

REV 01
August 2, 2021

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Contents

1.	Introduction	4
2.	Safety Instructions	4
3.	Disposal	5
4.	Related Documents	5
5.	Specifications	5
5.1	Electrical Specifications	5
5.1.1	Characteristics	5
5.1.2	Electrical Supply	6
5.2	Mechanical Specifications	7
5.3	Power and Control Connections	9
5.4	Environmental	9
5.5	Ratings	11
5.5.1	110% Overload	11
5.5.2	150% Overload	11
5.5.3	Ratings Notes	11
6.	System Design	12
6.1	Fusing	12
6.2	DC Link Inductor Details	13
6.3	Cooling Fan	13
6.4	Sharing Reactors	14
6.5	Control Power Supply Assemblies (SMPS)	14
6.6	Miscellaneous Assemblies	14
6.7	System Design Requirements to Satisfy UL508C	15
6.8	EMC Bonding for Electromagnetic Compatibility	15
6.9	Enclosure	18
6.9.1	Enclosure Requirements	18
6.9.2	DELTA Module Construction	18
6.9.3	Enclosure Construction	19
7.	Installation, Commissioning, Operation and Maintenance	19
8.	Spares	19
9.	Document Revision History	19

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1. Introduction

- The MVD500-4701-A is manufactured by Avid Controls under license from the General Electric Company.
- The MVD500 is an AC Inverter power module for use in an MV3000 variable speed drive system for the control of AC motors.
- Maximum AC current: 550 A rms
- Working AC voltage to 690 V rms (maximum 1200Vdc internal)
- IGBT based Transistor Bridge Module
- Air Cooled.
- Weight: 71 kg (156 lb.)
- Fits in the standard Air Cooled DELTA mounting frame on 250 mm (9.8") pitch

2. 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 must be regarded as part of the product. It should be stored with the product and must be 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 mal-operation 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.
- Where applicable, third party approvals to safety standards UL508C and CSA C22.2 No 14 are marked on the product. In the European Union:
 - Products within the scope of the Low Voltage Directive, 2006/95/EC are CE marked.
 - The product complies with the essential protection requirements of the EMC directive 2004/108/EC, 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 must not be taken into service until the machine has been declared in conformity with the provisions of the Machinery (Safety) Directive, 2006/42/EC.

3. 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 minimize 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

4. Related Documents

- This module is one component out of a range of components used for the MV3000 drive system. This data sheet gives details specifically for the items listed at the start of this document.
- For additional information on the installation, commissioning, operation, maintenance and performance of the complete drive system, please refer to the following General Electric documents:
 - T1689EN, MV DELTA Air Cooled Drive System
 - T1679EN, MV3000 Drive Range Software Technical Manual
 - T1676EN, MV3000 Getting Started Manual for AC-fed Drives
 - T2002EN, MV3000 Getting Started Manual for Active Energy Management Drives

5. Specifications

5.1 Electrical Specifications

5.1.1 Characteristics

AC Supply Voltage (Rectifier Fed)	575/600/690 rms (nominal), +/- 10% long term, +/- 15% for 0.5 to 30 cycles with loss of performance but no trip.
Operational Supply Frequency Range	45 to 63 Hz
Output Frequency Range	0 to 200 Hz
Maximum Continuous Operating DC Voltage:	1170 V (limited by SMPS over-voltage trip)
Maximum DC Surge Voltage	1275 V (SMPS limit must be respected, see Section 0)
Maximum DC Link Capacitor Bank Voltage	1315 V (SMPS limit must be respected, see Section 0)

Maximum Silicon Voltage (VCES)	1700 V (SMPS limit must be respected, see Section 0)
Heatsink/IGBT sensor over-temperature Trip	112°C
AC Current Rating with 1.1 x Overload	500 A rms (1)
AC Current Rating with 1.5 x Overload	367 A rms (1)
Instantaneous IGBT over-current Trip Level	1250 A (peak)
Brick-wall Current Level (2)	934 A (peak)
Suitable for use on a circuit capable of delivering not more than	30 000 A 690 V a.c.
DC Link Capacitance	7,833 µF
DC Link discharge time (maximum voltage to < 50V)	225 s
Notes (1) Refer to Avid Controls for de-rating factors at different PWM switching frequencies and ambient temperatures. (2) Also known as current clipping. This is the instantaneous current that will cause the MV3000 controller to limit the peak current to below the instantaneous trip current	

5.1.2 Electrical Supply

Function	Specification
Network Type	TN or TT (i.e. earthed/grounded neutral) or IT [#] network (i.e. isolated neutral) [#] The IT network must be: <ul style="list-style-type: none"> - Separated from the public mains supply by an isolating transformer. - Protected against transients - Have earth/ground fault reference and monitor. Refer to the MV DELTA manual "Special Requirements for IT Network" for details.
Voltage Unbalance	Negative sequence voltage not to exceed 3%.
OUTPUT SWITCHING FREQUENCY	
Default Setting	1.25 kHz, 2.5 kHz and 5 kHz for all drives (programmable by P35.00).
OUTPUT	
Overload Current	50% or 10% for one minute, once every 10 minutes, as selected.
INSULATION	
Voltage to Ground (Earth)	Recurring peak voltage not to exceed 1600 V (Common mode filtering may be required)
Standards	EN 50178, IEC61800-5-1, UL 840, CSA C22-2 No. 0.2,; Pollution Degree 2, 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.

5.2 Mechanical Specifications

- The unit is designed to slide in between a lower guide plate and an upper cross member of an Air Cooled DELTA mounting frame.

Width:	246 mm (9.7 in)
Depth:	578.5 mm (22.7 in), including DC terminal shroud
Height:	875 mm (34.4 in)
Weight:	71 kg (156 lb.)

- If the 600 mm wide mounting frame is used, this DELTA module will not fit in the right hand slot.

Figure 5.1 – Dimensions without shrouds

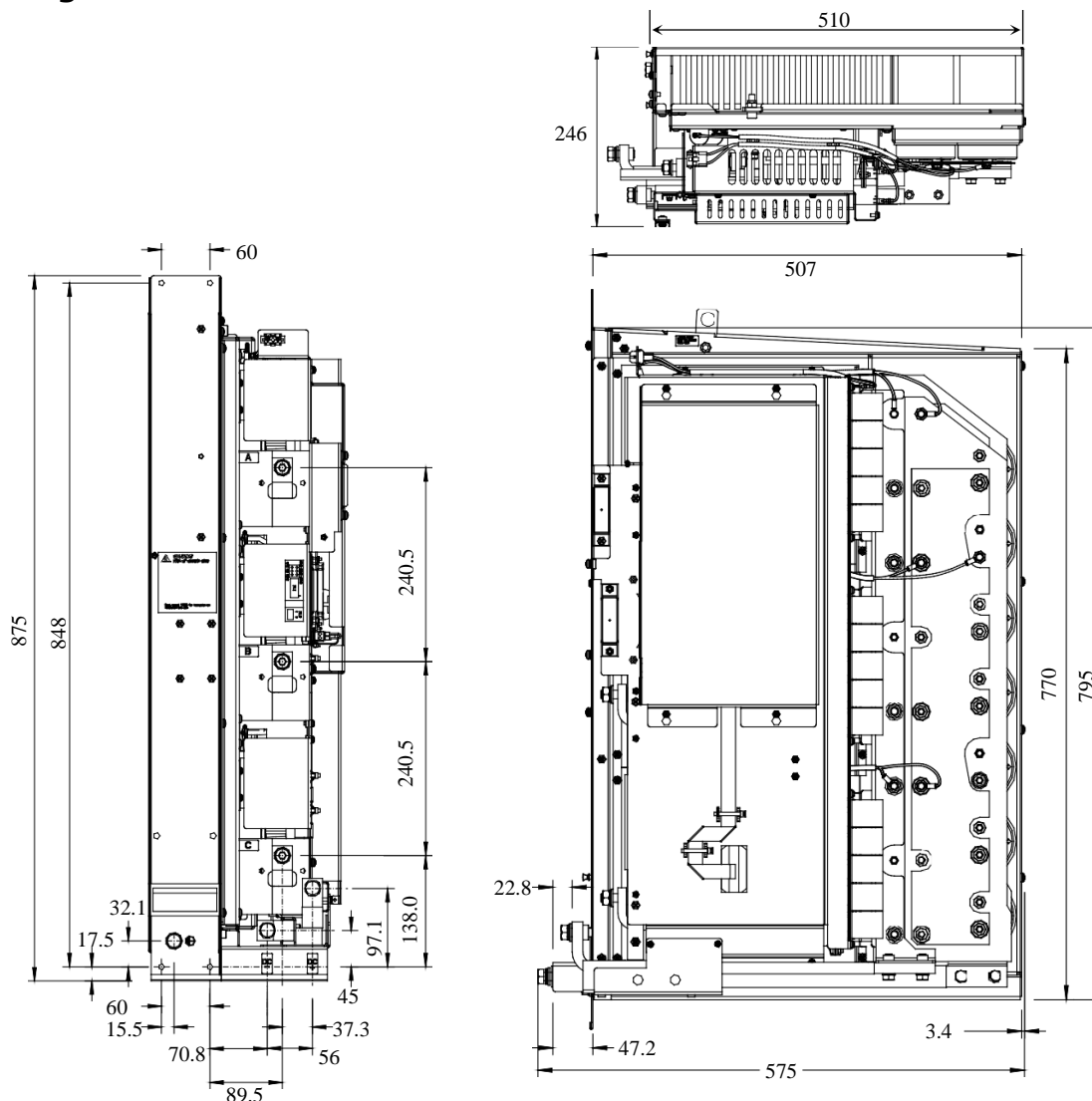
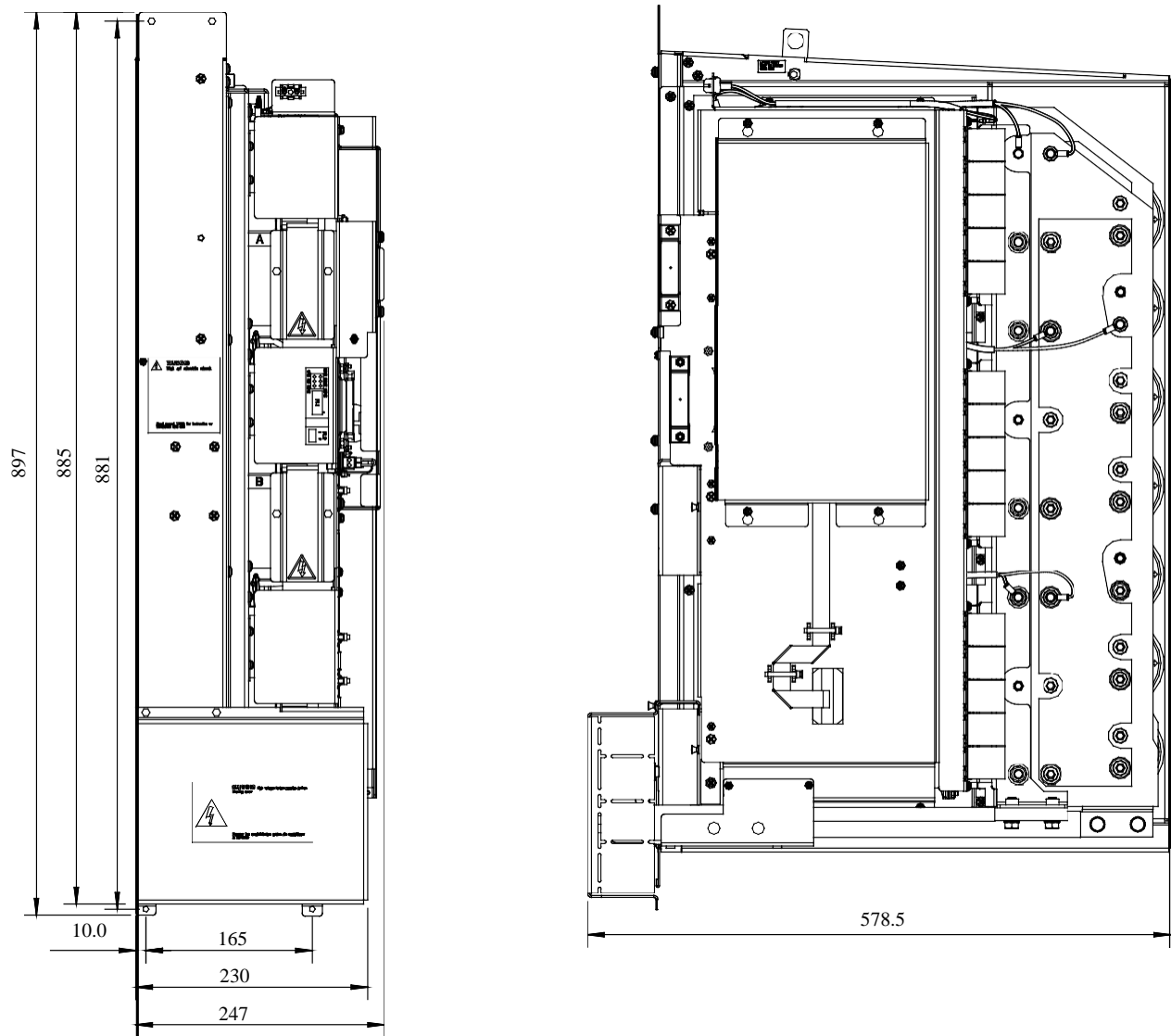


Figure 5.2 – Dimensions with shrouds



5.3 Power and Control Connections

Power	Connector	Typical Cable Size	Maximum cable Size
AC Power Connections	1 x M10 stud per phase	120 mm ² (250 MCM) per phase	120mm ² (250 MCM) per phase
DC Power Connections	1 x M10 stud per connection	120 mm ² (250 MCM) per phase	150mm ² (300 MCM) per connection
Earth Connection	1 x M10 bolt	Note 2	
Notes: (1) The AC and DC Power connections (above) are intended for inter-connection within the enclosure (not field wiring terminals). Sizes are based on High Temperature Cable up to a maximum allowed conductor temperature of 125°C (257F). Examples of high temperature cable are: silicon rubber (e.g. or Nexans type SIWO-KUL) or polyolefin (e.g. Huber and Schüner type Radox 125). (2) The recommended grounding for the DELTA is by direct connection (see T1689 for details).			
Control	Type	Description	
DC High Voltage Control Connection	3-way Amp ‘Mat-n-Lok’	Connector ‘TB1’ for SMPS & Voltage monitoring (Pin 1 = DC+, 2=n/c, 3=DC-)	
Low Voltage Control Connections	40-way Ribbon Connector 40-way Ribbon Connector	PCB connector PL3 (from the MV3000 SMPS) PCB connector PL1 (to/from MV3000 Controller)	

5.4 Environmental

Function	Specification
Operating Ambient Temperature	0 to 40°C (32°F to 104°F) de-rate to 50°C Note: If clean/dirty air is segregated, the control electronics and fan transformers can withstand 60°C (140°F). Open Type assembly (UL 508C): Maximum surrounding air temperature 60°C
Operating Relative Humidity	5 to 95% (non-condensing)
Operating Altitude	Normal operating altitude up to 1000 m (3280 ft.) above sea level. From 1000 m (3280 ft.) to a maximum of 2000 m (6551 ft.) de-rate by 7.3% per 1000 m (3280 ft.).
Operating 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.
Operating and Storage Chemicals (max.)	15 ppm H ₂ S 25 ppm NO ₂ 25 ppm SO ₂
Storage Temperature	-25 to +55°C (-13°F to 131°F)
Storage Relative Humidity	5 to 95% non-condensing
Storage Altitude	Up to 3000 m (9842 ft.) above sea level
Transport Temperature	-25 to +70°C (-13°F to 158°F)
Transport Relative Humidity	5 to 95% (non-condensing)

Transport Altitude	Will withstand air transport				
Enclosure Ingress Protection	IP00 (to IEC 60529; BS EN 60529), Open Type product (to UL508C, IEC 618005-1) These modules must always be installed in an appropriate enclosure with restricted access.				
Vibration - Operational	Type tested against the worst combination of the requirements of IEC 61800-2 (which specifies 'Class 3M1' of IEC 60721-3-3), EN 50178, IEC 61800-5-1 and DNV Rules for Ships, Jan. 2010 Part 4, Ch. 8, Section 3; summarized by the 'composite' column below:				
	Frequency	IEC 61800-2	IEC 81800-5-1 EN 50178	DNV	Composite
	2 to 5 Hz	0.3 mm amplitude			0.3 mm amplitude
	5 to 9 Hz	0.3 mm amplitude		20 mm amplitude	20 mm amplitude
	9 to 50 Hz	1 m/s ²	0.075 mm (from 10 Hz)	20 mm amplitude	20 mm amplitude
	50 to 57 Hz	1 m/s ²	0.075 mm		1 m/s ²
	57 to 150 Hz	1 m/s ²	9.81 m/s ²		9.81 m/s ²
	150 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 IEC 60721-3-2 when equipment is packed for transport: mass < 100 kg = 0.25 m; mass > 100 kg = 0.10 m				
Inclination	- Static conditions; list 15°, trim 5° - Dynamic conditions; rolling ± 22.5°, pitch ± 7.5° (may occur simultaneously)				

5.5 Ratings

5.5.1 110% Overload

575V			600V			690V		
Amps (rms)	Motor Power (kW)	Losses (kW)	Amps (rms)	Motor Power (kW)	Losses (kW)	Amps (rms)	Motor Power (kW)	Losses (kW)
500	427	4.31	495	440	4.32	475	485	4.34

5.5.2 150% Overload

575V			600V			690V		
Amps (rms)	Motor Power (kW)	Losses (kW)	Amps (rms)	Motor Power (kW)	Losses (kW)	Amps (rms)	Motor Power (kW)	Losses (kW)
367	313	2.78	367	326	2.83	367	375	3.03

5.5.3 Ratings Notes

- Rectifier fed (Diode Front End) drive with a DC link voltage = $1.35 \times V_{ac}$, Nominal supply voltage
- Assumed motor: efficiency 0.95 & power factor = 0.9 Ambient = 40°C (104°F)
- Altitude = 1000m (3280 ft.)
- PWM frequency = 1.25 kHz
- No sharing reactor in DELTA air stream
- Typical device characteristics
- 50 000 hours continuous use for DC capacitor bank
- Overloads are for 60s every 10minutes.
- The current must be reduced between overloads so that the rms current does not exceed the rated current shown.

6. System Design

- Refer to the manuals in Related Documents (Section 4) for general information. This section gives details specifically for this version of the DELTA module.

6.1 Fusing

- Semiconductor devices have a high power concentration in a very small physical size. Due to their relatively small mass, their capacity to withstand overloads and over-voltages is limited. Normal protection of the DELTA semiconductors is provided by internal solid –state switching. If this fails then standard fuses or circuit-breakers will not operate fast enough to prevent some or even complete damage to the device. The packaging surrounding the semiconductor may open, with the potential to cause damage external to the DELTA module. The extent of this damage depends on the correct co-ordination between the system’s energy level, the protective devices (e.g. fuses) and the design of the enclosure (arc-containment).
- For these reasons, high speed fuses (also called semiconductor fuses) must be used. The selection of these depend on many factors, including the current/time loading conditions, number of starts per hour/day, fuse cooling, ambient temperature, continuous or intermittent running and fuse connection/mounting arrangements.
- For multi-DELTA systems these must be fitted on the DC connections (DC+ and DC-) as detailed below:

From Rating Tables Above, Fuses for Ratings up to 340A		
Manufacturer Part Number Nominal fuse rating	Ferraz Shawmut (Mersen) 12,5URD73TTF0500 500A	2 off per DELTA
From Rating Tables Above, Fuses for Ratings up to 475A		
Manufacturer Part Number Nominal fuse rating	Ferraz Shawmut (Mersen) 12,5URD73TTF0700 700A	2 off per DELTA
Suitable micro-switches for fuse indication		
Ref. Number	For Ferraz Shawmut (Mersen) MS 7V 1-5 BS	2 off per DELTA

Typical fuses for 40°C ambient

6.2 DC Link Inductor Details

Part No	DC Rating (A)	Suitable for AC ratings (From Rating Tables above) A rms
50Z0038/01	423	360
MV3DCL250A4#	507	430
MV3DCL280A4#	568	480
MV3DCL315A4#	639	540
50Z0038/02	846	720
50Z0038/03	1270	1080
50Z0156/02	1700	1445
50Z0156/03	2550	2170
50Z0156/04	3400	2890
Notes: # Rated to 690V		

DC Link Inductor for 6-pulse applications

Part No	DC Rating (A)	Suitable for AC ratings (From Rating Tables above) A rms
50Z0043/01	476	405
50Z0043/02	953	810
50Z0043/03	1430	1215
Other ratings on request		

DC Link Inter-Bridge Transformer for 12-pulse applications

6.3 Cooling Fan

- The following table shows the available cooling fans.
- For reference, these fans have identical flow/pressure curves, the only difference being the supply voltage. These fans are equivalent of the “large” fans previously supplied by GE Power Conversion.

Model No	Description
MVC3017-4001	High capacity cooling fan, 500/575Vac, 3 phase, 50/60 Hz
MVC3014-4001A	High capacity cooling fan, 230Vac, 1 phase, 50/60 Hz

6.4 Sharing Reactors

- To ensure current sharing between multiple DELTA transistor modules, sharing reactors are required.

Reactor Part Number	Style	Mounting	Cooling	Rating Arms	Weight (kg) (lbs)	
MVC4017-4001	Air cored	Under DELTA cross-rail	Force Ventilation Losses In to the 'dirty air' path	500A	39.5	87

- Mounted under the ACD and fastened to the DELTA mounting frame. All losses from this reactor are ducted through the 'dirty-air' path. Note these losses may reduce the rating of the ACD, due to increasing the air temperature into the DELTA.

6.5 Control Power Supply Assemblies (SMPS)

- The MVC3003-40xx DELTA Switch Mode Power Supply (SMPS) units provide the electronic supplies for the DELTA Transistor Bridge Module and the MV3000e DELTA Controller in systems operating from 460 to 690VAC. The SMPS unit derives its supply from the D.C. Link.
- The following table shows the compatible MV3000 SMPS units (Position 1 defines the primary trip voltage):

SMPS Type	Timed Overvoltage Level	Instantaneous DC Overvoltage Level	Use on Parallel DELTA system	Start-up voltage	Under-voltage trip
MVC3003-4003	N/A	1188 V DC. ($\pm 1\%$)	Position 1 to 6	550 V DC	560 V DC
MVC3003-4020	1188 V DC ($\pm 1\%$)	1188 V DC ($\pm 1\%$)	Position 1	550 V DC	560 V DC
MVC3003-4030	1188 V DC ($\pm 1\%$)	1262 V DC ($\pm 1\%$)	Position 1	550 V DC	560 V DC
MVC3003-4025	N/A	1290 V nominal	Position 2 to 6	550 V DC	560 V DC

6.6 Miscellaneous Assemblies

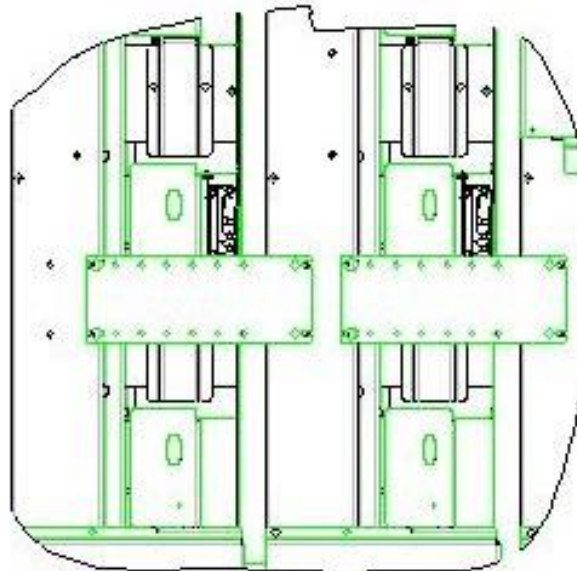
- This version of DELTA module uses the same mounting frames, cooling systems (fan boxes and supply transformers) and control and I/O modules as the other Air-Cooled DELTA modules. Please refer to related documents for details of these assemblies.

6.7 System Design Requirements to Satisfy UL508C

- UL 508C has several requirements that must be satisfied:
 - Motor over-temperature monitoring is required. Details of the required connections to the User I/O panel are given in T1689;
 - Semiconductor fuses should be located within the same enclosure as the DELTA module;
 - The integral short circuit protection provided by the DELTA module does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electric Code and any additional local codes.

6.8 EMC Bonding for Electromagnetic Compatibility

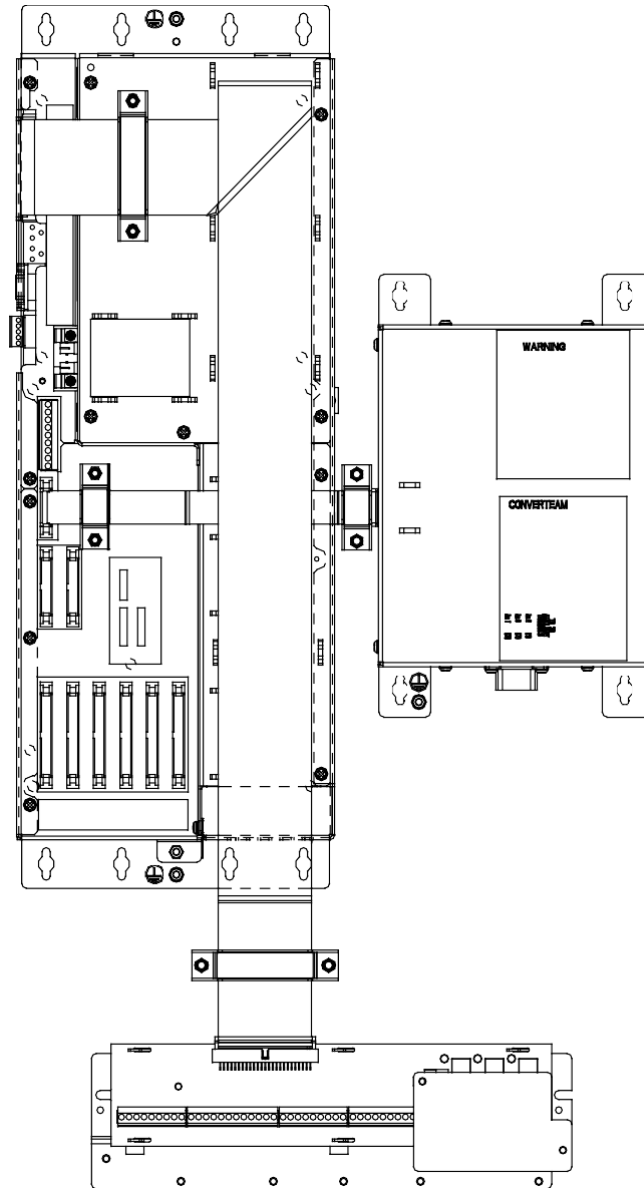
- The DELTA power modules must be bonded together and to the drive control module.
- A bonding plate is supplied with the DELTA module to aid with this EMC bonding.
 - These plates form a single metal highway providing a low resistive, low inductive path between the modules and the controller.
 - This arrangement forms a ground plane, against which the control ribbon cables are run, improving the noise immunity of the system.
 - The plate is secured using the screws supplied, pre-fitted to the front of the DELTA module.



Bonding plates linking adjacent DELTAs

- The installer of the modules into the enclosure must complete the bonding path (and cable routing) of the DELTA modules to the MV3000 controller.
- The dimensions of this plate depend on the location of the controller and so cannot be supplied with the module.
- The ribbon cable between the DELTAs and the control module must be screened and bonded at both ends.

- The requirements are schematically shown in this figure:



CAUTION

- The control components are supplied with limit cable lengths. Ensure that they are sufficiently close to allow the use of these pre-terminated cables.

- A low inductance, direct electrical bond is required and so an unpainted panel (e.g. plated or galvanized,) must be used
- The ribbon cables are ordered separately. The available lengths are as per the following table:

Part Number	Length
MVS3020-4007	0.7 m (27.5 in)
MVS3020-4008	0.8 m (31.5 in)
MVS3020-4009	0.9 m (35.5 in)
MVS3020-4010	1.0 m (39.4 in)
MVS3020-4011	1.1 m (43.3 in)
MVS3020-4012	1.2 m (47.3 in)
MVS3020-4013	1.3 m (51.2 in)
MVS3020-4014	1.4 m (55.2 in)
MVS3020-4015	1.5 m (59.0 in)
MVS3020-4016	1.6 m (63.0 in)
MVS3020-4017	1.7 m (66.9 in)
MVS3020-4018	1.8 m (70.9 in)

Part Number	Length
MVS3020-4019	1.9 m (74.8 in)
MVS3020-4020	2.0 m (78.7 in)
MVS3020-4021	2.1 m (82.7 in)
MVS3020-4022	2.2 m (86.6 in)
MVS3020-4023	2.3 m (90.6 in)
MVS3020-4024	2.4 m (94.5 in)
MVS3020-4025	2.5 m (98.4 in)
MVS3020-4026	2.6 m (102.4 in)
MVS3020-4027	2.7 m (106.3 in)
MVS3020-4028	2.8 m (110.2 in)
MVS3020-4029	2.9 m (114.2 in)
MVS3020-4030	3.0 m (118.1 in)

- The clamp for the control end must be separately ordered, as per this table:

Part Number	Description
MVS3018-4001	40 way ribbon clamp, one ribbon
MVS3018-4002	40 way ribbon clamp, two ribbons
MVS3018-4003	40 way ribbon clamp, three ribbons
MVS3018-4004	40 way ribbon clamp, four ribbons
MVS3018-4005	40 way ribbon clamp, five ribbons
MVS3018-4006	40 way ribbon clamp, six ribbons

- Ribbon cables must be run along earthed metal, not through 'mid-air'. Cable lengths must be selected to allow this routing.
- The cable bonding clamp at the DELTA end is provided with the DELTA.
- The 16-way and 50 way ribbon cables for the Mains Voltage Monitor (if fitted) and I/O termination panel respectively are supplied with those units.
- For best EMC practice the MV3000 controller, I/O panel and MVM unit (if fitted) are fitted to the same conductive panel.

6.9 Enclosure

- This module is as an ‘open type’ product (IP00) for installation into an enclosure (cabinet / cubicle).

6.9.1 Enclosure Requirements

- The essential requirements for the enclosure are:
 - Protection of personnel against direct contact of hazardous parts:
 - Electrical – all hazardous live parts, e.g. the DELTA module power circuit
 - Thermal - hot parts (on the DELTA module, the heatsink and busbars; for the system these plus high temperature cables, reactors, etc.)
 - Moving parts – on the DELTA none; on the system: the impellers of the cooling fans
 - Energy hazards – Electrical (including the stored energy in the dc capacitor bank, which takes up to eight minutes to discharge), the rotational mechanical energy in the fan (this stops within a few seconds) and the energy that could be supplied into the enclosure during catastrophic failure of any part of the system ‘arc-containment’.
 - Protection of the enclosed equipment against the environmental conditions
 - Mechanical impact against the enclosure
 - Environmental control against the ingress of water, dust and solid objects
 - Condensation control to meet the requirements of Pollution Degree 2 (see Section 5)
 - Reduction of radiated emissions from the drive and protection of the drive from radiating sources.

6.9.2 DELTA Module Construction

- The front of the unit is supplied with terminal shrouds to aid in the requirement to provide accidental protection to personnel against direct electrical contact during ‘proving dead’ procedures.
- All the insulation materials used in the DELTA module have a low flammability rating when tested against UL 94 (limited burn rate; will self-extinguish and do not drop burning particles when the source of ignition is removed).
- The DC link capacitor bank has discharge resistors fitted to discharge the capacitors to below 50V in less than 8 minutes after the isolation of the supply.

6.9.3 Enclosure Construction

Steel Enclosure

- To provide a conductive and magnetic screen in addition to safety segregation.

Earthing / Grounding

- To be locally earthed/grounded for both safety and for EMC.
- Note converters contain high leakage current equipment.
- Panels to be bonded together for earth/ground continuity and continuation of conductive screen/shield

Openings

- Designed to protect personnel (and equipment) against hazards listed in Section 6.9.1.
- Avoid all unnecessary apertures.
- All doors and covers to hazardous parts to be closed when the equipment is energized.

7. Installation, Commissioning, Operation and Maintenance

- Refer to the specific instructions, WARNINGS and CAUTIONS in the relevant Manual(s).
- In addition, for DELTA based systems, it is recommended that:
 - Individual phase currents from each module are measured to ensure that the 3 phase currents are balanced and that the phase currents between each DELTA share the current equally. The current sharing between DELTAs should be within 4%.
 - During routine maintenance, that the DELTA module is visually inspected for overheating / damaged components.

8. Spares

- The DELTA module contains no user serviceable components.

9. Document Revision History

Rev.	Date	Author	Changes
00	June 19, 2017	Gary Pace	Document created from GE document T2159EN Rev. 03
01	Aug 2 2021	Gary Pace	DC link discharge time changed to eight minutes