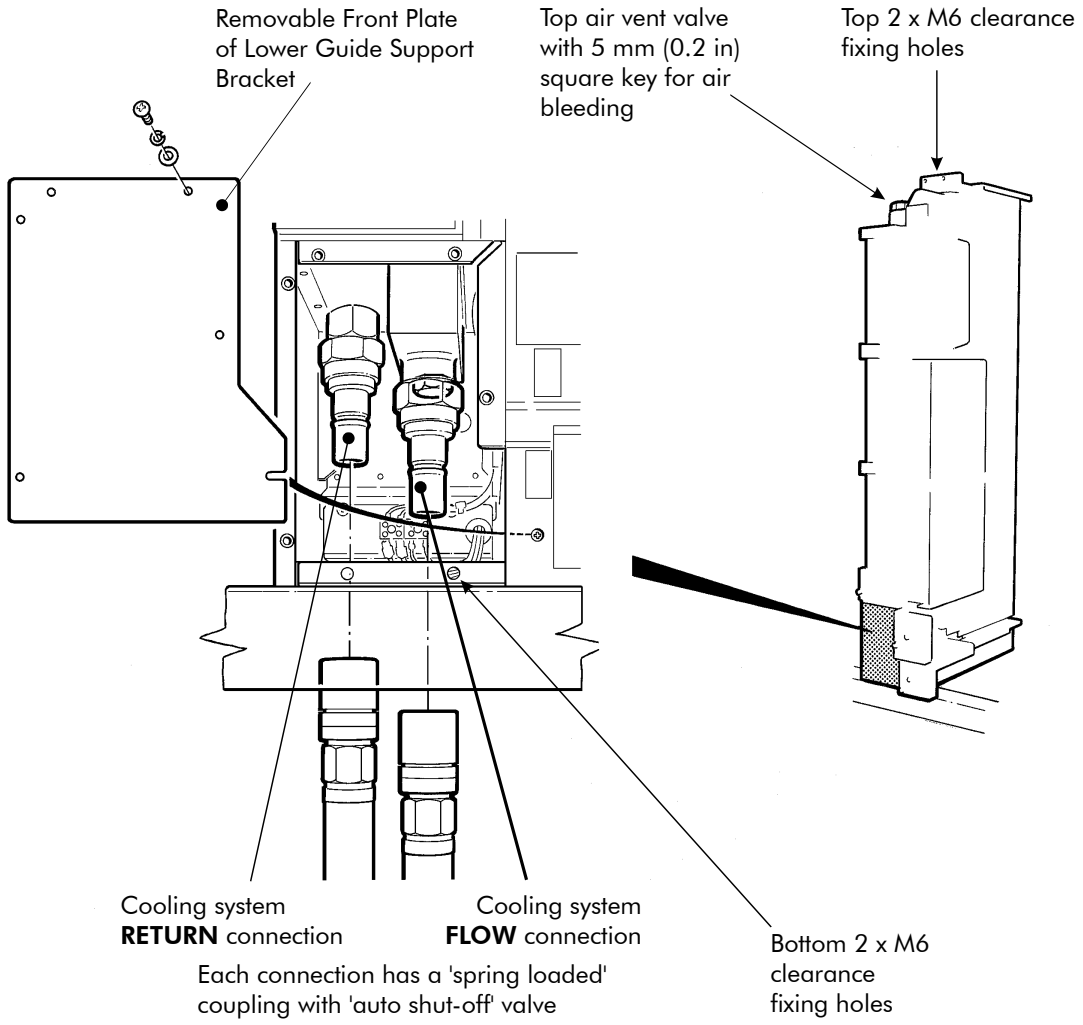


Figure 5-15 MV LCD Module Showing Positions of Piping, Couplings and Valves

A typical arrangement of MV LCD modules installed in a cubicle, with all piping and couplings fitted into position, is shown at Figure 4-1.

Important points to consider when routing and installing the pipes into a cubicle are:

(a) will the external cooling pipes enter the cubicle at top or bottom and have suitable arrangements been made at the cubicle and at the location on site?

(b) particular attention should be given to the position and method of securing the manifolds taking into account the pipe routing which will be dependent upon application requirements e.g. from the top or bottom of a cubicle;

(c) ensure equalisation of coolant flows when piping to multiple MV LCD modules which should be arranged on the diagonal principal so that the flow and return pipes are positioned diagonally opposite across the modules - refer to Figure 3-1.

(d) all flexible piping couplings should have their protective end caps removed prior to the connection being made - the end caps should be stored safely for use whenever the module is removed or refitted.

5.16.3 Recommendations for Routing Pipes into Multi-cubicle Suites

When routing piping into multi-cubicle suits there are additional recommendations which should be observed and these are:

(a) follow the diagonal flow principle for routing pipes to all the cubicles in a suite;

(b) if the diagonal flow principle cannot be used, for any reason, it is important that other methods of achieving an equalisation of coolant flow through all the cubicles in the suite be considered;

(c) one other method of achieving an equalisation of coolant flow is to use balancing valves, but when they are used it is important to establish a method of validating that equal flow is being achieved in each cubicle in the suite.

5.16.4 Retention and Fitting of Pipe in a Cubicle

Careful consideration should be given to the fitting and retention of all pipes in the cubicle. In particular the following should be considered:

(a) the method of fitting and retaining both flexible and rigid pipes should not restrict access to electronic equipment which may have to be removed;

(b) the minimum bending radii of all pipes should not exceed the specification included at Section 3 - COOLING SYSTEM DESIGN;

(c) method of retention for all pipes should be secure with an allowance for some movement of flexible pipes due to the temperature of the coolant;

(d) the routing of pipes should take account of the guidance at 5.16.2.

5.16.5 Vent Valves

Each module has a vent valve already fitted. Ensure that access is available for the operation of this valve - see Figure 5-15 for position and size of the valve.

5.16.6 Application Specific Warnings for High Temperatures on a Piping System

The location for all valves and piping in the coolant system will vary for each application. It is important that, wherever piping equipment is in a location accessible by personnel,

WARNINGS for High Temperatures be placed on, or near to, all pipes and associated valves etc. carrying hot coolant.

5.17 Installation of Electrical Equipment for the Liquid Cooling System

The electrical equipment for the external cooling system is described at Section 3 - COOLING SYSTEM DESIGN. All this equipment is user dependent and will normally be for control, protection and instrumentation. Some of the equipment may be installed in the cubicle but this is entirely dependent upon each application and is not described in this section.

6. Electrical Installation

WARNINGS

- **Earthing**

  Connect this equipment to earth (ground) using the earth terminal provided. The minimum size of the protective conductor must be in accordance with local safety regulations.

- **High Leakage Current**

  This equipment and the driven motor(s) must be earthed (grounded).

- **High voltages**

  Replace all shrouds and close all doors before energising the equipment.

- **Energy Discharge**

  Wait at least 5 minutes after isolating supplies and check that voltage between DC+ and DC- has reduced to a safe level before working on this equipment.

- **High Temperatures**

  Surfaces on the following items can reach high temperatures:
  - **reactors and transformers**
  - **cables**
  - **coolant pipes and couplings.**

CAUTIONS

- **This equipment contains solid state devices which may be affected by electrostatic discharge. Observe static handling precautions.**
- **Ensure that all conductors connected to this product are restrained.**
- **On some items, nuts, bolts and washers are supplied fitted to the terminal busbar. Remove these fasteners, place the user's crimp (or busbar) directly against the terminal busbar of the unit and re-fit the fasteners. This is to prevent large currents flowing through steel and causing overheating.**

Notes: (1) Some of the more complex items are supplied with shrouds to protect against accidental contact with live parts for front access only. No shrouds are supplied for the live right side or rear of the MV LCD items.

(2) For certain applications the shrouding supplied with these products may not provide the required protection. Additional shrouding must then be fitted.

(3) Recommended torque settings are given at Appendix B.

6.1 Introduction

This section details the terminal arrangements for the various items of MV Liquid Cooled DELTA (MV LCD) equipment. Wiring diagrams of specific modular drive arrangements are included at Appendix A.

Figure 6-1 and Figure 6-4 detail the electrical connections for the MV LCD Rectifier and Transistor Bridge Modules respectively.

Guidance for Electromagnetic Compatibility is at Section 4 - CUBICLE PLANNING.

6.2 Rectifier Bridge Module Terminals

Unit covered: MVRL2100-4601

A typical MV LCD Rectifier Bridge Module is shown at Figure 6-1.

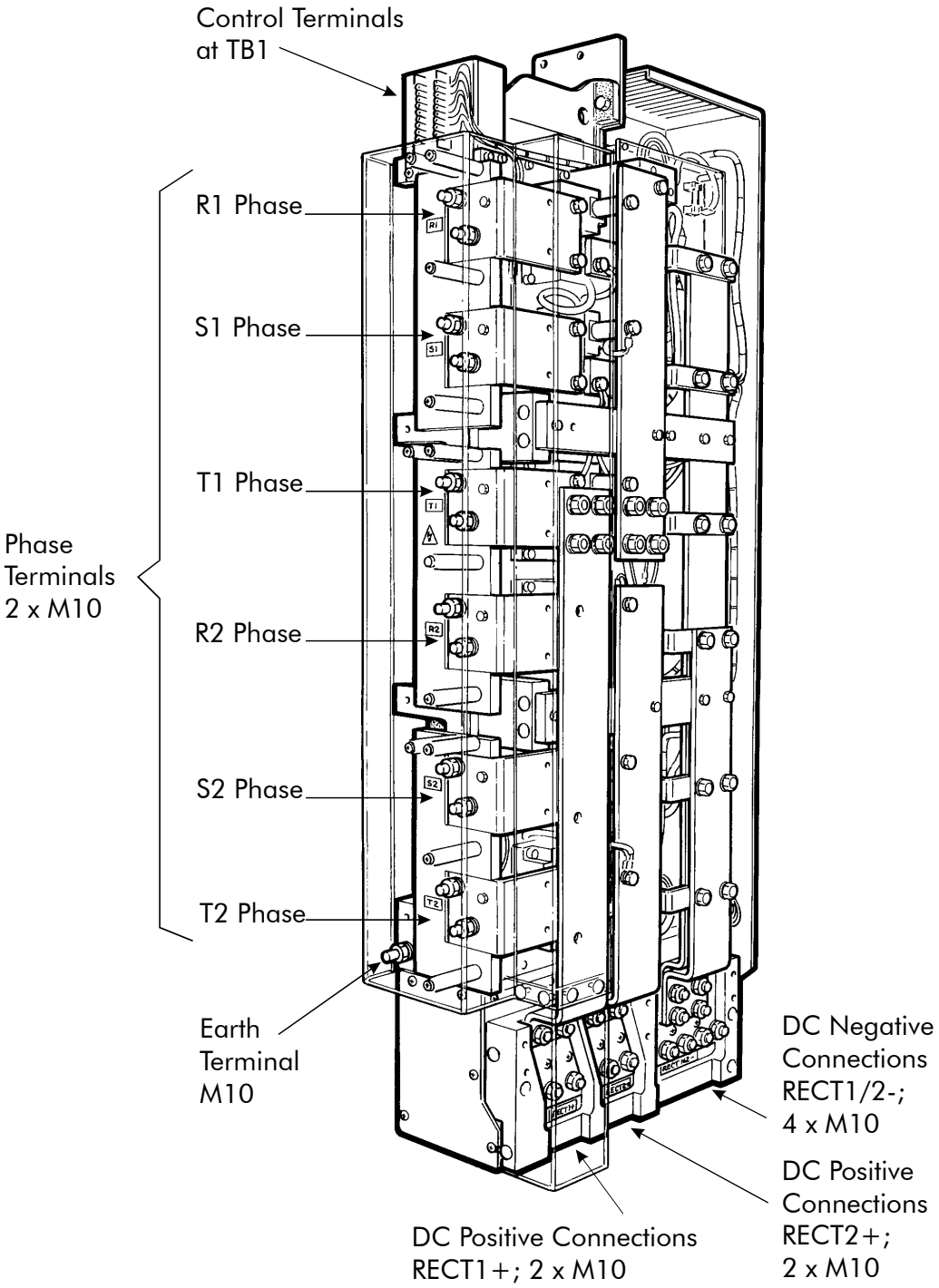


Figure 6-1 Typical View of a MV LCD Rectifier Bridge Module showing Electrical Connections

Note: Figure 6-1 does not show details of mechanical items, including the labels, which are shown at Figure 5-4. Refer to Figure 5-15 for details of coolant piping couplings and valves.

6.2.1 Control Terminals

The rectifier control terminals are mounted at the top of the front face of the Rectifier Bridge Module - see Figure 6-1. The terminals are the left half of a 10-pin plug and socket, referenced TB1, and may be unplugged for ease of wiring. See Figure 6-2 for the terminal layouts and functions.

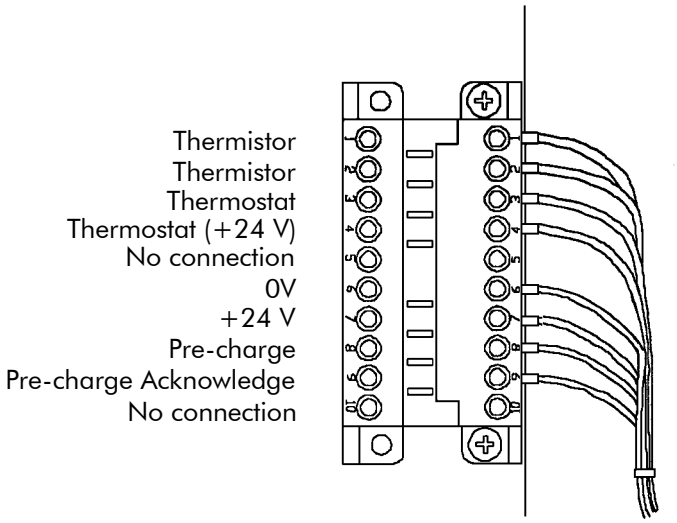


Figure 6-2 Rectifier Bridge Module MVRL2100 Control Terminals at TB1

Control Module connections are shown at Table 6-2.

Notes: (1) Terminals will accept up to 2.5 mm2 (12 AWG) flexible cables.

(2) To prevent failure of the Rectifier Bridge Module pre-charge components, the rectifier pre-charge acknowledge signal (TB1/9) must be connected to the control module. If this signal is not high the control module will not allow the drive to run.

6.2.2 Power Terminals for MVRL2100 Rectifier Bridge Module

All terminals appear at the front and on the right hand side of the module and are suitable for cable ring-crimp connection - see Figure 6-1. Refer to Appendix B for torque settings.

The six phase terminals, marked R1, S1, T1 and R2, S2, T2, are each two M10 studs located on the front of the module. An M10 plain and spring washer should be fitted under the nuts/bolts when connecting cables.

The d.c. positive connections, marked RECT1 + and RECT2 +, are each two M10 studs located on the right hand side of the module.

The d.c. negative connections, marked RECT1/2 -, are four M10 studs located on the right hand side of the module.

The earth terminal, see Figure 6-1, is one M10 stud, located on the front of the module and identified as shown at Figure 6-7.

There are two types of terminal shrouds used on the Rectifier Module as shown at Figure 6-3. One shroud protects the three phase terminals R1, S1 T1 and R2, S2, T2 and runs along the whole bridge. The RECT1 terminals, located at the lower front right corner of the module, are protected by a second smaller shroud. The larger shroud is attached to the module with M5 pozi-head screws, which fit into spacers on the module, and ‘snap’ type rivets, which fit into

the module as shown at Figure 6-3. The smaller shroud is attached to the module with the 'snap' type rivets. These shrouds must be fitted after the connections have been made.

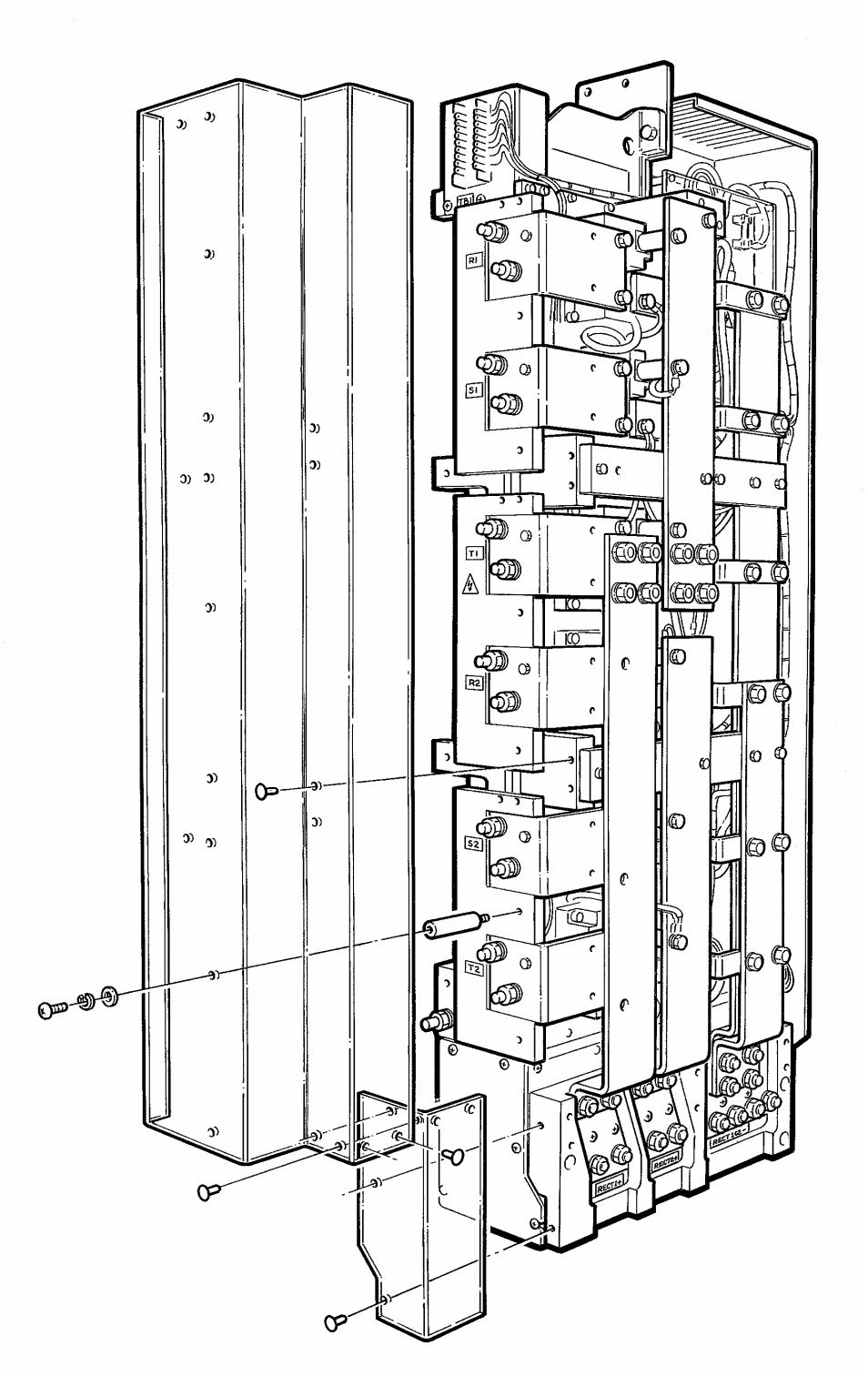


Figure 6-3 Rectifier Bridge Module Shrouds

6.3 Transistor Bridge Module Terminals

Unit covered: MVDL643-4701

A typical MV LCD Transistor Bridge Module is shown at Figure 6-4.

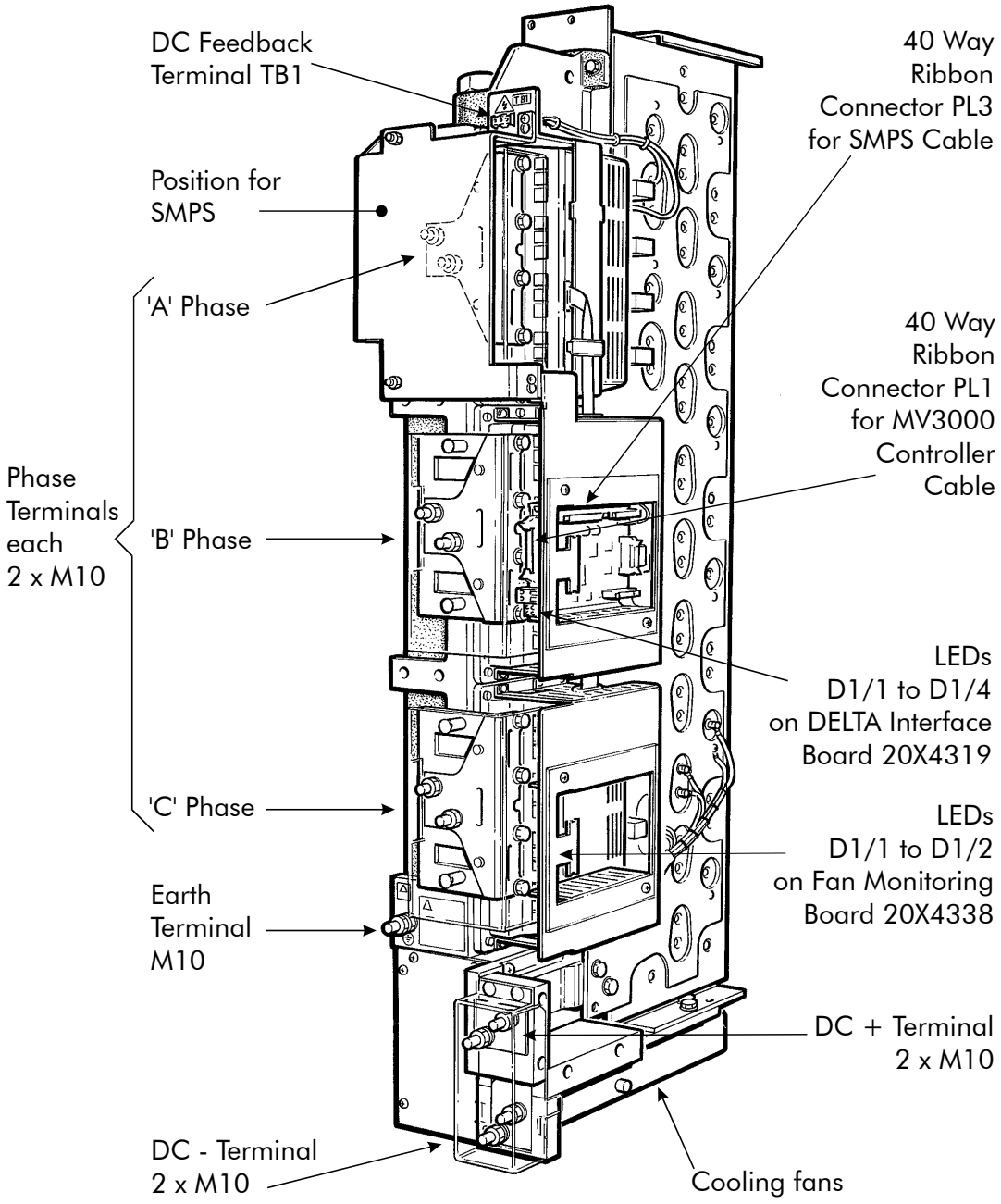


Figure 6-4 Typical View of a MV LCD Transistor Bridge Module showing Electrical Connections

Notes: (1) Figure 6-4 does not show details of mechanical items, including the labels, which are shown at Figure 5-5. Refer to Figure 5-15 for details of coolant piping couplings and valves.

(2) Refer to Figure 8-2 for functional details of the LEDs D1/1 to D1/2 and D1/1 to D1/4.

6.3.1 Control Connections

Details of all the control connections on the Transistor Bridge Module are:

(a) a 40 way ribbon cable connection from the controller to PL1 at the module;

(b) a 40 way ribbon cable connection to the SMPS from PL3 at the module;

(c) a d.c. cable connection to the SMPS from TB1;

Each Transistor Bridge Module is controlled via one 40-way ribbon cable which connects to the controller. The controller has the capability to drive up to six MV LCD Transistor Bridge Modules and the sequence of cabling to the controller connectors PL2 to PL7 is therefore very important - the controller software recognises which modules are in use and the positions of their connectors.

The 40-way ribbon cable connection to the module from the SMPS supplies power to the gate drive circuits on the Transistor Bridge Module.

The 2-way terminal block TB1 on each Module provides a d.c. supply to the SMPS.

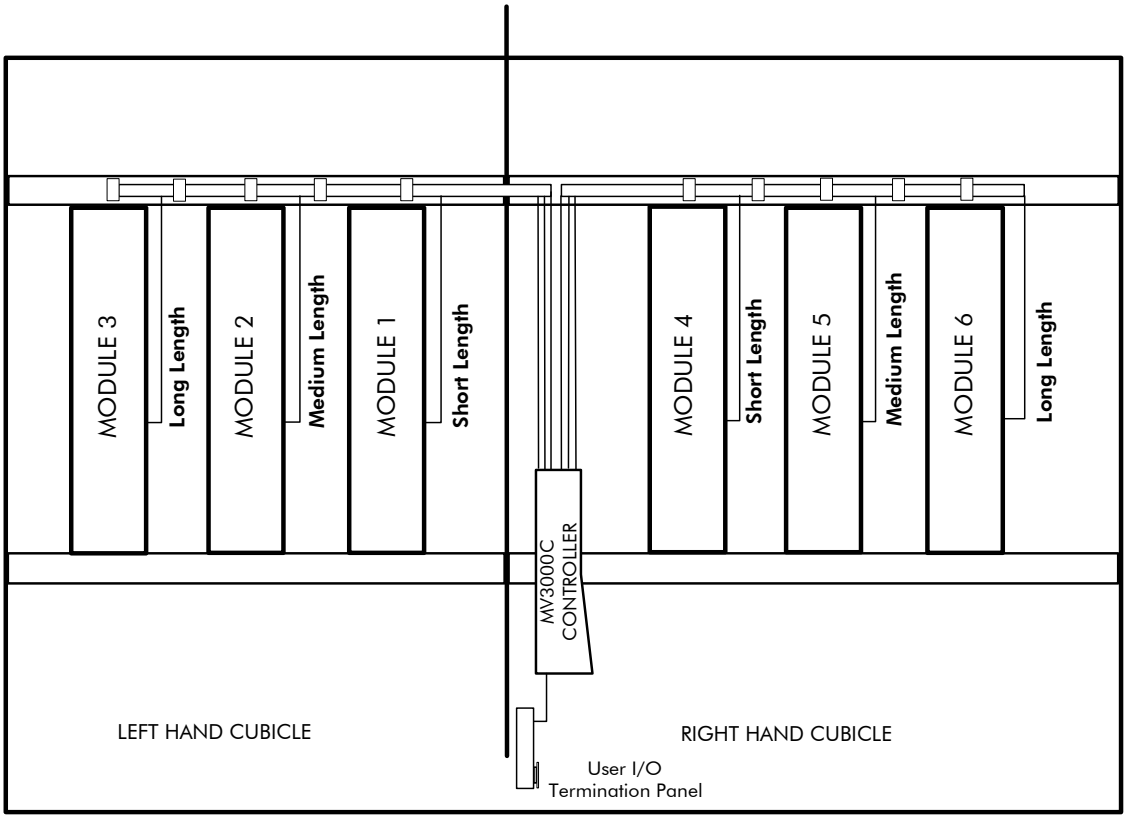


Figure 6-5 Routing of Ribbon Cables from the Controller to MV LCD Modules in a typical two cubicle layout - front view of cubicle

The ribbon cables for connections between the controller and the MV LCD Modules are supplied in three lengths as follows:

(a) A Short Length ribbon of 2.12 m (6.96 ft) for connecting Modules 1 or 4;

(b) A Medium Length ribbon of 2.38 m (7.8 ft) for connecting Modules 2 or 5;

(c) A Long Length ribbon of 2.72 m (8.92 ft) for connecting Modules 3 or 6.

The ribbon cables are supplied in kit form, referenced MVC3004-4001 to 4003, suitable for connecting a number of modules to the controller and these are listed at Table 6-1. The cables must be connected in sequence starting with Plug PL2 at the controller being connected to MV LCD Module 1.

Figure 6-5 shows a simplified cubicle arrangement of the ribbon cables routed between the controller and the modules.

Table 6-1 Ribbon Cable Kits for Connections between Controller and MV LCD Modules

For Connection to Module Number(s)	Ribbon Cable Lengths (Short, Medium or Long)	Ribbon Cable Kit Numbers
1	1 Short	MVC3004-4001
1 & 2	1 Short & 1 Medium	MVC3004-4002
1, 2 & 3	1 Short, 1 Medium & 1 Long	MVC3004-4003
1, 2, 3 & 4	2 Short, 1 Medium & 1 Long	MVC3004-4001 & MVC3004-4003
1, 2, 3, 4 & 5	2 Short, 2 Medium & 1 Long	MVC3004-4002 & MVC3004-4003
1, 2, 3, 4, 5 & 6	2 Short, 2 Medium & 2 Long	MVC3004-4003 & MVC3004-4003

6.3.2 Power Terminals for MVDL643 Transistor Bridge Module

Connections to the phase terminals, shown at Figure 6-4, are intended to be made by cables. Connections to the d.c. link terminals, DC+ and DC-, are intended to be made by either cables or busbars.

Phase terminals, marked A, B and C, are each two M10 studs. D.C. link terminals, marked DC+ and DC-, are each two M10 studs at the bottom of the module. The earth terminal, an M10 stud, is located on the lower left front face of the module.

The shrouds for power connections are attached by 'press fit' rivets as shown at Figure 6-6 and must be fitted after the connections have been made.

6.3.3 AC Power Cables

A MV LCD module is designed for connection with cables, the maximum size of which is 2 × 120 mm^2 (250 mcm) - see 2.7.7 for cable details.

In multiple MV LCD module applications, sharing between the machine bridge modules is achieved through the use of equal cable lengths which are each greater than 20 metres in length.

6.4 Connections to the Interbridge Transformer

Refer to Appendix A for connections to the Interbridge Transformer.

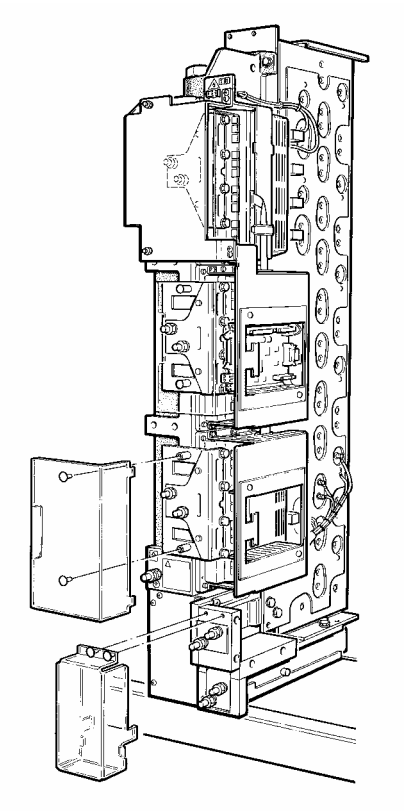


Figure 6-6 Transistor Bridge Module Shrouds

6.5 Module Earthing/Grounding Requirements

The steel module mounting frame into which a MV LCD module, Rectifier or Transistor module, is mounted can be used as the earthing method provided that the earth continuity is checked between the module earth terminal and the main cubicle earth point. The earth continuity must be equal to or less than 0.1 ohm, with at least 20 A supplied from a source of not more than 12 V, measured between the M10 earth terminal and the cubicle earth stud. If this value is not achieved then the module must be separately earthed via the M10 earth terminal at the lower front face of the module. The M10 earth terminal is identified on the module by the symbol shown at Figure 6-7.

Figure 6-7 Protective Earth (ground) symbol to IEC 60417 (Symbol 5019)

6.6 Line Contactors and Relays

When installing line contactors and relays in close proximity to, or connected to, the MV LCD modules, the coils must be fitted with suppression devices.

Suppression will normally take the form of a suitably sized series connected capacitor and resistor connected across the contactor/relay coil.

6.7 MV3000e Controller

All the connections at the MV3000e Controller for the MV LCD Transistor Bridge Modules, the Rectifier Bridge Modules, the User I/O Termination Panel and the Drive Data Manager™ (Keypad) are shown at Figure 6-8. Functions for PL12 connections at the Controller, for the rectifier bridges, are listed at Table 6-2.

Connections at the Drive Data Manager™ (Keypad) are shown at Figure 6-9 and the functions listed at Table 6-3. Connections at the User I/O Termination Panel are shown at Figure 6-10 and the functions listed at Table 6-4.

The MV3000e Controller should be wired to the associated equipment in accordance with the connection diagrams in Appendix A which show the connection arrangements for various configurations of network and machine bridges, the User I/O termination panel and the liquid cooling circuit.

There are particular rules which determine the position of each MV DELTA transistor bridge module in the mounting frames so that the controlling software correctly recognises the presence of the module in a particular position. The modules should be assembled in the mounting frames in a sequence from left to right (front view) without any spaces. The connection arrangement for the modules at the controller is shown in the connection diagrams at Appendix A. The first module in the mounting frame is connected to PL2 at the controller.

The configuration software does not recognise the position of a rectifier bridge module in a mounting frame.

Table 6-2 Controller PL12 Connection Functions for Rectifier Modules

Terminal Number	Function
1	NTC Temperature Monitor - Thermistor
2	NTC Temperature Monitor - Thermistor
3	Thermostat (24V = HEALTHY)
4	+24V
5	+24V
6	0V
7	+24V
8	Pre-charge Relay 24V
9	Pre-charge Acknowledge (24V = HEALTHY)

Table 6-3 Controller SK5 Connection Functions for Drive Data Manager™ Keypad

Terminal Number	Function	Comments
1	NC	Not connected
2	RS232 TX	
3	RS232 RX	
4	NC	Not connected
5	0V	
6	8V	8 V output from drive
7 & 8		Connected together
9	PWM ON	Indicates drive is active
Body	EARTH	Screen connection

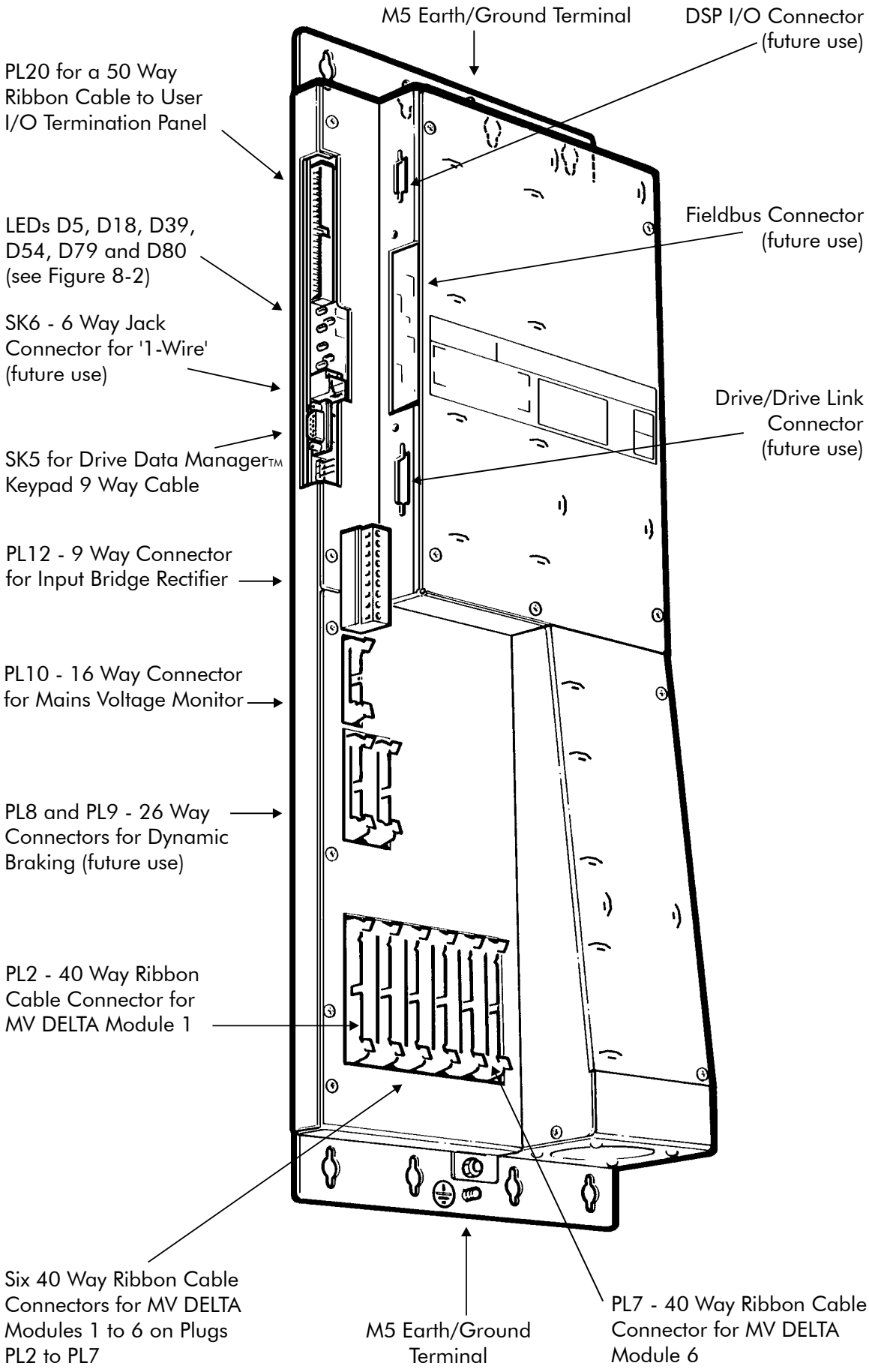


Figure 6-8 Connections to the MV3000e Controller (in a cubicle location)

6.8 Connections to the Drive Data Manager™ (Keypad)

- for use with the MV3000e Controller

The MVS3000-4001 Keypad is an optional item of equipment for use with the MV3000e Controller. The keypad is supplied separately from its mounting kit which also includes a 9 way connecting lead with a 'D' type connector. The connections for the Keypad are shown at Figure 6-9 and the functions listed at Table 6-3.

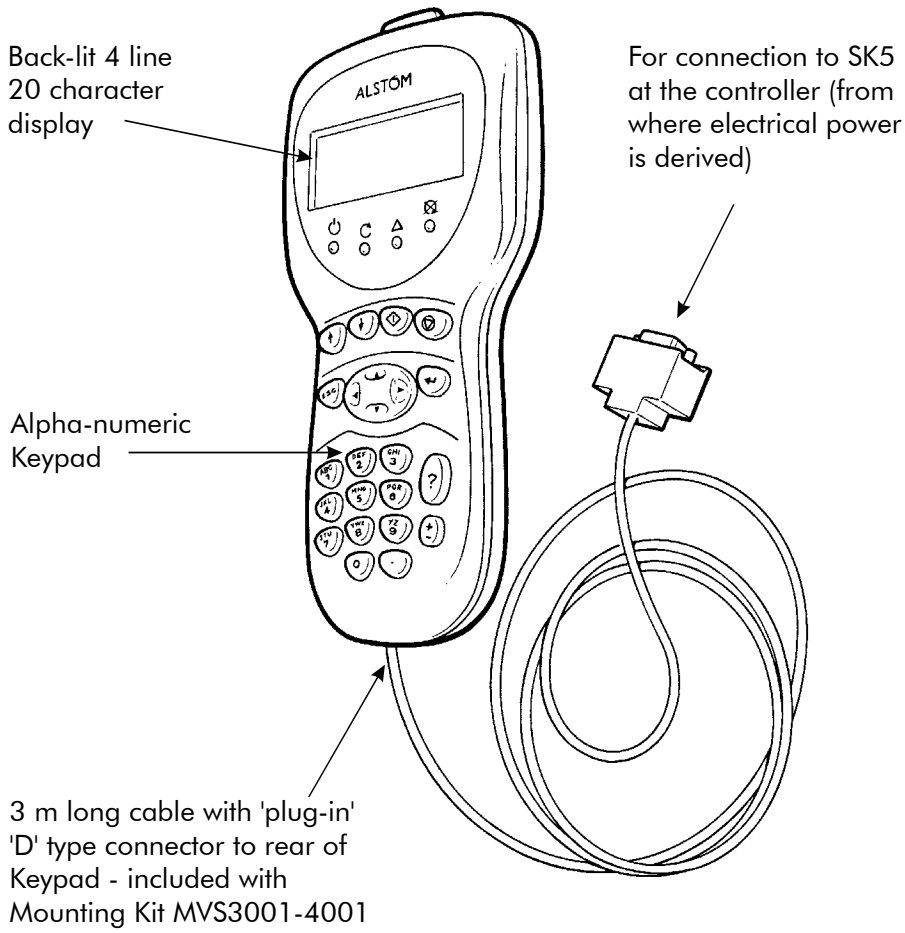


Figure 6-9 Connections to the Drive Data Manager™ (Keypad) MVS3000-4001

6.9 Connections to the User Input/Output (I/O) Termination Panel

Details of the connections between the MV3000e Controller and the User I/O Termination Panel are included at Table 6-4 and shown at Figure 6-10 and 6-11.

A 50 way ribbon cable, 2 m (6.5 ft) long, is supplied with the panel for connection to the MV3000e Controller. Refer to Section 4 - CUBICLE PLANNING for details of cable routing and segregation distances.

User connections to the I/O Termination Panel are dependent upon the particular application. However, multicore screened cables should always be used except for the connections to TB1, TB2 and TB3 where screened cable is not mandatory. For each screened cable, crimp the braid to an M4 (No. 8 or 3/16 in) ring crimp and secure it to the panel with the M4 screws provided (also see Figure 5-10).

Table 6-4 User Input/Output Terminations

TB6		Analogue Inputs/Outputs (Menu 7)	Specifications
Pin	Signal		
1/2	ANOP 1 and 2	Analogue outputs 1 and 2, Voltage (V) or Current (I) as selected by SW1.	V or I: (11 bit + sign), ±5% full scale accuracy, update time 5 ms V: –10 V to +10 V, ≤ 5 mA load I: –20 mA to +20 mA, ≤ 500 Ω load
3	AN GND	Analogue earth/ground for i/p and o/p.	Connected to earth/ground internally
4/9	–10.5 V/+10.5V	Reference supplies for analogue inputs.	Maximum Load: 5 mA current limited
5/6 7/8	AN I/P 2 –/+ AN I/P 1 –/+	Differential analogue input 2 Differential analogue input 1 Voltage (V) or Current (I) as selected by SW1.	V or I: (11 bit + sign), ±5% full scale accuracy: V: –10 V to +10 V, 100 kΩ load input Z I: –20 mA to +20 mA, 235 Ω load input Z Common mode volts = ±2.5 V maximum
TB5		**Encoder/PTC (Menu 13)**	**Specifications**
1	M_PTC	Input from motor PTC.	Resistive: Trip: P2.13 (0 Ω to 7 kΩ) Reset: P2.13 – 0.1 kΩ
2/5	FB –/FB+	Encoder power supply feedback for accurate setting	
4/6	+5 V/+24 V	Power supply outputs for the encoder.	+5 V: Adjustable, 4.5 - 6.5 V, 350 mA maximum +24 V Fixed, 350 mA maximum
3	0 V	Common return line for encoder power supply and the PTC.	Connected to earth/ground internally
7/8 9 - 12	Z–/Z+ B–/B+, A–/A+	Marker signal from encoder. Encoder position signals.	EIA RS422A, Max edge frequency 1.5 MHz EIA RS422A, Max edge frequency 1.5 MHz
TB4		**Communications**	**Specifications**
1/2 3/4	RS485 Tx +/– RS485 Rx +/–	Differential link for improved noise immunity. (Menu 32)	0 - 2 km range. Update time 10 ms.
5	GND	Common ground for communications links	Connected to earth/ground internally
6/7	CAN link	Connection to CANopen or to expanded I/O	Future
8/9	HSIO +/–	High speed digital link (Menu 20) Common mode volts ≅ 15 V	RS422 protocol, ± signal differential wrt GND pin.
TB3		**Digital Inputs (Menu 7)**	**Specifications**
3 to 8	DIGIN 1-6	For remote control of drive – default functions are shown in wiring diagram	Impedance: 15 kΩ Active: +12 V to +50 V Inactive: Open circuit or < 7 V
9	INTERLOCK	Hardware interlock – must be made to enable drive	Impedance: 15 kΩ Healthy: +12 V to +50 V Unhealthy: Open circuit or < 7 V
2 & 10	+24 V O/P	User supply for peripheral equipment	Volts range: +22.8 V to +25.3 V Max load: 500 mA
1	0 V (digital)	0 V reference of digital inputs	Connected to earth/ground internally
TB2		**Auxiliary Input Supply**	**Specifications**
+24 V Aux input		Allows monitoring and programming with main power switched off	Current, nominal (Keypad + CDC): 500 mA Current, max (all versions): 2.2 A
TB1		**Digital Outputs**	**Specifications**
DIGOUT 1 to 3		Volt-free changeover relay outputs	Max volts: 250 Vac, 30 Vdc Max current: 3 A (resistive load)

Notes: Refer to T1676 MV3000 Getting Started Manual - Commissioning Section for Menu 7 firmware details

(1) Set the DIP Switches to configure the analogue I/O for current or voltage operation then refer to Menu 7 of the MV3000 firmware to configure the relevant parameters

(2) Plant I/O is configured by Menu 7 of the MV3000 firmware.

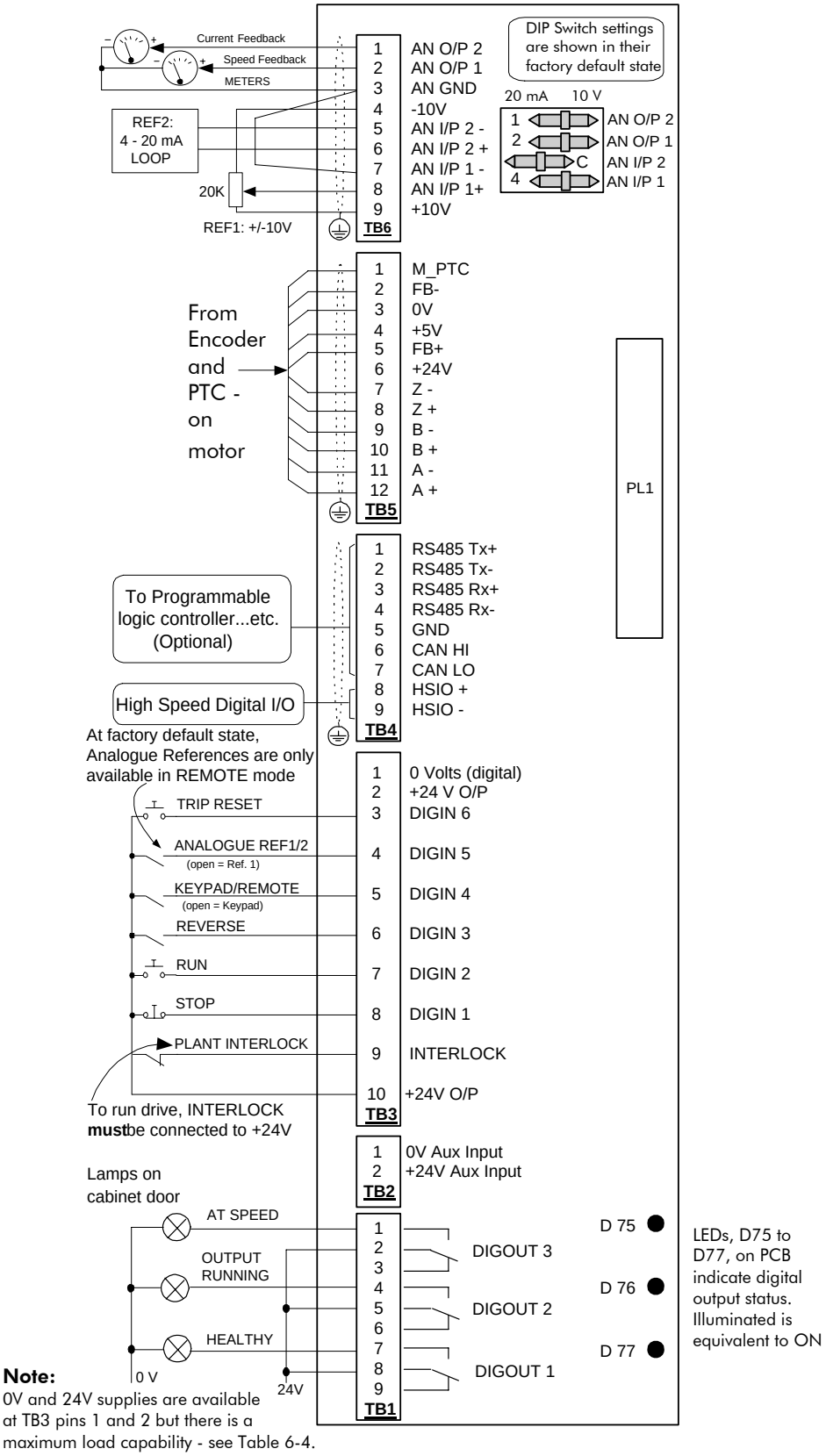


Figure 6-10 Wiring Diagram for User Input/Output Termination Panel

Note: TB4 and TB6 are each 9 way terminal blocks of the same connector pitch and so it is important that wiring for these blocks is connected to the correct terminal block. TB1 is also a 9 way terminal block but this has a different connector pitch to TB4 and TB6.

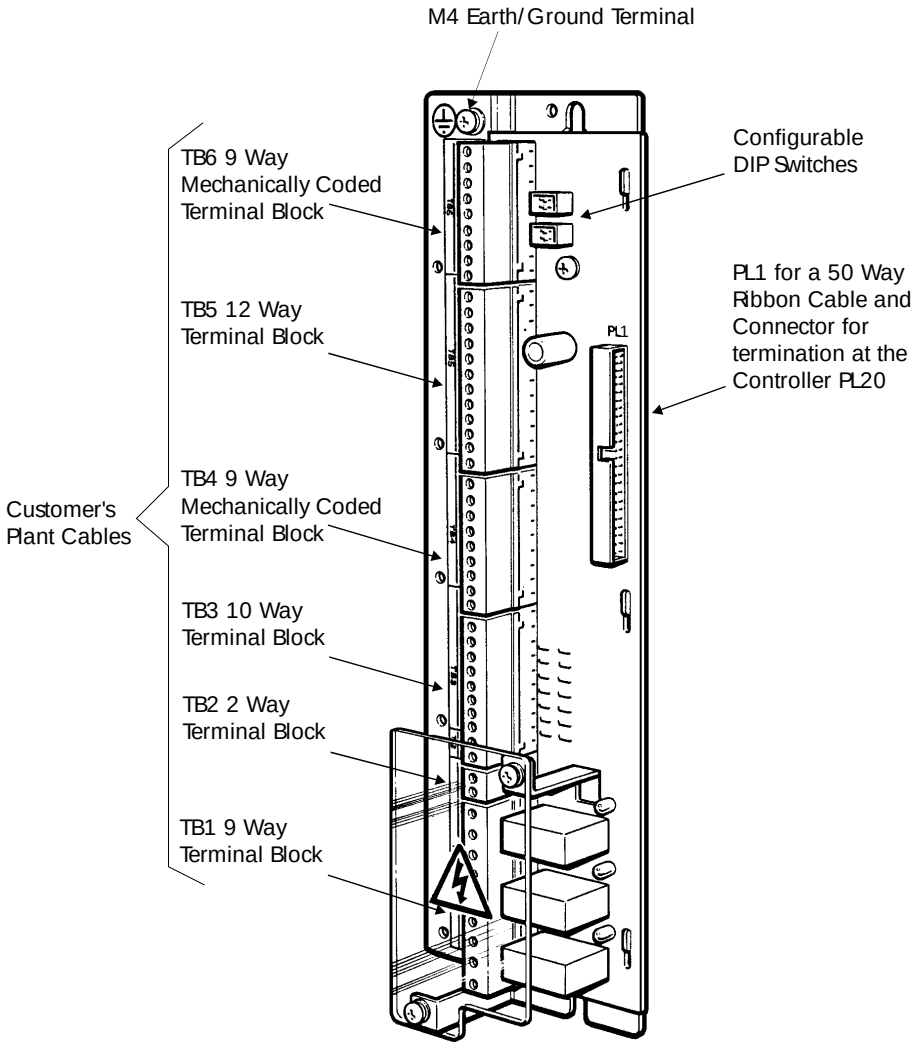


Figure 6-11 Connections to the User Input/Output Termination Panel

6.10 MV3000e Switched Mode Power Supply (SMPS)

The flying lead, supplied with the SMPS, should be connected to TB1 on the Transistor Bridge Module - see Section 5 - MECHANICAL INSTALLATION (5.13). A 40 way ribbon cable, supplied with the Transistor Bridge Module, should be connected to PL22 on the SMPS.

6.11 Fuses for Rectifier and Transistor Module Applications

6.11.1 Rectifier Bridge Module Input Fuse Protection

The recommended input fuses for use with the MV LCD Rectifier Bridge Module are detailed at Table 6-5. Appendix A includes details of the input power circuits and the fusing arrangements.

Table 6-5 Recommended Fuses for Rectifier Bridge Module Input Protection

MV DELTA Module Type	Requirements for each Rectifier Module	Quantity of fuses
	MVRL2100-4601 Voltage Rating 500 - 690 V a.c. Current Rating of 2100 A d.c. + 10% for 60 s in 600 s	
Manufacturer Part Number Ref. Number Microswitch Code Ref. Number Standard threaded stud for use with fuse Size Ref. Number	FERRAZ SHAWMUT (Le Carbone) 6.6 URD 233 TTF 1250 D 300 268 MS 3V 2-5 BS H 310 001 33 V 98 803	6
	MVRL2100-4601 Voltage Rating 500 - 690 V a.c. Current Rating of 920 A d.c. + 100% for 12 s in 180 s	
Manufacturer Part Number Ref. Number Microswitch Code Ref. Number Standard threaded stud for use with fuse Size Ref. Number	FERRAZ SHAWMUT (Le Carbone) 12.5 URD 73 TTF 700 R 300 510 MS 7V 1-5 BS K 310 003 73 V 98 803	6

6.11.2 Transistor Bridge Module DC Link Fuse Protection

For multiple transistor bridge applications, it is recommended that each module is fused at both the d.c. + and d.c. - terminals. Fuses must be rated for the d.c. link operating voltage. Refer to Table 6-6 for recommended fuse types and Appendix A for connection details.

6.11.3 Fuse Selection and Mounting

The fuses specified at Tables 6-5 and 6-6, for use with the Rectifier and Transistor Modules, are manufactured by Le Carbone. Fuses from other manufacturers may be used but they should be equivalent to the types specified in this manual.

The fuse manufacturer's data should be referred to for mounting instructions. In particular the following should be considered:

(a) hole sizes;

(b) mounting - proprietary parts required etc. and method of fitting;

(c) torque tightening figures;

(d) minimum cross sectional area for fuse attachment points e.g. Le Carbone specify 600 mm^2 for the fuses specified at Tables 6-5 and 6-6;

(e) power dissipation;

(f) microswitches - types and attachment methods.

Table 6-6 Recommended Fuses for DC Link Protection on a Transistor Bridge Module

MV DELTA Module Type	Requirements for each Transistor Module	Quantity of fuses
	MVDL643-4701 Voltage Rating 1250 V d.c. Current Rating of 643 A + 10% for 60 s in 600 s	
Manufacturer Part Number Ref. Number Microswitch Code Ref. Number Standard threaded stud for use with fuse Size Ref. Number	FERRAZ SHAWMUT (Le Carbone) 12.5 URD 2 x 72 TTF 1000 A 300 725 MS 7V 1-5 BS K 310 003 2 x 72 W 98 804	2
	MVDL643-4701 Voltage Rating 1250 V d.c. Current Rating of 272 A + 100% for 12 s in 180 s	
Manufacturer Part Number Ref. Number Microswitch Code Ref. Number Standard threaded stud for use with fuse Size Ref. Number	FERRAZ SHAWMUT (Le Carbone) 12.5 URD 73 TTF 630 Q 300 509 MS 7V 1-5 BS K 310 003 73 V 98 803	2

6.11.4 Microswitch Attachment

For fuse indication a microswitch attachment should be fitted to each fuse or parallel pair of fuses. The microswitch should be connected as shown in the circuit diagrams at Appendix A.

6.12 Installation of Electrical Equipment for the Liquid Cooling System

All the electrical equipment for the liquid cooling system should be installed in accordance with the application requirements. Details for the equipment are not included in this manual. However, such equipment will normally be used for the control, protection and instrumentation associated with the liquid flows.

7. Commissioning

WARNINGS

- **Exposed High Voltages**

  Enclose all items exposing high voltage before the equipment is energised.

- **Energy Discharge**

  Wait at least 5 minutes after isolating supplies and check that voltage between DC+ and DC- has reduced to a safe level before working on this equipment.

- **Multiple Circuits**

  This equipment may be connected to more than one live circuit. Disconnect all supplies before working on the equipment.

- **High Leakage Current**

  This equipment and the driven motors(s) must be earthed (grounded).

- **Radio Transmitters**

  Do not use mobile phones or walkie talkies within 2 metres (6 feet) of the equipment.

- **Health Hazards of Liquid Coolants**

  The coolant used in this equipment may be hazardous to health if not stored, handled and disposed of in accordance with the manufacturer's instructions.

- **High Temperatures**

  Surfaces on the following items can reach high temperatures:

  - **reactors and transformers**
  - **cables**
  - **coolant pipes and couplings.**

7.1 Introduction

The commissioning procedure for each drive with MV Liquid Cooled DELTA (MV LCD) modules will vary for each application; such details are not included in this manual. However, reference should be made to the MV3000e Getting Started Manual T1676 which does include general guidance for commissioning. When the equipment has been designed and built for a particular application by a System Integrator then it is important, for the safety of personnel and equipment, that all commissioning instructions prepared by the Integrator include the following details:

(a) warnings and cautions as necessary;

(b) mechanical checks;

(c) electrical checks;

(d) cooling system checks - internal and external to the enclosure.

7.2 Pre-commissioning Checks

7.2.1 Mechanical Checks

The pre-commissioning mechanical checks now outlined apply to MV LCD equipment housed in a cubicle and also, where appropriate, to MV LCD modules supplied loose. The checks

outlined include those for the cooling system within the cubicle and also external to it e.g. checks to ensure mechanical integrity of the piping. Check that:

(a) each module is of the same type and voltage grade for the application;

(b) the modules have been correctly assembled in the appropriate mounting frames in accordance with the instructions in Sections 5 and 6 of this manual;

(c) the modules have been assembled in the correct sequence i.e. no intermediate positions left empty;

(d) there is adequate clearance around the controller within the cubicle for ventilation;

(e) there is adequate clearance around the cubicle for ventilation, and that the ventilation louvres are not covered or blocked;

(f) all piping from a liquid cooled module to the cubicle mounted manifold is installed in accordance with the guidance at Section 5 - MECHANICAL INSTALLATION;

(g) all piping from the cubicle/enclosure manifold to the external cooling system is designed and installed in accordance with guidance at Section 3 - COOLING SYSTEM DESIGN.

Note: Check that the material compatibility rules have been followed in the cooling system.

7.2.2 Electrical Checks

When mechanical checks have been completed, including all piping checks, all the electrical equipment, specific to the particular application, should be checked for correct installation, wiring and earthing. The latter particularly to ensure safety earthing and protection against high leakage currents. These checks apply to all the following equipment:

(a) control equipment;

(b) protection equipment;

(c) instrumentation;

(d) associated motors.

Some specific checks are also recommended. Check that:

(1) the SMPS is compatible with the module voltage grade;

(2) the drive has been installed in accordance with the instructions in Sections 5 and 6 of this manual - particularly that shrouds are fitted;

(3) all configurable components are correctly set e.g. the DIP switches on the User I/O Termination Panel;

(4) all interlocking circuits are correctly connected;

(5) there are no earth (ground) faults on the motor(s);

(6) it is safe to perform the commissioning procedure, which will involve energising and rotating the motor;

(7) you are familiar with the controls for the MV3000e Controller and use of the Drive Data Manager™ (Keypad);

(8) all electrical supplies are available and within specification.

When all these checks have been carried out refer to 7.3 for details of the Insulation Tests.

7.3 Insulation Tests

When the pre-commissioning checks have been completed it is recommended that insulation tests be carried out, prior to the equipment being commissioned, to check that cables have not been damaged during installation and that the equipment is correctly bonded for earthing purposes. These tests will vary in detail for each application, particularly the tests which are carried out at a cubicle level, and therefore only general guidance is included.

For ease of testing it is recommended that the MV LCD equipment be considered in four groups. The tests are detailed for each group with all the test conditions applicable to other groups also being specified. The equipment performance should be checked after all the insulation tests have been completed to ensure that no component damage has occurred.

7.3.1 Equipment Groups

The groups of equipment are:

(a) Group A - the main power circuit;

(b) Group B - the auxiliary circuits;

(c) Group C - the low voltage circuits;

(d) Group D - the 'earthed' parts.

7.3.1.1 Group A - The Main Power Circuit

This circuit comprises:

(a) main fuses;

(b) main isolator;

(c) module power connections i.e. d.c. and a.c. cabling/busbars but not the modules themselves;

(d) output reactors.

Note: Motor contactors for a MV LCD module, which are application dependent, would also be considered a part of the main power circuit for purposes of insulation testing.

7.3.1.2 Group B - The Auxiliary Circuits

These circuits, which are generally application dependent, comprise:

(a) main 3 phase supply (e.g. 440 V a.c.) and all items connected to it e.g. supply monitoring;

(b) single phase control supplies and all items connected to it e.g. fans, pumps, heaters etc.

7.3.1.3 Group C - The Low Voltage Circuits

The low voltage circuits are generally application dependent. However, the following items of equipment would normally be expected as part of the low voltage circuits:

(a) all circuits connected to control circuit components e.g. contactor coils, relay circuits, earth leakage CT etc;

(b) all circuits connected to the User I/O Termination Panel.

7.3.1.4 Group D - The 'Earthed/Grounded' Parts

These circuits comprise the cubicle structure, earth/ground bar, signal ground and screen bars, and earthed metalwork in general, including component mounting/ containers.

7.3.2 Preliminary Checks Prior to Carrying Out Insulation Voltage Tests

Before any of the following insulation voltage tests are carried out proceed as follows:

(a) join together all the components in each of the three groups A to C;

(b) check with an Avometer or Digital Volt Meter, on the high resistance range, that each of the above groups is isolated from each other and from earth;

(c) ensure that the MV LCD modules are completely disconnected.

Proceed to carry out the following insulation tests in the order specified.

7.3.3 Insulation Tests for each Group

The insulation tests, and the test procedures, for each of these groups of equipment for a MV LCD system are detailed at Table 7-1.

When Insulation Voltage Tests have been carried out remove all the wires which were put in place for the insulation testing and re-connect the equipment in accordance with the circuit diagrams.

Table 7-1 Insulation Voltage Tests

EQUIPMENT GROUP	TEST CONDITIONS	INSULATION TESTS
A **The Main Power Circuit**	(a) ensure that the MV LCD modules and the MV3000e controller are completely disconnected except for the main earth cable(s); (b) disconnect all other wires, including those on the User I/O Termination Panel, by unplugging; (c) short together the main d.c. busbars; (d) short together all the disconnected MV LCD module power connections; (e) short together all the main output terminals; (f) connect the output of the flash test set to the main d.c. busbars.	**Earthed Circuits:** Groups B, C and D **Test Voltage:** 2.5 kV r.m.s. 50 Hz for 1 minute **Application Time**: Measure the insulation resistance using a 500 V Insulation Tester or other suitable instrument. Apply the test voltage for one minute. Measure the insulation resistance again after the test.
B **The Auxiliary Circuits**	(a) ensure that the wiring for electronic units is disconnected and shorted together.	**Earthed Circuits:** Groups A, C and D **Test Voltage**: 2 kV r.m.s. 50 Hz for 1 minute **Application Time:** Measure the insulation resistance using a 500 V Insulation Tester or other suitable instrument. Apply the test voltage for one minute. Measure the insulation resistance again after the test.
C **The Low Voltage Circuits**	(a) unplug the terminal blocks on the User I/O Termination Panel; (b) unplug the cables from the controller; (c) disconnect the wires from all other control circuit components. **Note:** Depending upon the application there may be auxiliary Earth Leakage Relays fitted, if so, the wires should be disconnected from the Relays.	**Earthed Circuits:** Groups A, B and D **Test Voltage:** 100 V r.m.s. 50 Hz for 1 minute to be obtained from a Variac, or other suitable variable voltage supply, through a high resistance (1 to 5 k ohm) with a 100 mA meter in series to detect any leakage current - there should be no measurable leakage current. **Application Time** 1 minute but do not use an Insulation Tester on these circuits.
D **The 'Earthed/ Grounded' Parts**	The Test Conditions are an integral part of each group.	The Tests are an integral part of each group.

7.4 Preparation of the Cooling System

7.4.1 Initial Checks prior to Coolant Loading

To ensure cooling efficiency for the power devices in the MV LCD modules carry out the following checks before loading the coolant into the cooling system.

Check that:

(a) all modules have been assembled in the appropriate mounting frame;

(b) all cooling system connections are correctly made and the external cooling system has been appropriately designed (see Section 3 - COOLING SYSTEM DESIGN);

(c) the FLOW and RETURN pipes are in correct positions at the module;

(d) all flexible pipes are securely fastened within the cubicle/enclosure;

(e) all materials used in the external cooling system are compatible with the materials in the module cooling path (see Section 2 - SPECIFICATION);

(f) the coolant to be used is of a recommended type or a compatible alternative;

(g) the coolant mixture and concentration meet required temperature range;

(h) the end caps from all couplings on the flexible pipes have been safely stored for future use during re-commissioning or maintenance.

7.4.2 Initial Tests prior to Running the Cooling System

Carry out the following tests before running the cooling system:

(a) flush the system with de-mineralised water to remove any debris; clean strainer;

(b) a pressure test, pneumatic or hydrostatic, to ensure the cooling system withstands working pressure – a hydrostatic test may use the intended coolant (see 7.5).

7.5 Filling the Cooling System

7.5.1 Precautions

Precautions, which should be observed when using a coolant, are:

(a) only use coolant with corrosion inhibitors;

(b) read the manufacturer's Safety Instructions before using the coolant;

(c) handle, use, store and dispose of coolant in accordance with the manufacturer's instructions - use protective gloves when handling the coolant;

(d) do not mix coolants from different manufacturers or different types from the same manufacturer.

7.5.2 Procedure

The procedure for filling the cooling system will depend on the specific application. The requirements will vary for each application but will normally include the following stages:

(a) calculate the amount of coolant mixture required for a complete cooling system - allow for the volume of coolant in modules, all pipework, pumps, manifolds and the header tank;

(b) determine the concentration required for a recommended coolant mixture based on the lowest temperatures likely to be experienced and the details at Section 3 - COOLING SYSTEM DESIGN – for recommended types and manufacturers;

Note: As the percentage of ethylene glycol within a coolant mixture increases, the efficiency of the coolant to remove the heat from the module reduces slightly. Concentrations above 50% offer no further protection against low temperatures and above 75% provide less low temperature protection. A minimum concentration of 33% must be included to ensure adequate corrosion protection.

(c) prepare the required amount of a coolant mixture, to the required concentration, to meet the requirements of the cooling specification and with an allowance for some spare concentrate mixture to be stored for 'top up' purposes;

(d) fill the cooling system either via the header tank or through a suitable filling location if a closed system is used;

(e) when the system has been filled, carefully vent all air as follows:

(1) bleed each module at its top air vent valve (see Figure 5-15), with a 5 mm (0.2 in) square key, **do not fully remove the bleed screw from the valve;**

(2) ensure that coolant does not 'flood out';

(3) when all air has been purged, tightly close the bleed screw.

(f) top up the system, if necessary;

(g) carry out a visual check for coolant leaks in the system;

(h) record details of coolant type and loading date on plant records (see Figure 8-3).

7.6 Running the Coolant Pump only

When the cooling system has been filled with the specified coolant mixture run the coolant pump to check the integrity of the cooling system and to trap any foreign bodies from the system in a strainer. Proceed as follows:

(a) start up the coolant pump and run for one hour at working pressure;

(b) visually check the cooling system for coolant leaks;

(c) after one hour switch off the pump;

(d) isolate the strainer by closing the ball valves on each side of it;

(e) remove the strainer from the system and clean it of any foreign bodies;

(f) replace the strainer;

(g) open the ball valves;

(h) now proceed with checks for the instrumentation and controls.

7.7 Checks for Instrumentation and Controls

Checks for the control, protection and instrumentation included for each cooling system design may vary and these will normally be included at the system integration stage. They should be checked prior to the complete drive system being commissioned.

(a) start up the coolant pump;

(b) start up the heat exchanger fan and check for fan operation;

(c) carry out another visual check for coolant leaks during operation of coolant pump;

(d) if flow meters are fitted check that the flow rate meets the specification at Section 3 - COOLING SYSTEM DESIGN;

(e) check all feedback signals from the header tank if fitted - this should include a trip signal for the condition when the coolant level is too low;

(f) check for interlocking with other aspects of a drive, for example:

(1) when coolant flow is stopped;

(2) co-ordination of FAN ON and PUMP ON;

(g) proceed to commission the drive in accordance with MV3000e Getting Started Manual T1676 carrying out coolant temperature checks at 7.9 during commissioning.

7.8 Commissioning

After the pre-commissioning checks, the insulation tests and preparation of the Liquid Cooled system have been carried out as described in this section proceed to commission the full drive equipment. The commissioning should be in accordance with instructions in the MV3000e Getting Started Manual T1676 and, when applicable, the instructions prepared by a System Integrator. Details for customising the MV3000e Controller parameters for specific applications i.e. application programming, are also in the T1676 Manual.

7.9 Coolant Temperature Checks During Commissioning

The commissioning procedures, which are defined in the MV3000e Getting Started Manual T1676, must be followed.

If the external coolant temperature can be measured this can be compared with the transistor bridge temperatures. Prior to running the bridge, its temperature, which is indicated by the feedback signals to the controller, via parameter P11.05 for the Machine (Output) Bridge 1, for example, can be compared against the coolant flow temperature and should be of a similar value.

Run the transistor bridge and monitor the bridge temperatures via the feedback signals to the controller. Check that there are no significant variations between the temperatures of the bridges of different modules. If there is a variation, check the flow and return temperatures for the coolant at each module and compare with other modules. A variation of temperature, between the modules, may arise because of an unequal coolant flow and this should be investigated and corrected.

8. Maintenance

WARNING

- **Radio Transmitters**

  Do not use mobile phones or walkie talkies within 2 metres (6 feet) of the equipment.

- **Health Hazards of Liquid Coolants**

  The coolant used in this equipment may be hazardous to health if not stored, handled and disposed of in accordance with the manufacturer's instructions.

CAUTION

Any metallic item touching the coolant duct or the aluminium heatsink MUST BE STAINLESS STEEL - note particularly when fitting screws.

8.1 Introduction

This section describes maintenance for the ALSPA MV Liquid Cooled DELTA (MV LCD) modules and the MV3000e Controller in a MV3000e Liquid Cooled DELTA System.

No component maintenance is described for the module or the controller. If either product requires component maintenance a request for assistance should be made to an Converteam Service Centre via the appropriate national address at the back of this manual.

Some users may have the facilities, the skill and the appropriate lifting equipment to enable a replacement MV LCD module to be fitted should this become necessary. This section of the manual therefore includes sufficient detail to enable such users to remove and refit a module.

Because of the technology used in the MV LCD module there is a requirement for periodic maintenance to be carried out and this is also detailed in this section of the manual.

Throughout this section of the manual reference to a MV LCD Module should be read as applying to either a Rectifier Module or a Transistor Module unless a type of module is specifically stated.

8.2 Special Tools, Equipment and Materials

8.2.1 For the MV LCD Module (Transistor or Rectifier Bridge)

Special tools and equipment for work with the MV LCD Module are:

(a) a torque screwdriver or torque wrench for M10 size;

(b) a PZ3 screwdriver for M6 Pozidrive screws;

(c) socket head key ('radiator bleed' type) 5 mm (0.2 in) square across flats;

(d) small container for a few millilitres of coolant;

(e) larger container (e.g. a bucket) for at least 1.75 litres (0.38 UK gallon or 0.46 US gallon) of coolant;

(f) a suitable container for storage of coolant;

(g) spare hose coupling Staubli Unimation Part RMI16 Type N007117 96-SKT socket (Converteam Part Number 47307/100) attached to a suitable length (e.g. 1 metre or 3 ft) of hose (for draining a module into a large container);

(h) suitable ‘soak-up’ material (e.g. cloths, rags, absorbent paper) for the surplus coolant;

(i) two pairs of gloves - one pair for handling the module and the coolant hoses (when uncoupling) and a waterproof pair for protection when handling the coolant;

(j) a crane suitably rated for lifting the MV LCD module (see Section 5 - MECHANICAL INSTALLATION).

8.2.2 For the MV3000e Controller

The special tools and equipment for work with the MV3000e Controller are:

(a) a torque screwdriver or torque wrench for M5 size;

(b) a PZ screwdriver for M3 and M4 Pozidrive screws.

8.2.3 For Packing a MV LCD Module or a MV3000e Controller

Appropriate tools, equipment and materials are required for the preparation of a MV LCD Module and/or a MV3000e Controller for transportation including:

(a) tools and equipment for the MV LCD Module, to:

(1) lift the module;

(2) wrap the module in a protective layer of paper packing/wrapping;

(3) seal the module in an anti static bag;

(4) evacuate the air from the bag prior to final sealing;

(5) weigh the module;

(6) seal and label the packing crate.

(b) tools and equipment for the MV3000e Controller, to:

(1) seal the module in an anti static bag;

(2) evacuate the air from the bag prior to final sealing;

(3) weigh the controller;

(4) seal and label the packing box.

(c) packing materials for the MV LCD Module including:

(1) a waterproof anti static bag size 1500 mm long x 730 mm wide x 840 mm high (≈ 60 in x 29 in x 33 in);

(2) 300 g (≈ 11 oz) of desiccant for moisture protection inside the bag;

(3) a supply of paper packing/wrapping suitable for the protection of a module during transit and for wrapping the packing crate;

(4) a tri-wall packing case, with wooden pallet, of internal dimensions 1370 mm wide x 600 mm deep x 350 mm high (≈ 54 in x 23.5 in x 14 in) which is capable of withstanding the conditions of transportation.

(d) packing materials for the MV3000e Controller including:

(1) a gusseted waterproof anti static bag size 508 mm long x 610 mm wide (≈ 20 in x 24 in) for the controller;

(2) 10 g (≈ 0.5 oz) of desiccant for moisture protection inside the bag;

(3) suitable polystyrene materials for retaining the controller in position in a packing box;

(4) a suitable packing box of internal dimensions 604 mm wide x 318 mm deep x 168 mm high (≈ 24 in x 13 in x 7 in) which is capable of withstanding the conditions of transportation.

8.3 Disconnection of Electrical Supplies from a MV LCD Module

WARNINGS

- **Energy Discharge**

  Wait at least 5 minutes after isolating supplies and check that voltage between DC+ and DC- has reduced to a safe level before working on this equipment.

- **Multiple Circuits**

  This equipment may be connected to more than one live circuit. Disconnect all supplies before working on the equipment.

- **High Leakage Current**

  This equipment and the driven motor(s) must be earthed (grounded).

- **High Temperatures**

  Surfaces on the following items can reach high temperatures:

  - **reactors and transformers**
  - **cables**
  - **coolant pipes and couplings.**

8.3.1 Preliminary Checks

Before commencing any work on a MV LCD module check that:

(a) above WARNINGS have been followed;

(b) all electrical power is switched off to the cubicle/enclosure housing the module and any interlocked circuits from other sources which feed into that cubicle/enclosure - wait at least 5 minutes after isolating supplies;

(c) the cooling system has been switched off i.e. no coolant is flowing;

(d) instructions for the safe handling, use, storage and disposal of the coolant, supplied by the manufacturer, have been read and followed;

(e) a suitably rated crane is available - see Section 5 - MECHANICAL INSTALLATION;

(f) two people are available for use of the crane and handling of the module.

8.3.2 Recommended Procedure for Disconnection of Wiring from a Module

Remove all electrical wiring from either a rectifier module or a transistor module in the following sequence:

(a) remove the terminal shrouds;

(b) disconnect all power cables, a.c. and d.c., noting their connection positions;

(c) disconnect all control wiring from terminal boards and/or ribbon connections;

(d) if disconnection is from a transistor module remove the SMPS - see 8.12.

8.4 Removal of a MV LCD Module from a Cubicle

WARNING

Heavy Weights

Items marked with weights greater than 20 kg should only be moved with lifting apparatus.

CAUTION

The modules are delicate and vulnerable to damage - handle carefully.
Only lift or move them by use of the lifting point.
Lay them down on the plain left-hand face when not fitted in a frame.
Do not leave modules unsupported in the upright position.

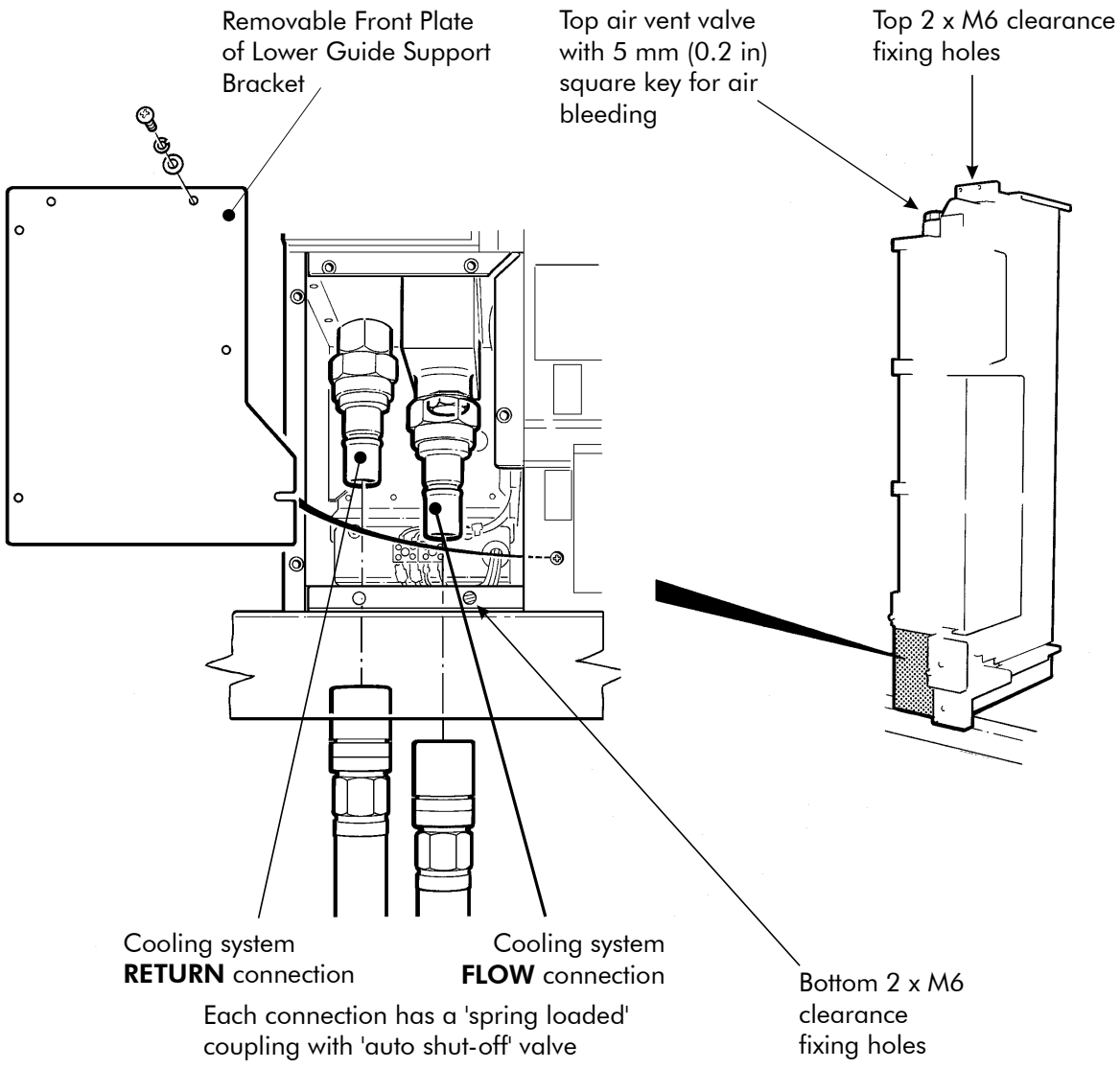


Figure 8-1 MV LCD Module Showing Positions of Piping, Couplings and Valves

The removal of a MV LCD module from a cubicle requires use of the crane and the presence of two people. Note that, under normal circumstances, the time involved for carrying out preliminary checks and disconnecting wiring will normally be sufficient for the cooling pipes and connectors to have cooled down from the high temperature prevailing during normal operation. However, it is recommended that the cooling hoses be disconnected with care. As a precaution gloves should be worn when handling these couplings. Proceed to remove the module from a cubicle in the following sequence:

(a) refer to Figure 8-1, release the Removable Front Plate and remove it from the front of the module - note that one fixing screw is accessed through a hole in the insulation for the transistor module;

(b) refer to Figure 8-1, disconnect the FLOW cooling system flexible hose from the module by releasing the 'spring loaded' couplings - carefully pour the coolant out of the coupling, approximately 20 ml (≈ 0.7 fl oz), into a small container ensuring that it does not spill onto any electronic equipment;

(c) refer to Figure 8-1, disconnect the RETURN cooling system flexible hose from the module by releasing the 'spring loaded' couplings - carefully pour the coolant out of the coupling, approximately 20 ml (≈ 0.7 fl oz), into a small container ensuring that it does not spill onto any electronic equipment;

(d) release the module from its frame by undoing the four M6 Pozi-head fixing screws, spring and plain washers - two sets at the top and two at the bottom;

(e) withdraw the module until it reaches the STOP SCREW and then attach the crane shackle to the lifting hole in the top of the module (see Figures 5-4 and 5-5);

(f) take up the weight of the module on the crane and carefully withdraw the module from its frame, over the STOP SCREW (at the bottom right-hand guide);

(g) with the crane taking the weight of the module, completely withdraw the module from its frame;

(h) with the module hanging on the crane and steadied in its vertical position by one person, drain the coolant out of the module into a suitable large container (e.g. a bucket) - drain by attaching the spare hose to the 'spring loaded' coupling for the FLOW hose on the module and then attaching it to the RETURN coupling to drain both sides of the module;

(i) when all the coolant has been drained from the module remove the spare hose and coupling and move the module into a safe position with its left hand side (when viewed from the front) laid on a flat surface;

(j) check the drained coolant for any solid particles and remove them, by filtration if necessary;

(k) retain the cleaned coolant for subsequent return to the cooling system for use when a new module is fitted;

(l) take the 'end caps' out of store and fit them to all couplings.

8.5 Transporting a MV LCD Module

CAUTIONS

- **DO NOT TRANSPORT the module at any time with the coolant inside it - there is a risk of damage due to differential expansion.**
- **DO NOT FLUSH the module after it has been drained - there is a risk of damage due to corrosion from the use of ordinary water.**

8.5.1 Preparation of the MV LCD Module for Shipping

If it becomes necessary for a MV LCD module (transistor or rectifier bridge) to be taken out of service and transported to an Converteam factory or service centre it is most important that the module is prepared for shipping in the following way with strict adherence to the above cautions:

(a) remove the module from the cubicle as described at 8.4;

(b) check that the module has been drained;

(c) check that the air vent valve is sealed;

(d) check that the 'end caps' have been fitted to all couplings;

(e) prepare for shipping.

8.5.2 Packing a MV LCD Module for Shipping

When packing a MV LCD Module for shipping it is preferable to use the original packing material. However, if that packing material is not available, the module should be packed as now generally described. The instructions which follow apply to use of original packing material or new material. Proceed as follows:

(a) obtain a suitable packing crate of internal dimensions 965 mm wide x 710 mm deep x 300 mm high (≈ 38 in x 28 in x 12 in);

(b) obtain suitable materials, namely a sheet of polystyrene for the base of the crate, an anti static bag size 1030 mm long x 730 mm wide x 840 mm high (≈ 41 in x 29 in x 31 in) to accommodate a module, 300 g (≈ 11 oz) of desiccant for moisture protection inside the bag, a supply of paper packing/ wrapping to protect the module prior to it being placed in the bag and for packing the sealed module when it is in the packing crate;

(c) obtain the appropriate tools and equipment to lift the module and pack it, namely equipment to wrap a paper packing/wrapping around the module, equipment to evacuate the air from the bag prior to final sealing, equipment to seal the bag, weighing equipment and tools to seal and label the packing crate;

(d) pack the module in the following sequence ensuring that no static materials come into contact with the module:

- obtain all materials, tools and equipment for the task;
- prepare a packing crate with a sheet of polystyrene in its base;
- carefully wrap the module in paper packing to protect all sharp edges and protruding items - remove terminal shroud and pack loose;
- place an anti static bag in the bottom of the packing crate;
- lower the wrapped module into the anti static bag and add 300 g (≈ 11 oz) of desiccant to the bag;
- partially seal the bag and then evacuate the air from the bag before finally sealing it;
- pack around the bag to ensure no movement of the module during transportation;
- secure the top of the packing crate;
- label the crate with address details and all the warnings for transit including weight, this way up, protect against water, stacking limitations, temperature limitations and identification of lifting points.

8.6 Fitting a MV LCD Module into a Mounting Frame in a Cubicle

WARNINGS

- **Exposed High Voltages**

  Enclose all items exposing high voltage before the equipment is energised.

- **High Leakage Current**

  This equipment and the driven motors(s) must be earthed (grounded).

The fitting of a MV LCD module into a cubicle requires use of a crane and the presence of two people. The procedure now described is based on the fitting of a module to a cubicle which already has an external cooling system in use; no instructions are included for the filling of a cooling system at this stage. If such instructions are required refer to Section 7 - COMMISSIONING for full details.

Proceed to fit the module into a cubicle in the following sequence:

(a) lift the module into its cubicle frame with the crane and using the detailed guidance at Section 5 - MECHANICAL INSTALLATION;

(b) secure the module into position with the four M6 Pozi-head fixing screws, spring and plain washers - two sets at the top and two at the bottom of the module;

(c) remove the crane from the module;

(d) if a transistor module refit the SMPS;

(e) open, but do not remove, the top vent valve on the module;

(f) connect the FLOW cooling system flexible hose to the module with the ‘spring loaded’ coupling after removing its ‘end cap’;

(g) connect the RETURN cooling system flexible hose to the module with the ‘spring loaded’ coupling after removing its ‘end cap’;

(h) allow the top vent valve to bleed air out of the module until the coolant is present - this usually takes about 2 to 3 minutes;

(i) soak up any surplus coolant at the vent valve and ensure that no coolant drops onto the electronic equipment;

(j) return cleaned coolant (from 8.4 (k)) to the cooling system;

(k) the module is now ready for all the electrical wiring to be replaced for the electronic units and the power cables (see 8.7 and/or 8.8);

(l) the module is now ready for the cooling system to be run;

(m) check that the cooling system is running correctly;

(n) the module is now ready for all the electrical power to be restored to the equipment and the drive tested for normal operation as described in the MV3000e Getting Started Manual T1676;

(o) safely store all the ‘end caps’ from the couplings for later use.

8.7 Re-connection of a MV LCD Rectifier Module

When the MV LCD rectifier module has been secured in the cubicle the electrical wiring should be re-connected. The re-connection procedure is a reversal of the disconnection procedure at 8.3.2 with all connections tightened to the torque settings at Appendix B.

8.8 Re-connection of a MV LCD Transistor Module

When the MV LCD module has been secured in the cubicle the electrical wiring should be re-connected as follows, with all connections tightened to the torque settings at Appendix B:

(a) re-connect the d.c. terminals;

(b) re-connect the a.c. power terminals for phases A, B and C;

(c) refit the SMPS assembly;

(d) re-connect the 40 way ribbon cable between the SMPS and connector PL3 at the DELTA Interface Board;

(e) re-connect the cable from the SMPS to TB1 on the module;

(f) re-connect the 40 way ribbon cable from the controller to connector PL1 at the DELTA Interface Board;

(g) re-fit all terminal shrouds;

(h) carry out cable insulation and earth bonding tests as described at Section 7 - COMMISSIONING;

(i) carry out the pre-commissioning checks detailed at Section 7 - COMMISSIONING;

(j) proceed to re-commission the equipment in accordance with the instructions for the particular application.

8.9 Removal of a MV3000e Controller from a Cubicle

A MV3000e Controller should only be removed from a cubicle when the power has been isolated. Removal of the controller does not require any special equipment. Proceed with removal as follows:

(a) disconnect all ribbon cables and other electrical wiring from the controller and ensure that each is labelled for its appropriate controller connection;

(b) remove the controller from the cubicle by releasing the four M5 fixing screws.

8.10 Transporting a MV3000e Controller

If it becomes necessary for a MV 3000C Controller to be taken out of service and transported to an Converteam factory or service centre it is most important that the subsequent instructions are followed.

When packing the controller for shipping it is preferable to use the original packing material. However, if that packing material is not available, the controller should be packed as now generally described. The instructions which follow apply to use of original packing material or new material. Proceed as follows:

(a) obtain a suitable packing box of internal dimensions 604 mm wide x 318 mm deep x 168 mm high (≈ 24 in x 13 in x 7 in) which is capable of withstanding the conditions during transportation;

(b) obtain suitable polystyrene materials for retaining the controller in position in the packing box, a waterproof gusseted anti-static plastic bag size 508 mm long x 610 mm wide (≈ 20 in x 24 in) to accommodate the controller, 10 g (≈ 0.5 oz) of desiccant for moisture protection inside the bag and suitable sealing tapes;

(c) obtain the appropriate tools and equipment to pack the controller, namely equipment to evacuate the air from the bag prior to final sealing, equipment to seal the bag, weighing equipment and tools to seal and label the packing box;

(d) pack the controller in the following sequence ensuring that no static materials come into contact with the controller:

- obtain all materials, tools and equipment for the task;
- attach a 10 g (≈ 0.5 oz) bag of desiccant to the controller and then securely place the controller in the polystyrene retaining pieces;
- place the assembly of controller and retaining pieces into the waterproof anti-static bag and partially seal the bag;
- remove all air from the bag and completely seal it;
- place the bag into a packing box;
- check to ensure that no movement of the controller is likely during transportation and then secure the packing box;
- label the box with address details and all the warnings for transit including weight, this way up, protect against water, stacking limitations and temperature limitations.

8.11 Fitting and Re-connecting a MV3000e Controller in a Cubicle

(a) Refer to 5.10 for the mounting details of a MV3000e Controller.

(b) Re-connect all the cables and electrical wiring.

8.12 Removal of a SMPS from a MV LCD Transistor Module

These instructions for the removal of a SMPS assume that the MV LCD Transistor Module is housed in a mounting frame within an enclosure. Proceed as follows:

(a) ensure that cables connected to the SMPS, from TB1 on the module and PL3 on the MV DELTA Interface Board, have been disconnected from the SMPS;

(b) partially release the two M5 pozi-head fixing screws (with captive single coil spring washer) which hold the SMPS onto the front of the module;

(c) remove the SMPS by lifting it from the fixing screws and withdrawing it from the front of the module.

8.13 Fitting a SMPS to a MV LCD Transistor Module

The instructions for fitting a SMPS assume that the MV LCD Module, onto which the SMPS is to be fitted, is housed in a mounting frame within an enclosure.

Refer to 5.13 for instructions on how to fit a SMPS to a module.

8.14 Removal of a User I/O Termination Panel

Refer to Figure 5-10 and proceed to remove a User I/O Termination Panel as follows:

(a) remove the terminal shroud;

(b) disconnect all wiring from the terminal blocks, keeping a record of all wiring positions at each terminal block;

(c) disconnect the 50 way controller ribbon cable from PL2;

(d) record the positions of the configurable DIL switches at the top of the printed circuit board;

(e) release the two M5 pozi headed fixing screws and withdraw the panel.

8.15 Fitting a User I/O Termination Panel

The procedure for fitting a User I/O Termination Panel is a reversal of the removal procedure. Ensure that the configurable DIL switches are set to the same positions as those on the panel which has been removed.

8.16 Handling, Storage and Disposal of Coolant

8.16.1 Handling of Coolant

The coolant is subject to particular conditions during handling and these instructions are normally included with the coolant. Refer to the manufacturer's instructions for advice about a particular coolant. It is recommended that the instructions be retained with this manual. However general first aid advice, if a coolant should come into contact with the body, is as follows:

(a) For Contact with the skin

- wash thoroughly with plenty of water; use soap if available;
- remove contaminated clothing;
- if irritation persists get medical attention.

(b) Contact with the eyes

- rinse immediately with plenty of running water until irritation subsides - this may take up to 15 minutes;
- if irritation persists get medical attention.

(c) Contact by inhalation

- remove to fresh air;
- if effects persists, seek medical advice;
- in emergency situations:

  - use proper respiratory protection to immediately remove the affected victim from exposure;
  - administer artificial respiration if breathing has stopped;
  - keep at rest;
  - call for prompt medical attention.

(d) Contact by ingestion

- rinse mouth with water;
- if conscious, give water to drink and transport to hospital.

8.16.2 Storage of Coolant

The coolant should be stored in suitable containers in an indoor location. The freezing point of the undiluted ethylene glycol is -12^{o}C (10.4 ^{o}F).

CAUTION

Always store the undiluted coolant at a temperature above its freezing point to avoid impairment of its cooling and corrosion inhibiting properties.

8.16.3 Disposal of Coolant

The coolant, and its container, should be disposed of in accordance with the manufacturer's instructions for compliance with local and national Health and Safety and Environmental legislation. Such disposal will normally be done by approved waste contractors. The method of emptying the cooling system is detailed at 8.4.

8.17 Preventive Maintenance

There are simple preventive maintenance routines which should be carried out to ensure operating efficiency for the equipment and these are now described.

8.17.1 Monthly Checks - With the Power Off

The following checks should be carried out monthly, with the power off:

(a) ensure that all ventilation louvres to the cubicle are unobstructed;

(b) examine the input and output power terminations for any signs of overheating.

8.17.2 Six Monthly Checks - With the Power Off

The following checks should be carried out every six months, with the power off:

(a) carry out the monthly checks detailed at 8.17.1;

(b) check that all terminations are secure;

(c) remove any accumulated dust from the equipment, using a suction type cleaner with a non-conducting nozzle.

8.17.3 Periodic Checks of the Cooling System - With the Power Off

At a period determined by the application and environmental conditions under which the equipment is operating carry out the following checks, with the power off:

(a) check all pipes and connections in the cooling system for any loss of coolant;

(b) if there has been any loss of coolant top up the system with a coolant of the same type and concentration - it is recommended that a supply of coolant is retained for 'top up' purposes when the original mixture of coolant is prepared (see 7.5.2);

(c) carry out a periodic check of coolant concentration and compare this with the originally specified concentration - correct any variation.

8.17.4 Renewal of Coolant - With the Power Off

The coolant should be renewed each year as follows, with the power off:

(a) empty the coolant from the cooling system and dispose of it in accordance with the coolant manufacturer's instructions;

(b) if a strainer is fitted in the cooling system remove it, clean it and replace it in position - record the details;

(c) flush out the cooling system with a de-mineralised water;

(d) renew the coolant immediately after the cooling system has been flushed out and record details of the following items (see typical record sheet at Figure 8-4):

- date coolant renewed;
- coolant type;

- water type;
- concentration;
- volume of mixture in cooling system;
- type of flushing agent used;
- details of any samples which are sent for analysis.

8.17.5 Cleaning of a Strainer

If a strainer is fitted in the cooling system it should be regularly cleaned. The most convenient time to clean it is when the cooling system is down for renewal of the coolant as described at 8.17.4.

However, if problems occur during normal operation, because of the strainer becoming blocked, then it should be cleaned more frequently and the cleaning period adjusted accordingly.

Records should be retained of all the cleaning dates.

8.18 Diagnostics at the MV3000e Controller

The MV3000e Controller provides diagnostic information which can be accessed by use of the optional Drive Data Manager™ (Keypad). The drive conditions for which diagnostic information is available are:

(a) drive status;

(b) fault condition;

(c) warning of a problem;

(d) trips.

The MV3000e Controller includes a set of LEDs (Light Emitting Diodes) to provide the information in (a) to (d). The LED functions are shown at Figure 8-2. All of the diagnostic information, and some of the helpful hints for fault diagnosis, are detailed in the MV3000e Getting Started Manual T1676.

Figure 8-2 Functions of LEDs for MV3000e Controller for DELTA Modules

8.19 Diagnostics at the MV LCD Transistor Module

The transistor module includes two sets of LEDs to provide an indication of correct operation for the DELTA Interface Board (the DIB - 20X4319) and the Fan Monitoring Board (20X4338). The functions of these sets of LEDs are shown at Figure 8-3.

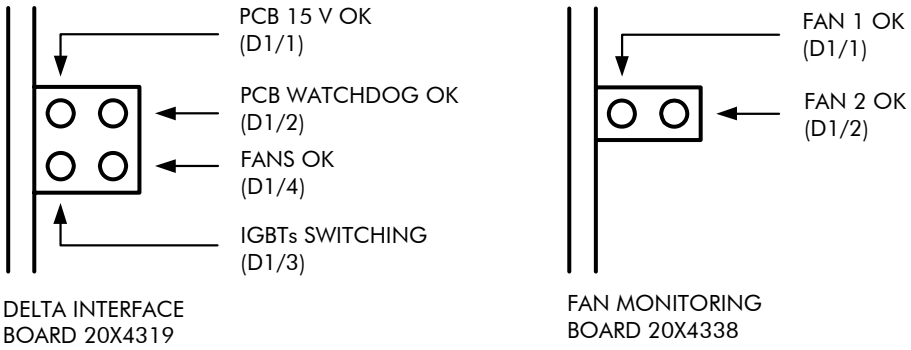


Figure 8-3 Functions of LEDs for DELTA Interface and Fan Monitoring Boards

8.20 Spares and Servicing

8.20.1 Spares

There are no recommended spares for the MV LCD modules or the MV3000e Controller except for the pre-charge protection fuses for the rectifier module which are detailed at 8.20.3. If either a module or a controller is suspected of being faulty it should be referred to Converteam for servicing.

8.20.2 Servicing

Before removing a module for return to Converteam for servicing a user should ensure that the facilities, the skills and the appropriate lifting equipment are available to replace the module - detailed instructions are included at 8.2 to 8.8.

When any equipment is being returned for servicing it is important that all the details available about the conditions under which the equipment failed are conveyed, preferably in writing, with the returned equipment.

When referring to Converteam about any modules and/or controller the serial number for the suspect item must always be quoted. Any references to replacement ribbon cables should quote the part number from the original ribbon/connector.

8.20.3 Pre-charge Fuses

The recommended pre-charge protection fuse for the MVRL2100-4601 rectifier module is Bussmann type KTK-8 rated at 8 A and 600 V (cartridge size 10 x 38 mm) – Converteam reference S82028/310. Replacing these fuses with another rating or type will invalidate safety approvals.

Three pre-charge fuses are located on the upper printed circuit board which is located at the rear of the rectifier module.

8.21 Capacitor Reforming

If this equipment is kept in store for long periods of time, usually greater than two years, it may be necessary to reform capacitors before putting the equipment of which they are a part into service. This requirement applies to the d.c. link capacitors on the MV LCD module. Consult Converteam or one of its agents for details.

COOLANT RENEWAL RECORDS

DATE RENEWED	COOLANT TYPE	WATER TYPE*	CONCEN-TRATION (%)	VOLUME OF MIXTURE IN LITRES	FLUSHING AGENT	SAMPLE ANALYSIS		REMARKS
						Volume	Date sent for test	

Note: * : The water may be de-mineralised, de-ionised or distilled and this should be recorded.

Figure 8-4 Typical Form for Coolant Renewal Records

Note: This page may be photocopied.

9. Disposal

This equipment or any part of the equipment should be disposed of in accordance with the laws of the country of use.

Modern high technology materials have been used in the manufacture of the equipment to ensure optimum performance. Care has been taken with the selection of these materials to minimise risks to health and safety. However, some materials require special consideration during disposal.

In common with all products of this type, the high voltage electrolytic capacitors contain an electrolyte which must be disposed of as hazardous waste. The electrolytes are solutions of organic and/or boric acid. The major solvents in the capacitors are butyrolactone and ethylene glycol. The electrolyte is non-carcinogenic, but may cause irritation to the skin if contact is prolonged.

Liquid coolant is subject to special considerations during handling, storage and disposal. Refer to the manufacturer's instructions.

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Appendix A MV LCD Connection Diagrams

A.1 Scope

This document shows the standard connections for a.c. input ALSPA MV Liquid Cooled DELTA (MV LCD) modular drives (current ratings of 643 A and larger). These modular drives are constructed using the ALSPA MV LCD modules and range from the connection of a single Transistor Bridge Module and a Rectifier Bridge Module, to multiple modules connected in parallel.

This document is based on the installer having the complete parts and circuit element lists for the drive to be installed. Ensure that ALL parts required are listed before start of installation.

The mechanical and electrical installation of MV LCD modules, the related MV3000e controller and User I/O Termination Panel are shown in this manual at Sections 5 and 6.

A.2 Introduction

Each drive circuit diagram is built from a series of circuit elements. This document contains a variety of these circuit elements for a range of different drive configurations. (Using circuit elements allows the large number of standard, different drive configurations to be shown in one document).

These configurations for MV3000e systems allow different :

(a) main supply inputs, including:

(1) type of supply: 6 pulse or 12 pulse (for harmonic reduction) including:

(i) isolated secondary supply transformer;

(2) supply voltage: 525 - 690 V;

(b) drive current ratings:

(1) 643 A and above;

(2) 1.1 x and 1.5 x overload current ratings for the Transistor Bridge Module and, at present time, 1.1 x overload current rating for the Rectifier Bridge Module;

(3) 1 - 6 Machine Transistor Bridge Modules;

(4) 1 - 2 Network Rectifier Bridge Modules.

The complete drive circuit diagram is a set of 6 separate circuit elements. These elements are in the form of a letter followed by a number. The letter defines the circuit element type. The number shows the circuit element configuration, e.g:

‘J1’ shows a ‘Network Bridge (Power), 6 Pulse Supply Input, 1 (single) Rectifier.

Table A-1 details all the circuit element types used with the ALSPA MV LCD range of modules and controller. All of the circuits for each element type are included at A.3.

One circuit element out of each of all 6 sections must be used to generate a complete drive. Figure A-1 shows the outline of a complete drive diagram, using MV LCD modules.

Table A-1 Circuit Element Types for the MV LCD range of modules

Element Type	Description	Circuit Reference
D	Machine Bridge (Control)	MVD1 to MVD6
E	User Termination Panel	MVE4
G	Machine Bridge (Power)	MVG1 to MVG6
H	Liquid Cooling Circuit	H
I	Network Bridge (Control)	MVI1 to MVI2
J	Network Bridge (Power)	MVJ1 to MVJ4

The selection of particular circuit elements depends on the drive configuration. This information may be supplied with the parts list for the drive, or may be derived from the information supplied with each section of this document.

WARNING

Earthing

Connect this equipment to earth (ground) using the earth terminal provided. The minimum size of the protective conductor must be in accordance with local safety regulations.

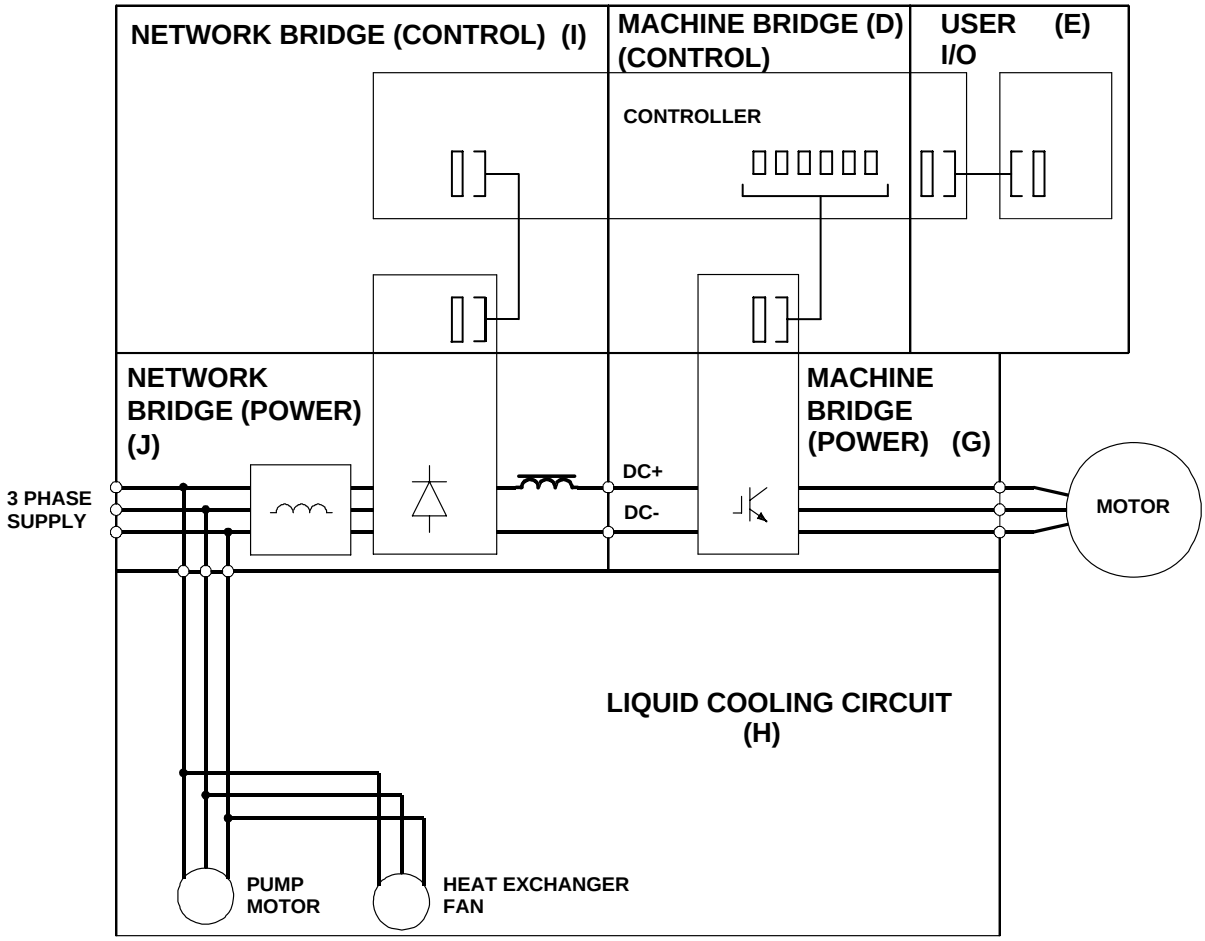


Figure A-1 MV LCD Drive Circuit Diagram

A.3 List of Circuit Element Diagrams for MV Liquid Cooled DELTA

A.3.1 Circuit 'MVD' Machine Bridge (Control)

Circuit MVD1	:	Machine Bridge (Control), 1 Transistor Bridge Module
Circuit MVD2	:	Machine Bridge (Control), 2 Transistor Bridge Modules
Circuit MVD3	:	Machine Bridge (Control), 3 Transistor Bridge Modules
Circuit MVD4	:	Machine Bridge (Control), 4 Transistor Bridge Modules
Circuit MVD5	:	Machine Bridge (Control), 5 Transistor Bridge Modules
Circuit MVD6	:	Machine Bridge (Control), 6 Transistor Bridge Modules

A.3.2 Circuit 'MVE' User Termination Panels

Circuit MVE4	:	MV3000e User I/O Termination Panel

A.3.3 Circuit 'MVG' Machine Bridge (Power)

Circuit MVG1	:	Machine Bridge (Power), 1 Transistor Bridge Module
Circuit MVG2	:	Machine Bridge (Power), 2 Transistor Bridge Modules
Circuit MVG3	:	Machine Bridge (Power), 3 Transistor Bridge Modules
Circuit MVG4	:	Machine Bridge (Power), 4 Transistor Bridge Modules
Circuit MVG5	:	Machine Bridge (Power), 5 Transistor Bridge Modules
Circuit MVG6	:	Machine Bridge (Power), 6 Transistor Bridge Modules

A.3.4 Circuit H Liquid-to-air Cooling System

Circuit H Liquid Cooling System, 1 Fan and 1 Pump

A.3.5 Circuit 'MVI' Network Bridge (Control)

Circuit MVI1 (Double),	:	Network Bridge (Control), 1 Network Rectifier Bridge Module
Circuit MVI2	:	Network Bridge (Control), 2 Network Rectifier Bridge Modules (Double),

A.3.6 Circuit 'MVJ' Network Bridge (Power)

Circuit 'MVJ1' Rectifier	:	Network Bridge (Power), 6 Pulse Supply Input, 1 (Double)
Circuit 'MVJ2'	:	Network Bridge (Power), 6 Pulse Supply Input, 2 (Double) Rectifiers
Circuit 'MVJ3'	:	Network Bridge (Power), 12 Pulse (Isolated) Supply Input, 1 (Double) Rectifier
Circuit 'MVJ4'	:	Network Bridge (Power), 12 Pulse (Isolated) Supply Input, 2 (Double) Rectifiers

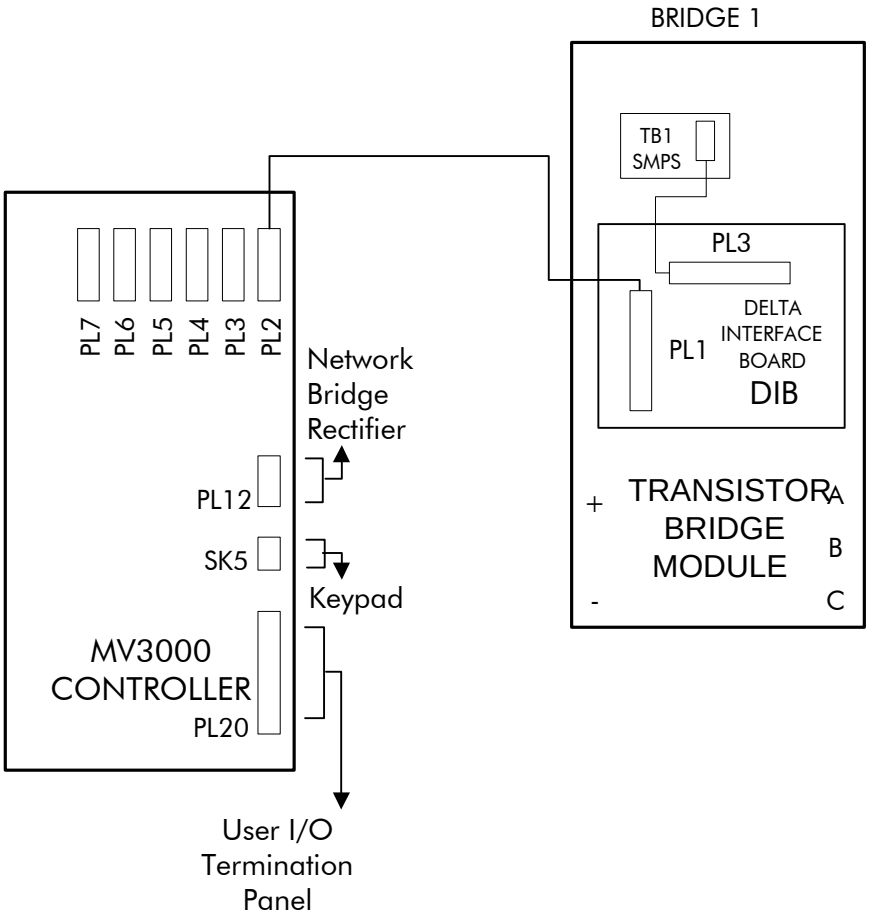
A.4 Machine Bridge (Control)

This section is based on:

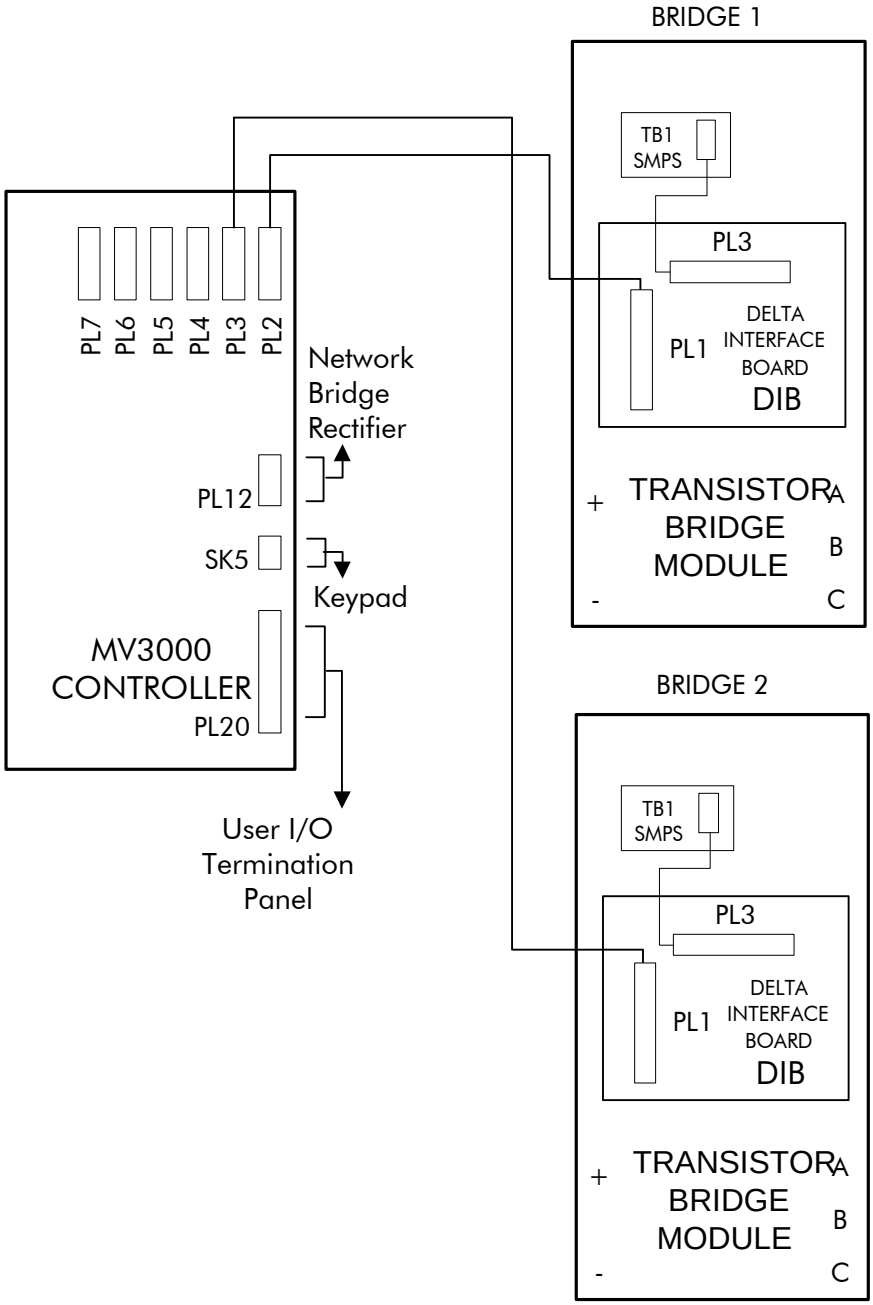
(a) use of MV3000e Controller with one Power Interface Board (PIB);

(b) number of Transistor Bridge Modules - dependent on drive current rating.

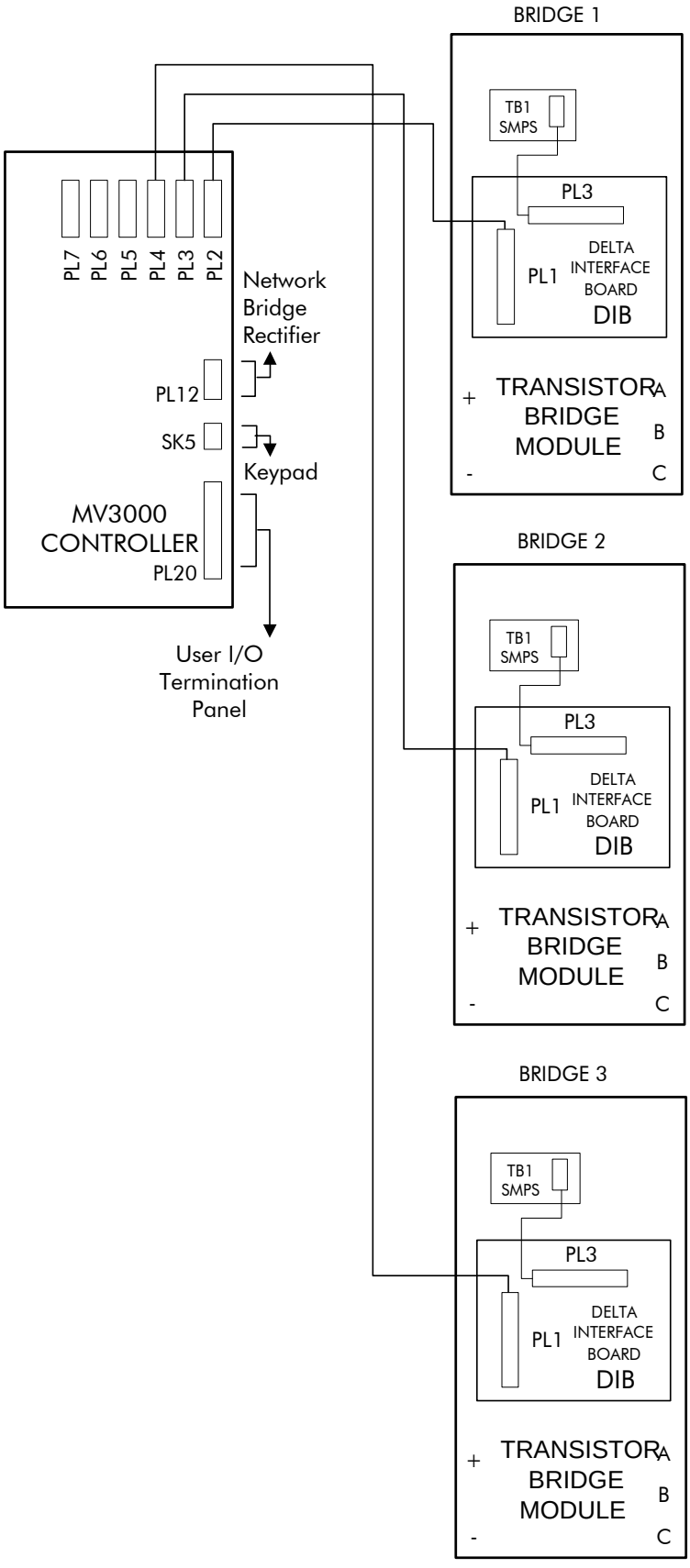
A.4.1 Circuit 'MVD1' Machine Bridge (Control), 1 Transistor Bridge Module



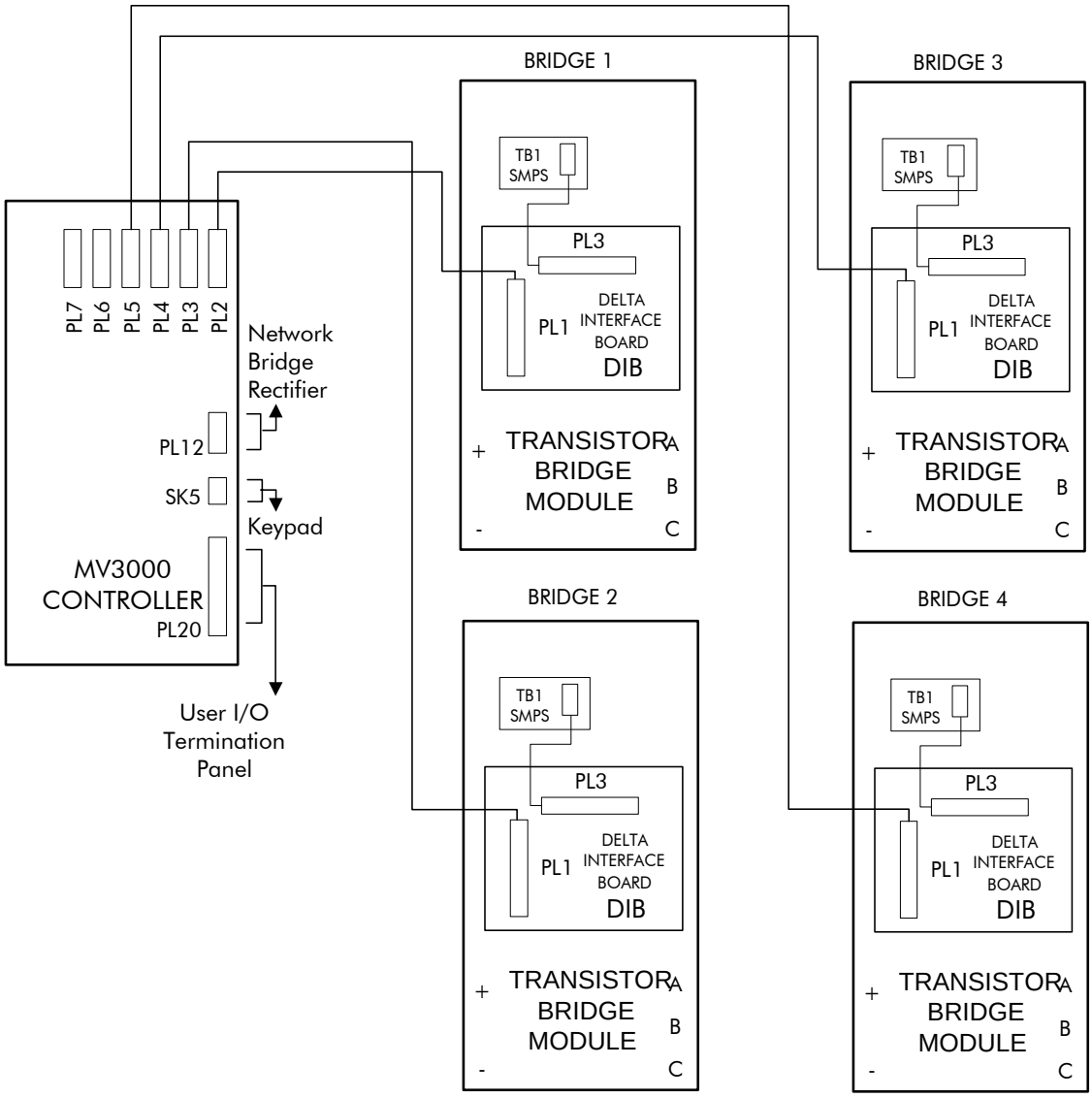
A.4.2 Circuit 'MVD2' Machine Bridge (Control), 2 Transistor Bridge Modules



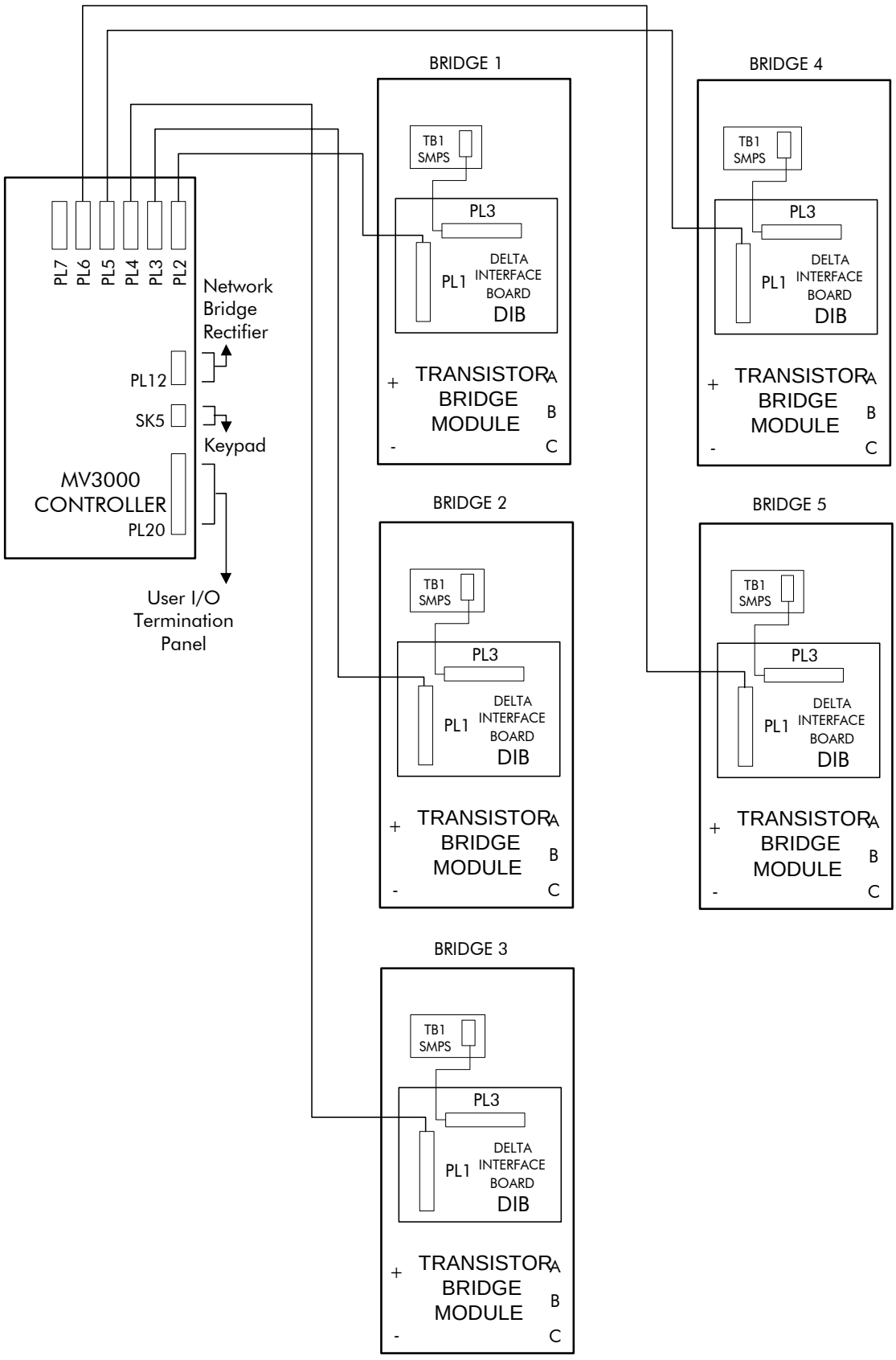
A.4.3 Circuit 'MVD3' Machine Bridge (Control), 3 Transistor Bridge Modules



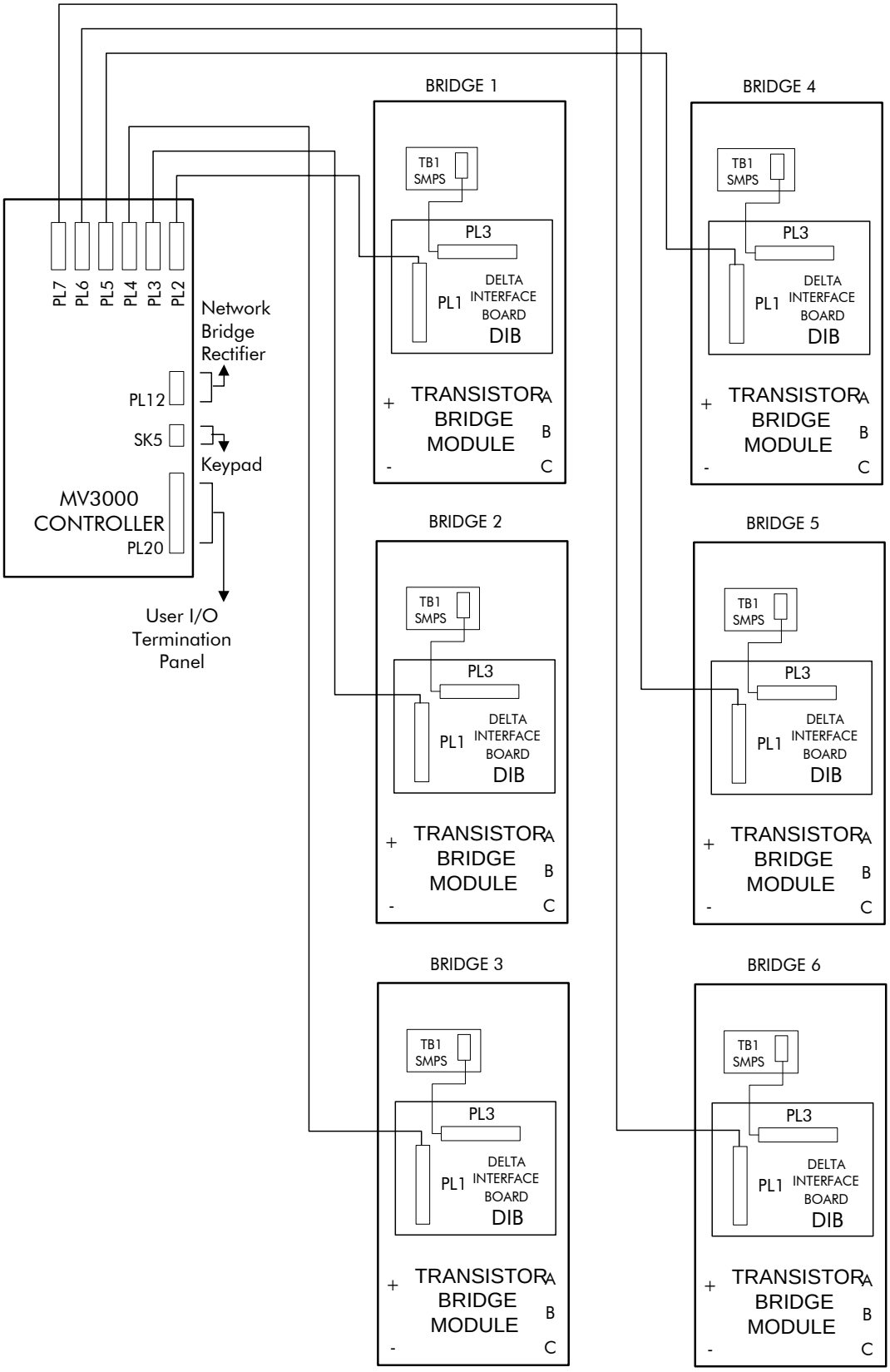
A.4.4 Circuit 'MVD4' Machine Bridge (Control), 4 Transistor Bridge Modules



A.4.5 Circuit 'MVD5' Machine Bridge (Control), 5 Transistor Bridge Modules

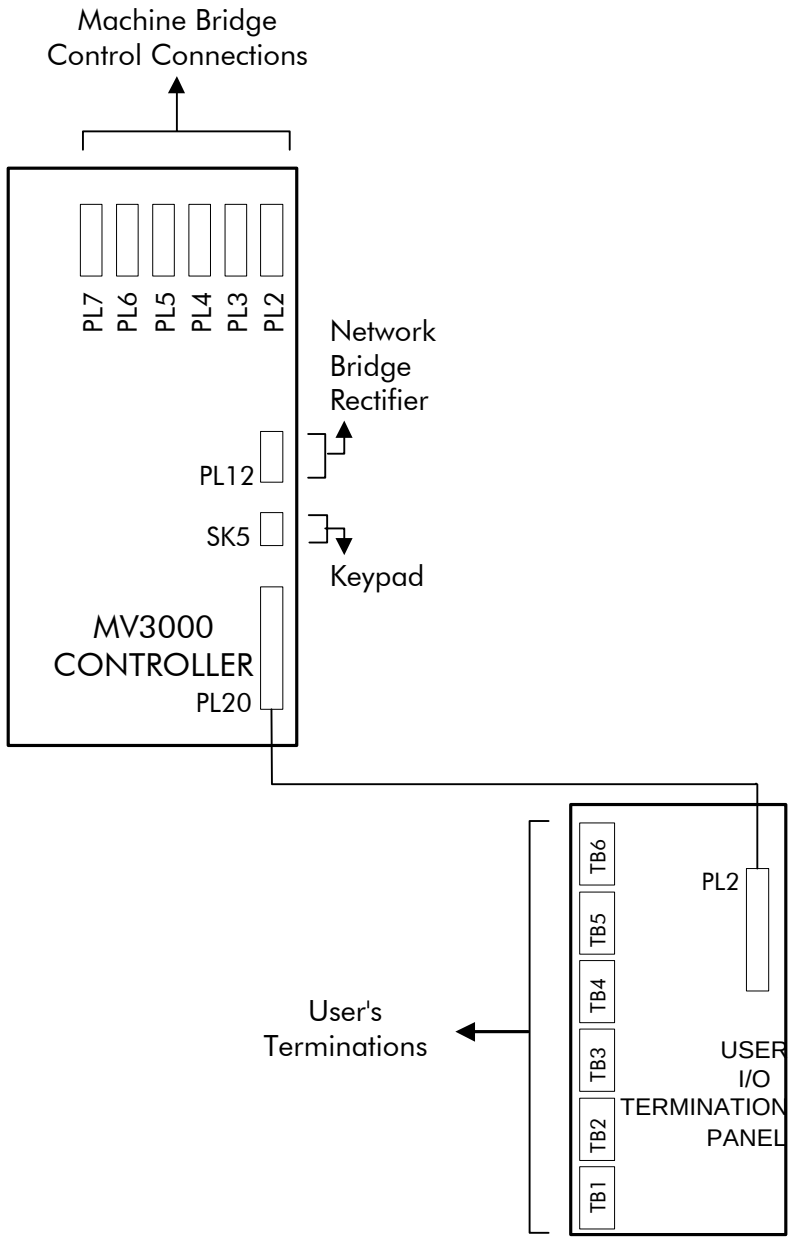


A.4.6 Circuit 'MVD6' Machine Bridge (Control), 6 Transistor Bridge Modules



A.5 User Termination Panels

A.5.1 Circuit 'MVE4' MV3000e User I/O Termination Panel (Control)

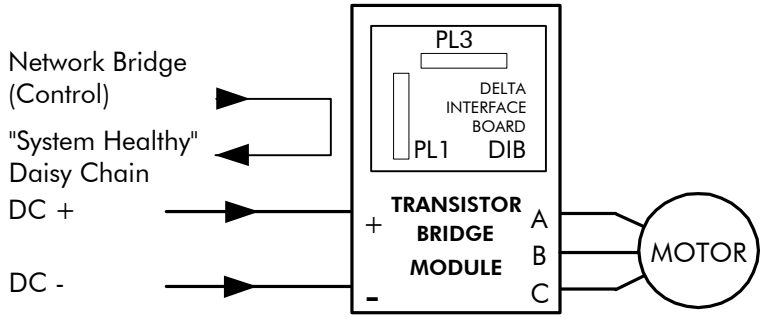


A.6 Machine Bridge (Power)

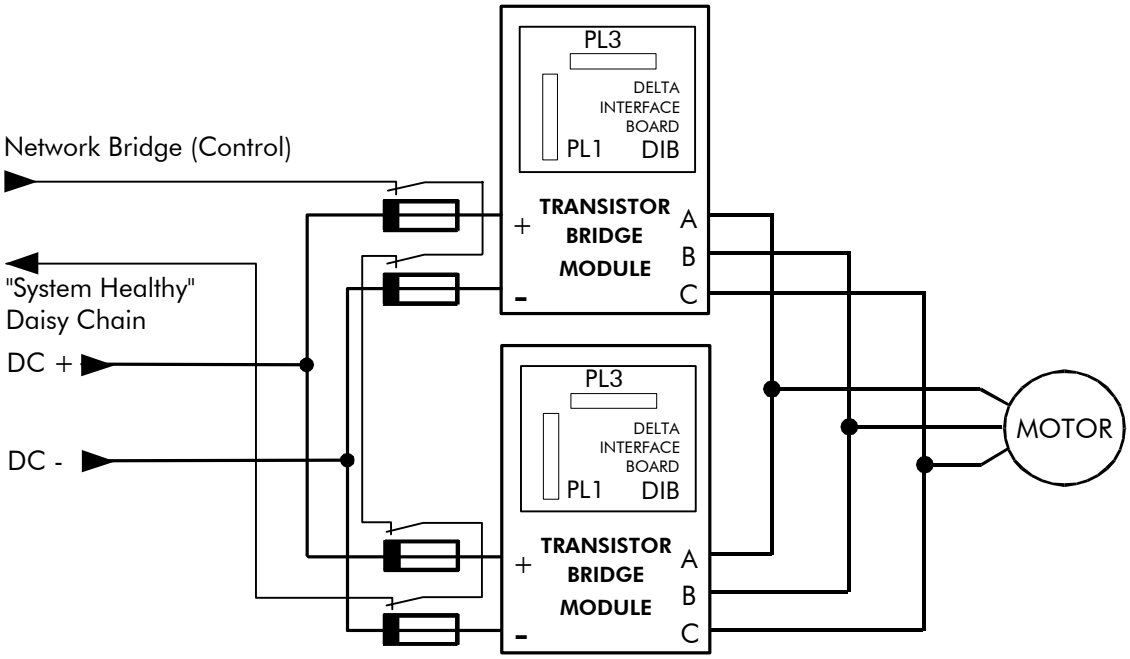
Note: Optional filters are not shown. Refer to Section 2 - SPECIFICATION in this manual for details of these items.

In applications where two or more MV LCD modules are used in parallel (see 'MVG1' to 'MVG6') the connection from the LC DELTA module to the motor must be made by the use of cabling of at least 20 metres in length.

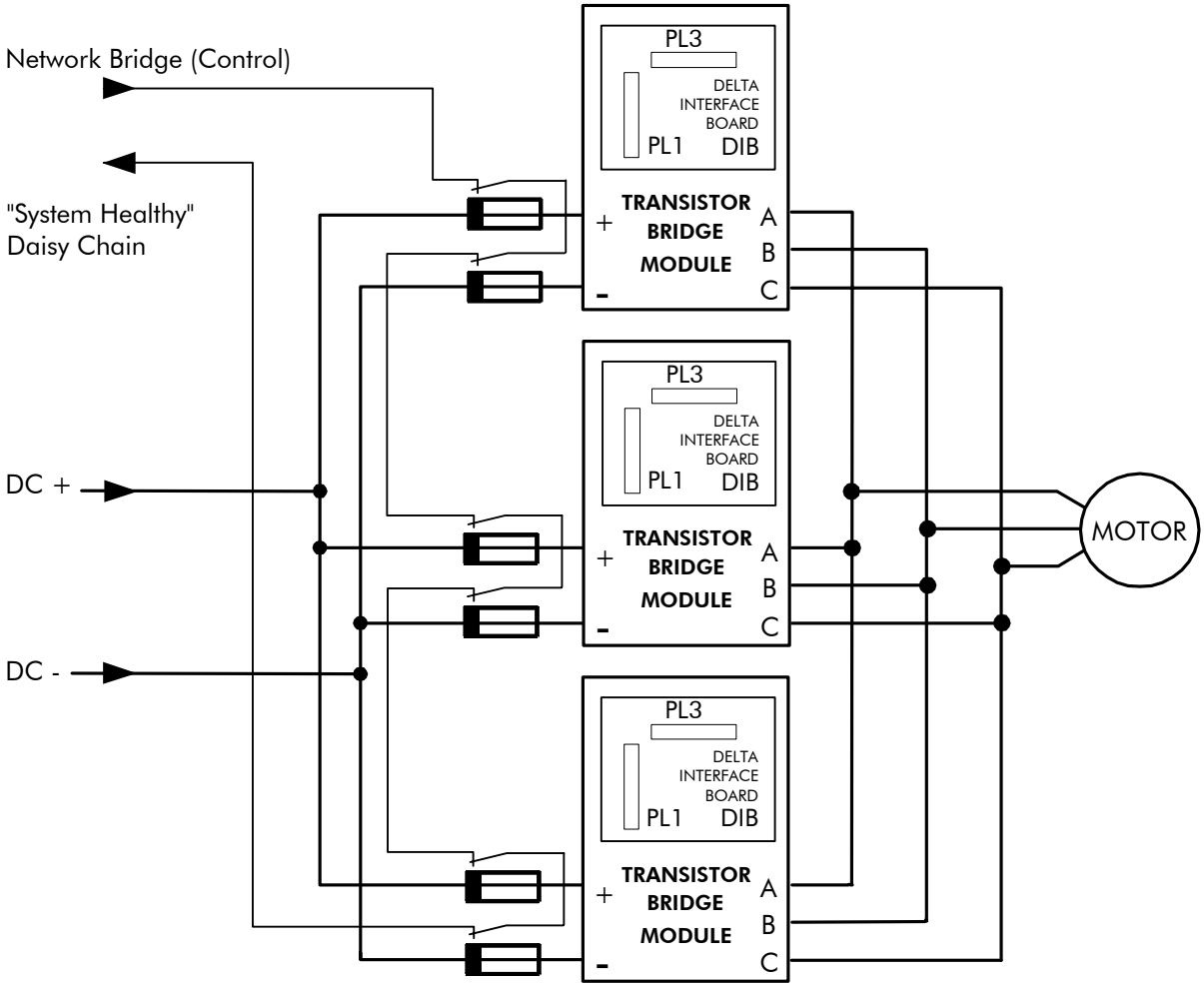
A.6.1 Circuit 'MVG1' Machine Bridge (Power), 1 Transistor Bridge Module



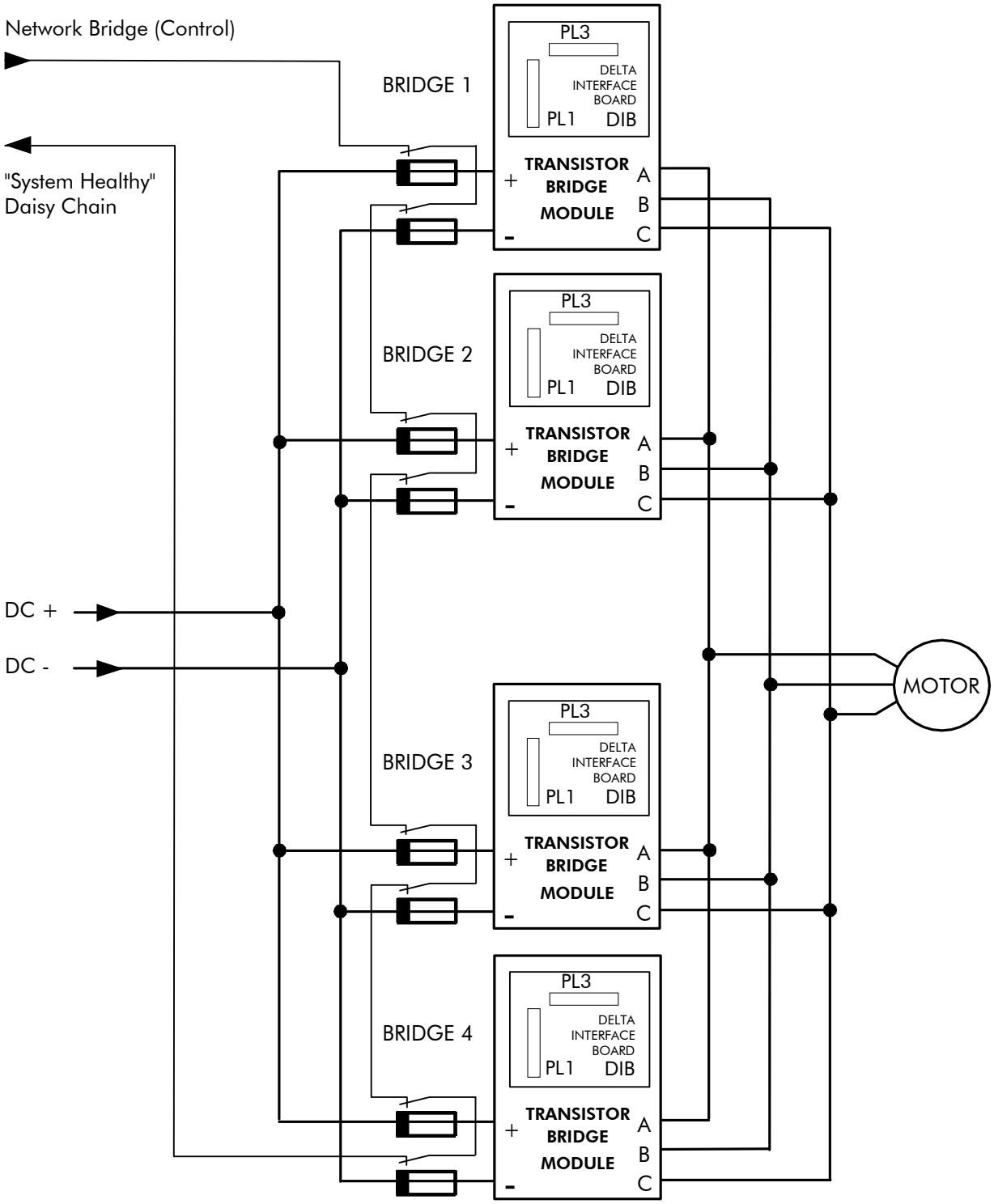
A.6.2 Circuit 'MVG2' Machine Bridge (Power), 2 Transistor Bridge Modules



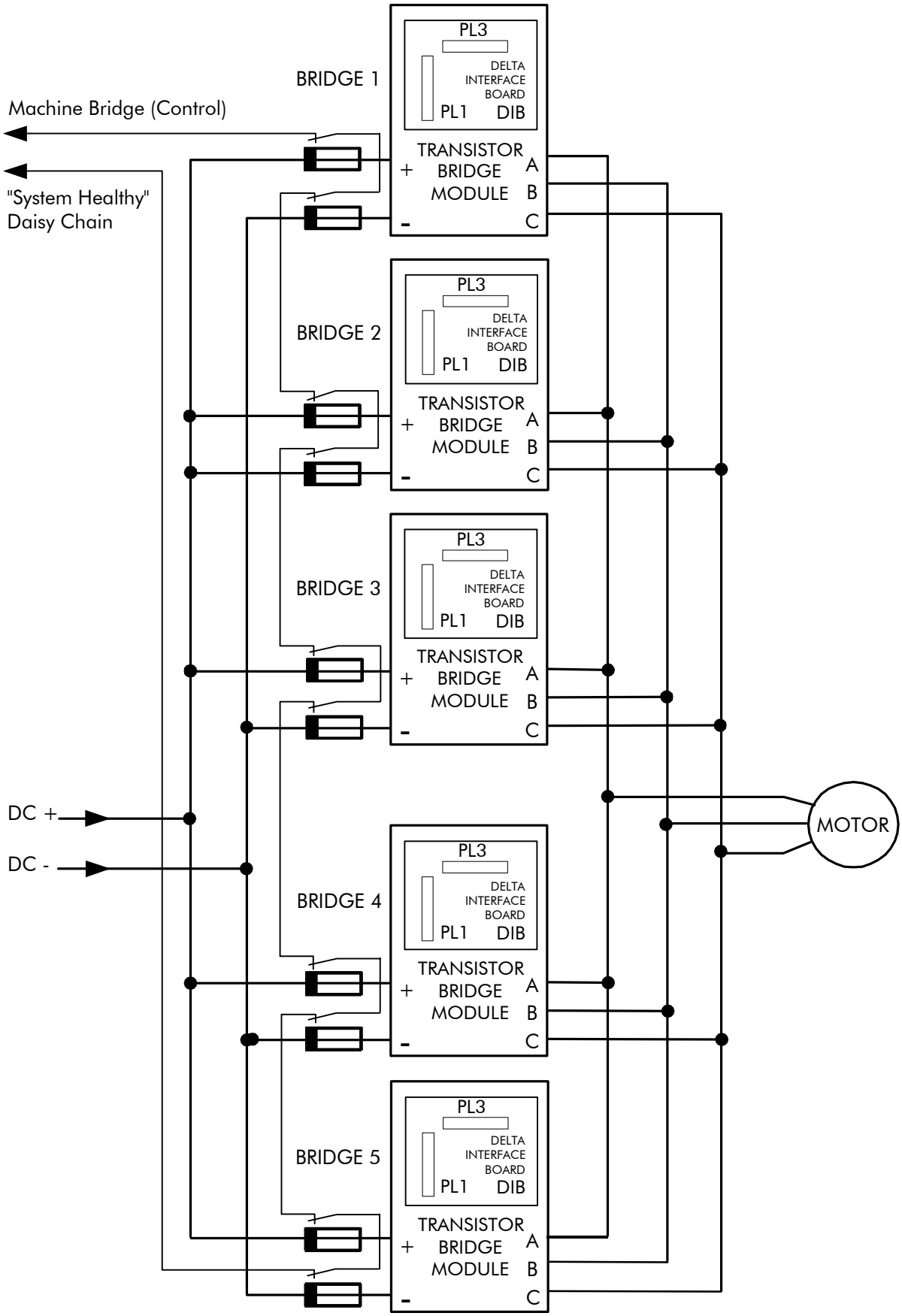
A.6.3 Circuit 'MVG3' Machine Bridge (Power), 3 Transistor Bridge Modules



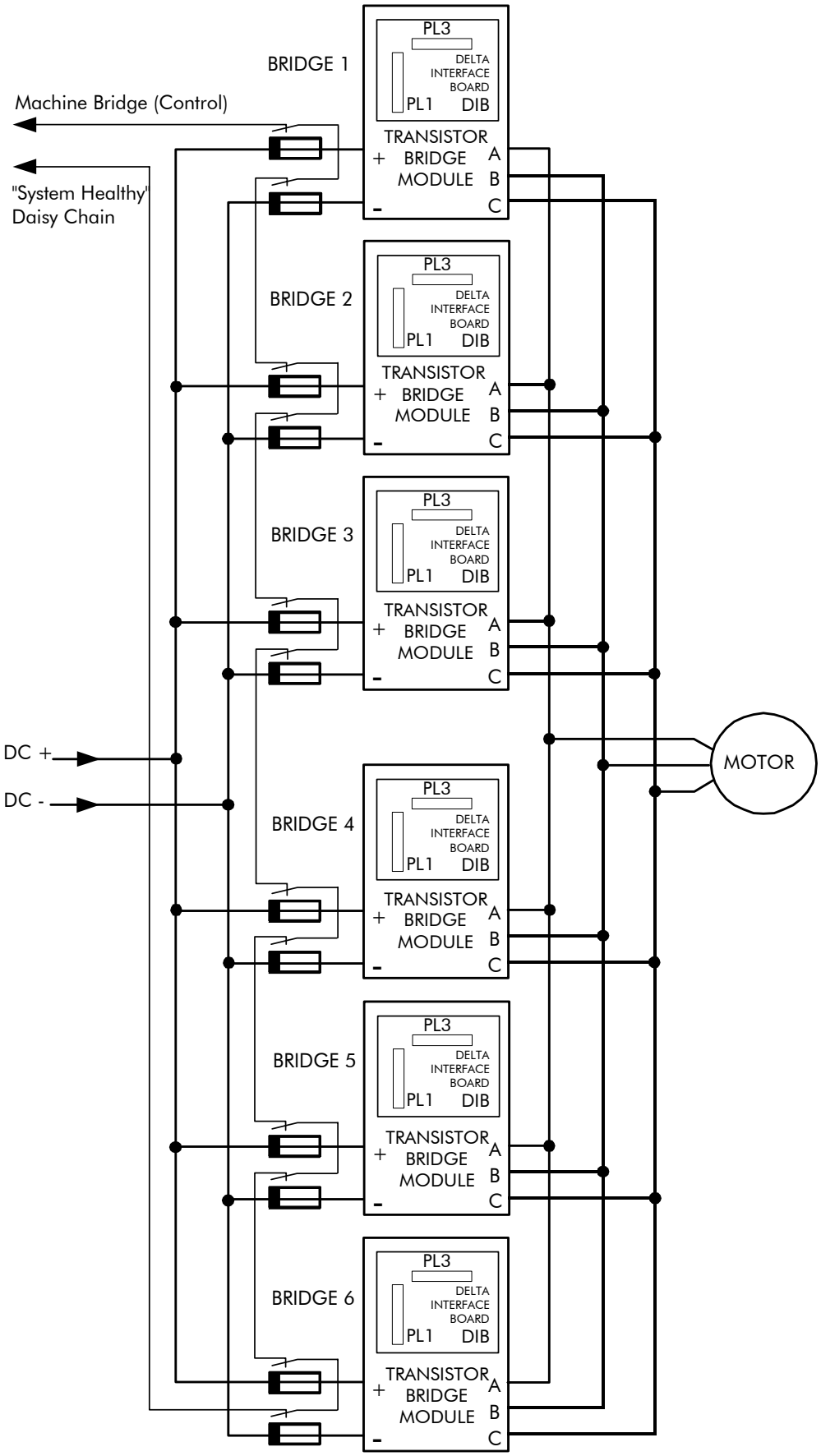
A.6.4 Circuit 'MVG4' Machine Bridge (Power), 4 Transistor Bridge Modules



A.6.5 Circuit 'MVG5' Machine Bridge (Power), 5 Transistor Bridge Modules



A.6.6 Circuit 'MVG6' Machine Bridge (Power), 6 Transistor Bridge Modules



A.7 Liquid-to-air Cooling System

A.7.1 Circuit 'H' Liquid-to-air Cooling System, 1 Fan and 1 Pump

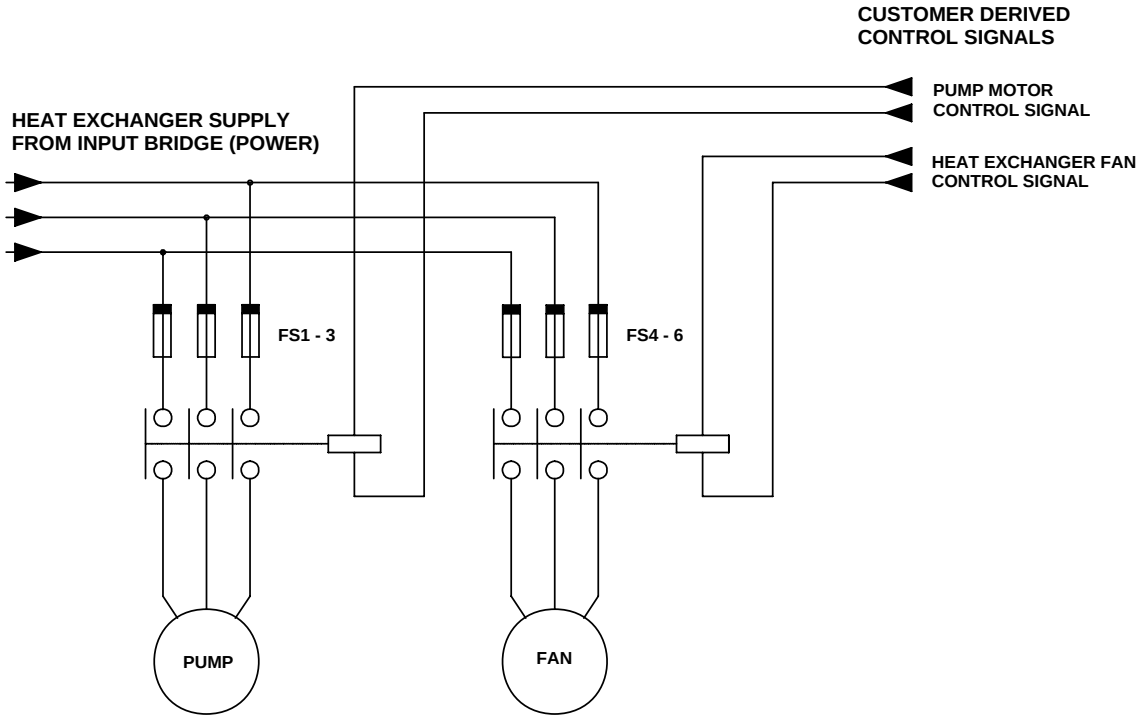
It is recommended that machines used for the Liquid Cooling System include protection against:

(a) over temperature;

(b) loss of pressure;

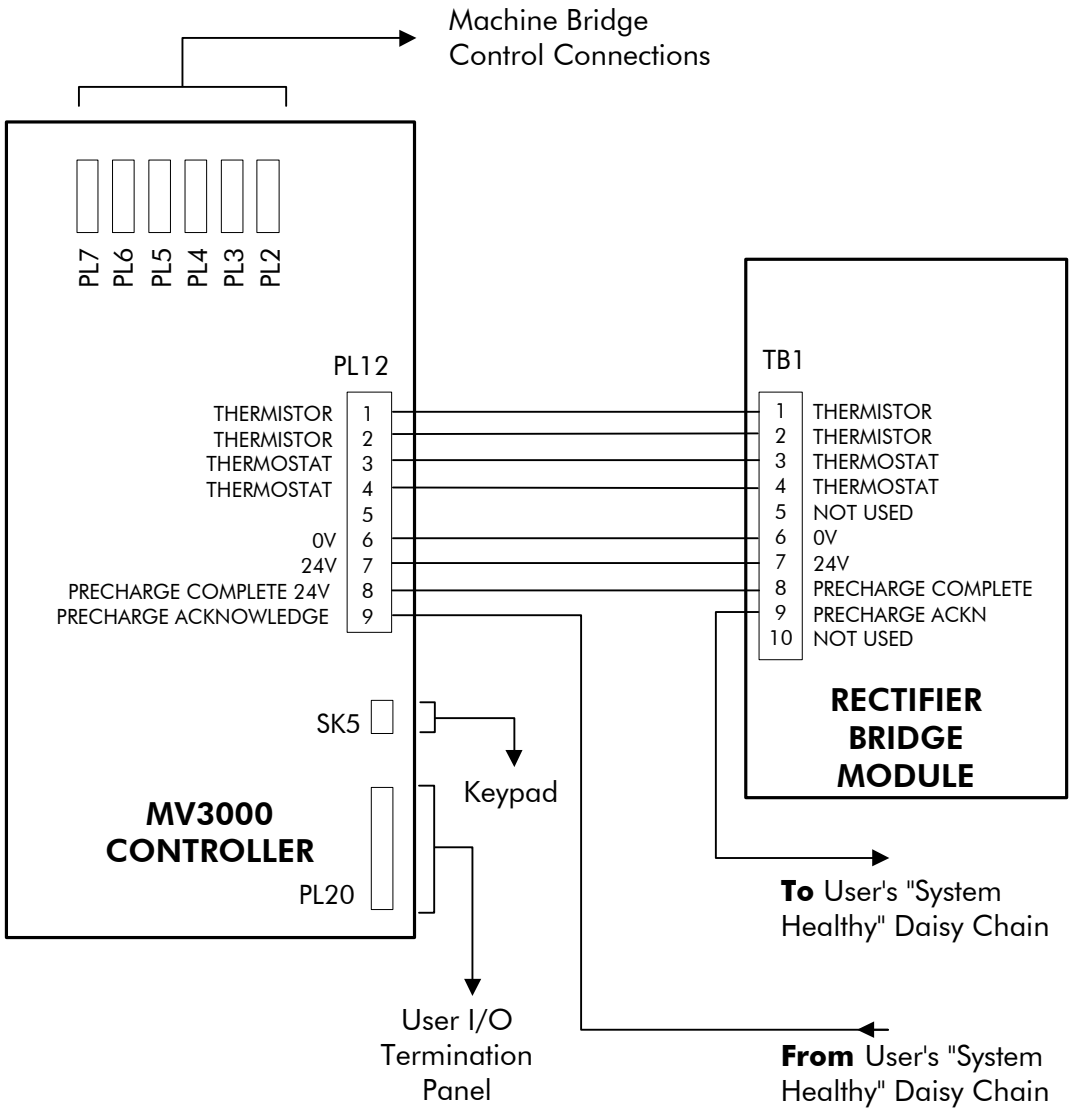
(c) loss of flow.

These protection mechanisms can be linked back to the associated controller via protection relays.

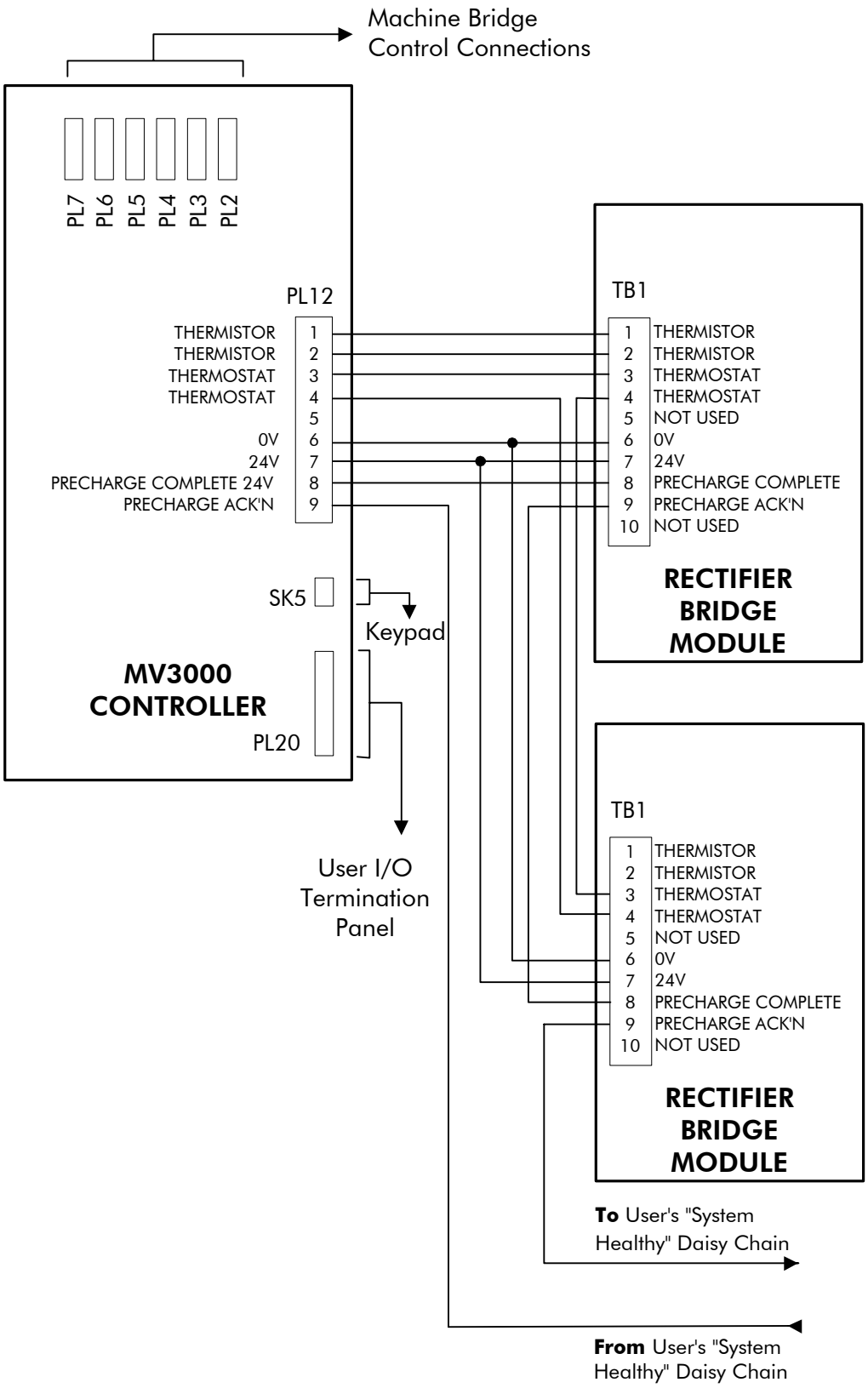


A.8 Network Bridge (Control)

A.8.1 Circuit 'MVI1' Network Bridge (Control), 1 Network Rectifier Bridge Module (Double)

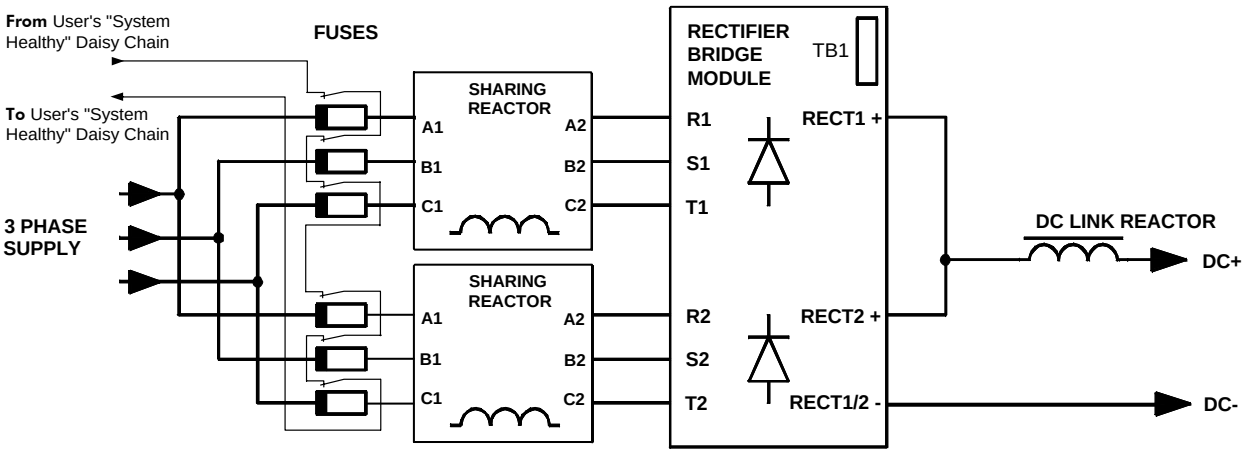


A.8.2 Circuit 'MVI2' Network Bridge (Control), 2 Network Rectifier Bridge Modules (Double)

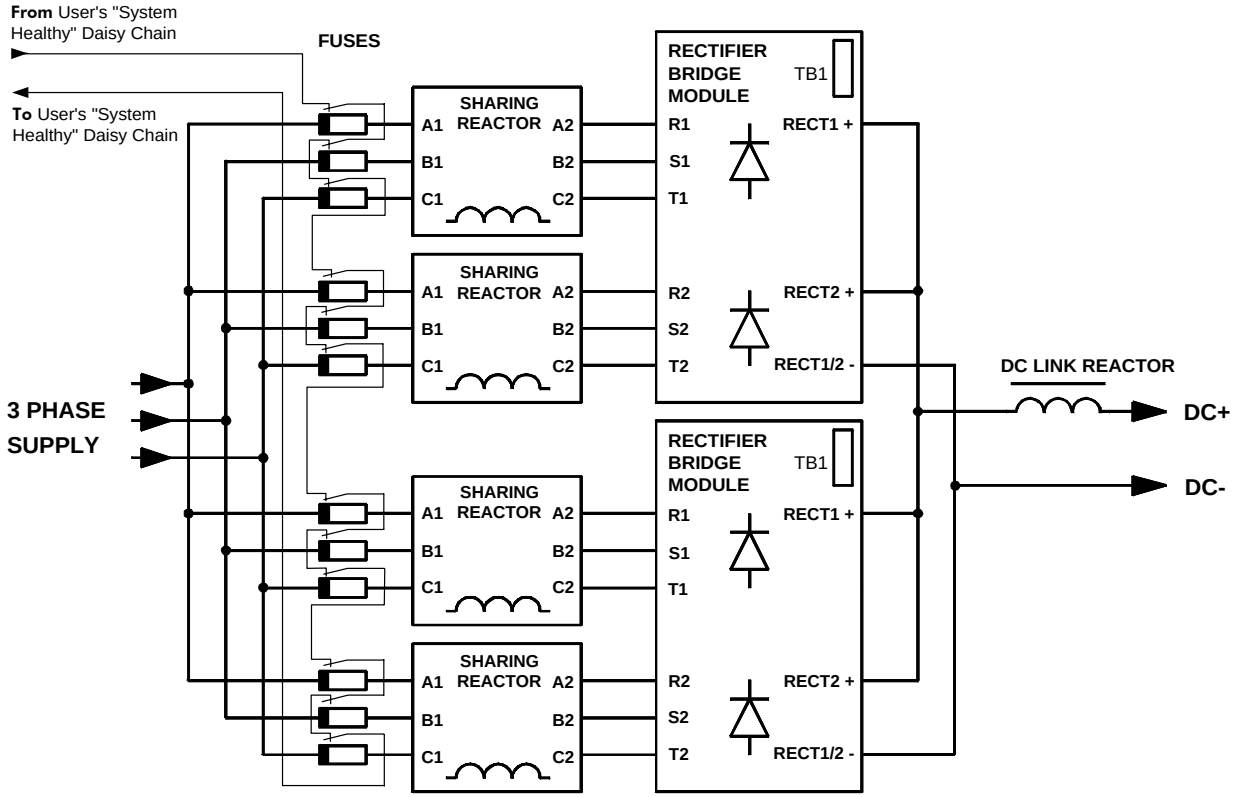


A.9 Network Bridge (Power)

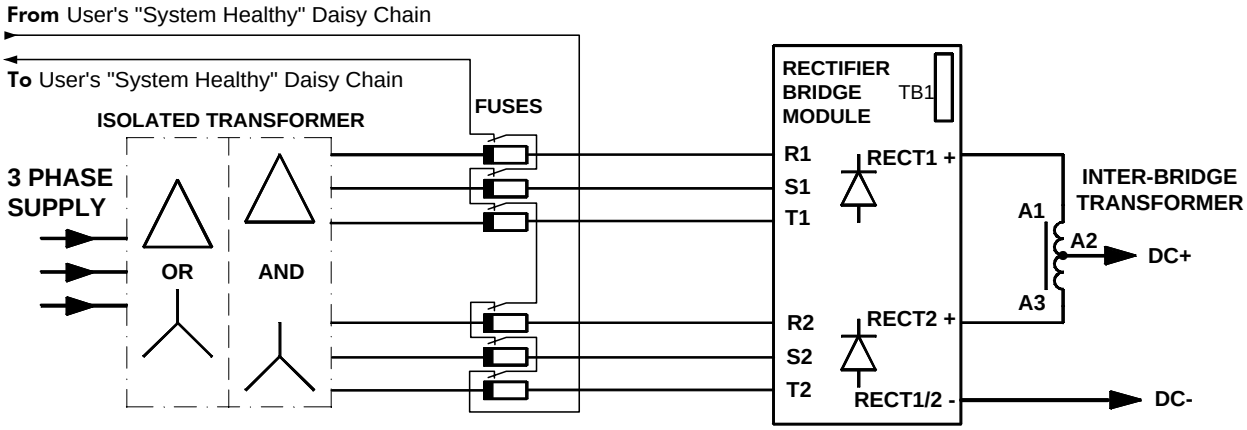
A.9.1 Circuit 'MVJ1' Network Bridge (Power), 6 Pulse Supply Input, 1 (Double) Rectifier



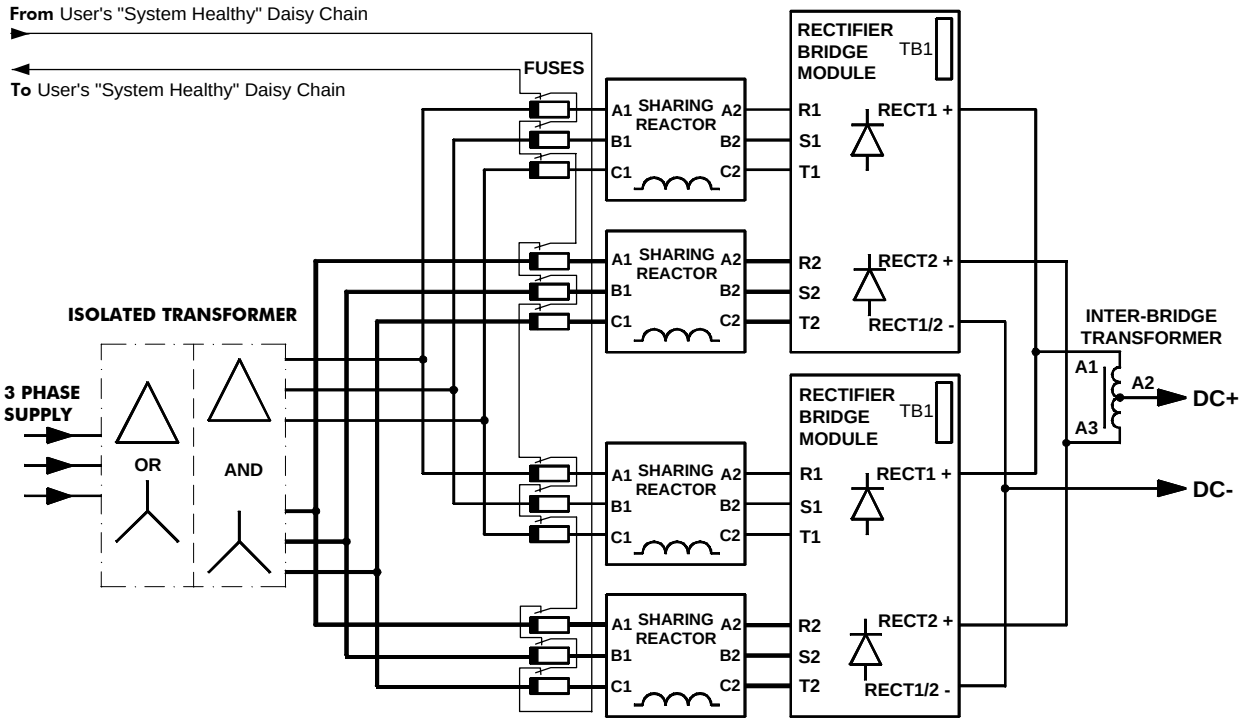
A.9.2 Circuit 'MVJ2' Network Bridge (Power), 6 Pulse Supply Input, 2 (Double) Rectifiers



A.9.3 Circuit 'MVJ3' Network Bridge (Power), 12 Pulse (Isolated) Supply Input, 1 (Double) Rectifier



A.9.4 Circuit 'MVJ4' Network Bridge (Power), 12 Pulse (Isolated) Supply Input, 2 (Double) Rectifiers



Appendix B Recommended Torque Settings

B.1 Scope

This document details the recommended tightening torque settings for connectors used on the ALSPA MV LCD based modules.

The recommended torque settings are applicable to high-tensile steel (Grade 8.8) fasteners fitted with a single turn spring washer under the nut, and with the threads being zinc plated, passivated and unlubricated over the normal operating temperature of these components.

Specifically **excluded** are :

(a) fasteners with any other material (e.g. brass);

(b) fasteners with any other finish (e.g. raw steel, cadmium plated, lubrication of any sort);

(c) slotted holes in either steel or copper.

B.2 Torque Settings for Electrical Connections

The figures included at Table B-1 are for electrical connections of copper conductor crimps to device terminals and to all copperwork except busbars for which figures are included at Table B-2.

B.3 Torque Settings for Busbar Joints

The figures at Table B-2 are for all busbar joints on copperwork.

B.4 Torque Settings for Mechanical Connections

The figures at Table B-3 are for the assembly and mounting of steel parts where specific electrical connection, other than continuity, is not involved.

Table B-1 Torque Settings for Electrical Connections

Fastener Size Carbon Steel (8.8)	Torque Setting		
	Nm	lbf in	lbf ft
M5	3.5 - 5.5	30 - 48	2.5 - 4
M6	7 - 10	60 - 90	5 - 7.5
M8	10.5 - 16	96 - 144	8 - 12
M10	27 - 40	240 - 360	20 - 30
M12	40 - 60	360 - 576	30 - 48
M16	90 - 135	780 - 1200	65 - 100

Table B-2 Torque Settings for Busbar Joints

Fastener Size Carbon Steel (8.8)	Torque Setting		
	Nm	lbf in	lbf ft
M8	20	180	15
M10	40	360	30
M12	64	576	48

Table B-3 Torque Settings for Mechanical Connections

Fastener Size Carbon Steel (8.8)	Torque Setting		
	Nm	lbf in	lbf ft
M5	4 - 6	36 - 54	3.0 - 4.5
M6	7 - 10	60 - 90	5 - 7.5
M8	16 - 25	144 - 216	12 - 18
M10	34 - 47	300 - 420	25 - 35
M12	54 - 82	480 - 720	40 - 60
M16	135 - 200	1200 - 1800	100 - 150

Index

Introduction

This index applies to the English Edition of the T1693 Technical Manual for the ALSPA MV Liquid Cooled DELTA Drive System.

The index is prepared with word-by-word alphabetisation and is presented with page numbers for subject location. Page numbers for appendices are prefixed with the appendix letter e.g. A-1 in the index is Appendix A page 1.

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