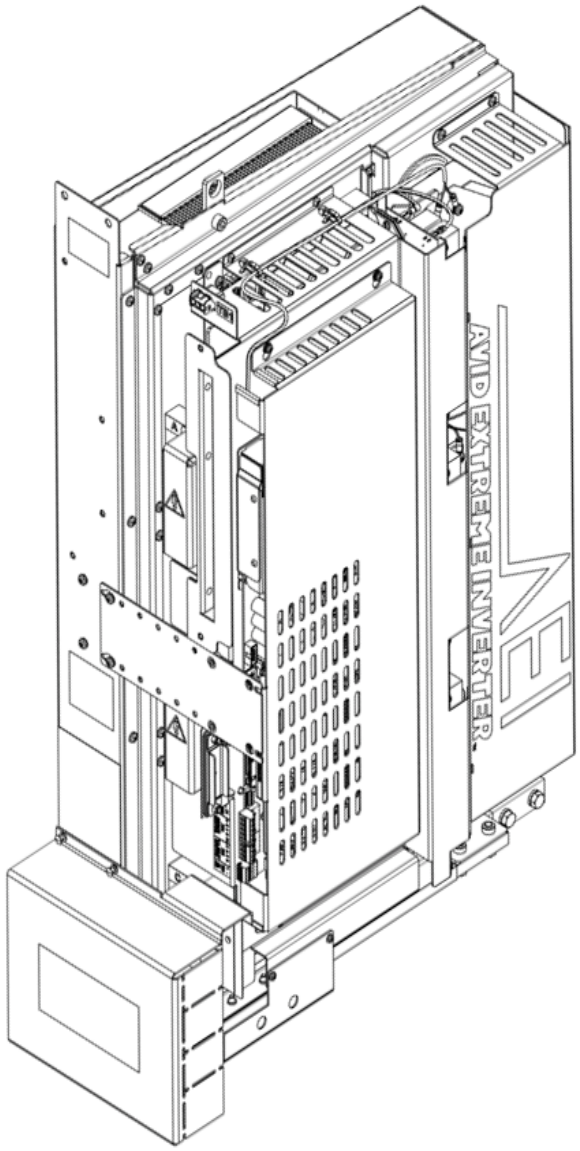

REV 02
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Contents

1. Introduction

- The AEI550A inverter modules are high reliability air cooled inverter modules with nominal ratings of 550A at 690Vac for use with MV3000 AC drives, controlled by the Common Drive Controller (CDC).

- Its significant technical attributes are:
  - Sintered solder-free IGBT modules for extended life operation
  - Ruggedized IGBT die for improved environmental robustness
  - Reduced internal voltage overshoot
  - More robust, fully digital gate driver
  - IGBT modules are fully sealed for protection from condensation
  - Continuous, accurate monitoring of IGBT silicon temperature under all operating conditions

1.1 Terms and Definitions

AEI	Avid Extreme Inverter
AEI-APU-X	Avid Extreme Auxiliary Power Unit
CDC	Common Drive Controller
CIB	Controller Interface Board
IGBT	Insulated Gate Bipolar Transistor

1.2 Related User Documents

- The documents below are available on request from Avid Controls:

Document Number	Description
DTS-MID0124	Auxiliary Power Unit Types D, E & F – Customer Data Sheet
DTS-03280-ASY-A	Auxiliary Power Unit Type G – Customer Data Sheet
DTS-01357-ASY-A	High Performance Fan, 400V – Customer Data Sheet
DTS-01231-ASY-A	High Performance Fan, 230V – Customer Data Sheet
DTS-03246-ASY-A	High-Capacity Fan, 575V – Customer Data Sheet

- These documents are provided with the purchase of the specific products detailed.

- These should be kept for the life of the product.

2. WARNINGS

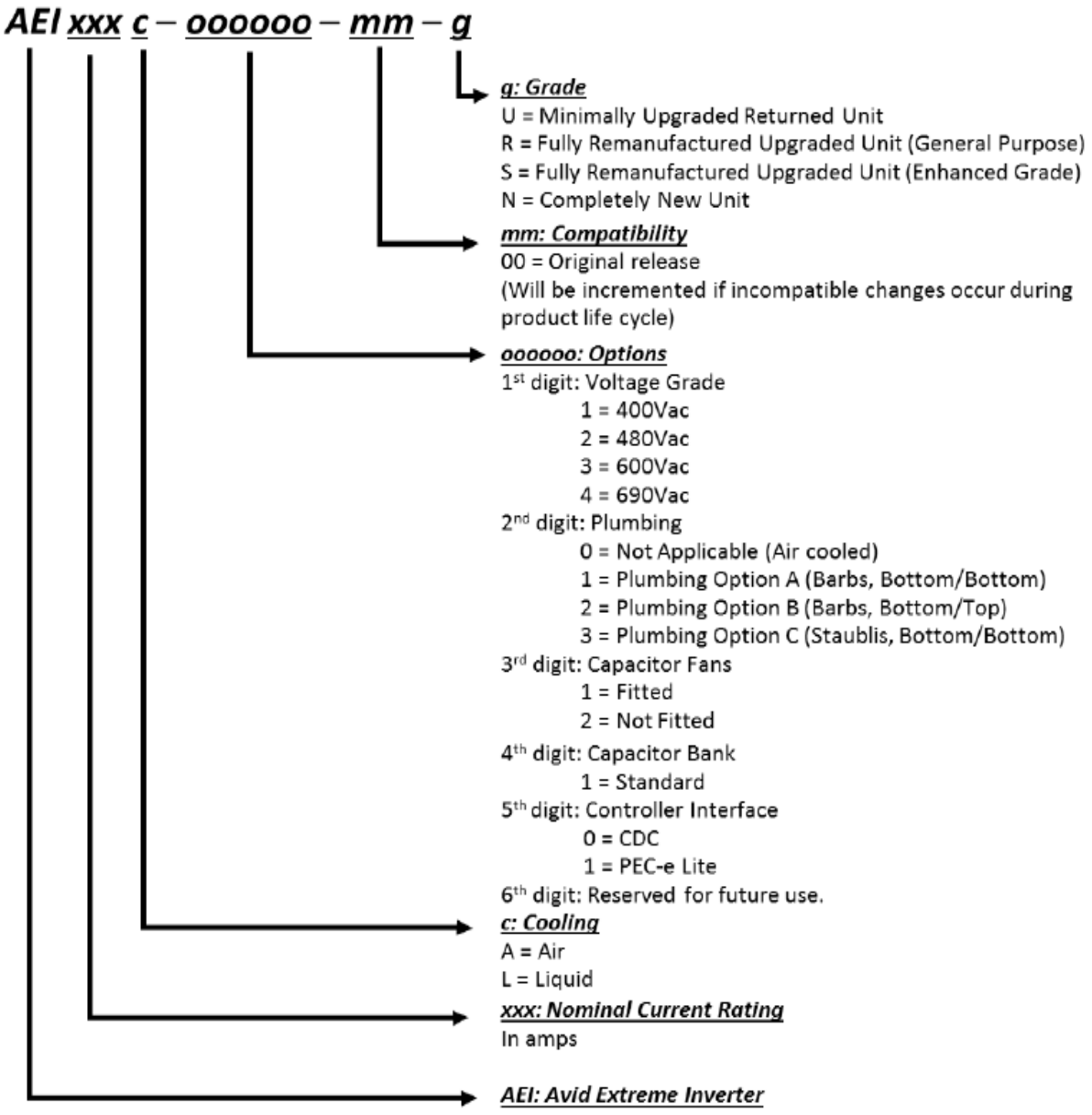
Operation of this equipment requires detailed installation and operation instructions provided in this manual; this information should be retained with this product.

- This equipment may be connected to more than one live circuit.
- The AEI modules are of IP00 construction and must be built into an enclosure or cabinet.
- All power supplies must be switched off and isolated before working on the equipment, failure to do so could result in death or serious injury.
- Wait at least ***five*** minutes after isolating supplies and check that the voltage between DC+ and DC- has reduced to a safe level before working on the equipment.
- Risk of burn - Surfaces can reach high temperatures and remain hot for some time after power is removed.
- Unit is heavy: 71kg (156 lb.) so use safe lifting and handling methods.
- If the Power Drive System that utilizes AEI modules is configured to auto-restart, the motor may start rotating without an operator input. Precautions Must be taken to prevent injury to personnel.
- Units are designed and manufactured to comply with EN 61800-5-1 and UL 61800-5-1. To maintain this compliance when used with a controller other than the MV3000 Common Drive Controller (CDC), motor thermal protection ***MUST*** be implemented.

3. Specification

3.1 Model Numbers

- All Avid Extreme Inverter products use a consistent Model Number scheme:



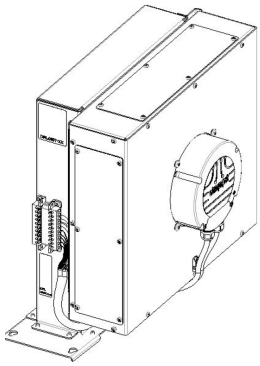
3.2 Electrical – Power Section

Specification	*AEI550A*	Notes & Applicable Conditions
Continuous Current, 690V	550A	High-Capacity fan required – see section 3.4 for details 60s Overload = 150% once per 10 minutes DC Link Voltage = 1100V PWM Frequency = 2.5 kHz
Continuous DC Link Operating Voltage	1188 V	
Short Term (7.5s) DC Link Operating Voltage	1262 V	
Non-Operating DC Link Withstand Voltage	1350 V	
DC Link Capacitance	7833 µF	+20/-10 %
Maximum PWM Frequency	2.5 kHz	In some circumstances, higher frequencies may be used with de-rating – contact Avid Controls if this is required.

3.3 Electrical – Control & Interface Section

Specification	*AEI550A*	Notes
Control Power Source	Avid Auxiliary Power Unit (APU) Model Numbers: AEI-APU-B	Customers wishing to provide their own auxiliary power must contact Avid Controls for further information. Use of a non-approved power supply will void the product warranty.
Analog Outputs	4 Channels +/-10V	Optional indication for phase currents, temperatures etc. DIP switch function selection See section 6.3 for more details
Fault Indication	• Fault Codes indicated by controller for all compatible faults • Two-digit LED display for additional diagnostic codes • Two 24V Solid-State relay outputs for indication of fault status	See section 7.5 for definition of fault codes.
Operational Indication	Two-digit LED display for display of DC link voltage, currents and temperatures	See section 7.4 for details.
Remote Monitoring	Two wire RS485 (non-isolated) MODBUS RTU Protocol	See section 0 for details.
DC Link Voltage Feedback Accuracy	+/- 4V @ 1000V DC	Measured internally within unit

3.4 Cooling



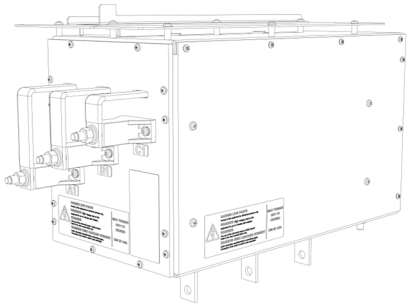
- A cooling fan is required for each AEI module.
- Three models of fan are available:

Model Number	Description	Voltage	Item Number
AEF-HC-575-03-A	High-Capacity Fan	600V 3 Ph.	03246-ASY-A
31V6900-10-A	High-Capacity Fan	400V 3Ph.	01357-ASY-A

- Fans should be checked for compliance with any applicable energy efficiency directives or regulations in your state, region or territory. Contact Avid for further assistance with this.

3.5 Sharing Reactors

- To ensure current sharing between multiple AEI transistor modules, sharing reactors are required.
- Avid Load Sharing Reactors (AEI-REA-550-00-N) are available.
- The AEI-REA-550-00-N is used as an output reactor in multiple transistor bridge configurations.
- The module fits directly below its corresponding AEI/Delta module and is fitted on the standard cubicle cross rails.
- The module is air cooled using the cooling fan which is required for each AEI module.



3.6 Environmental

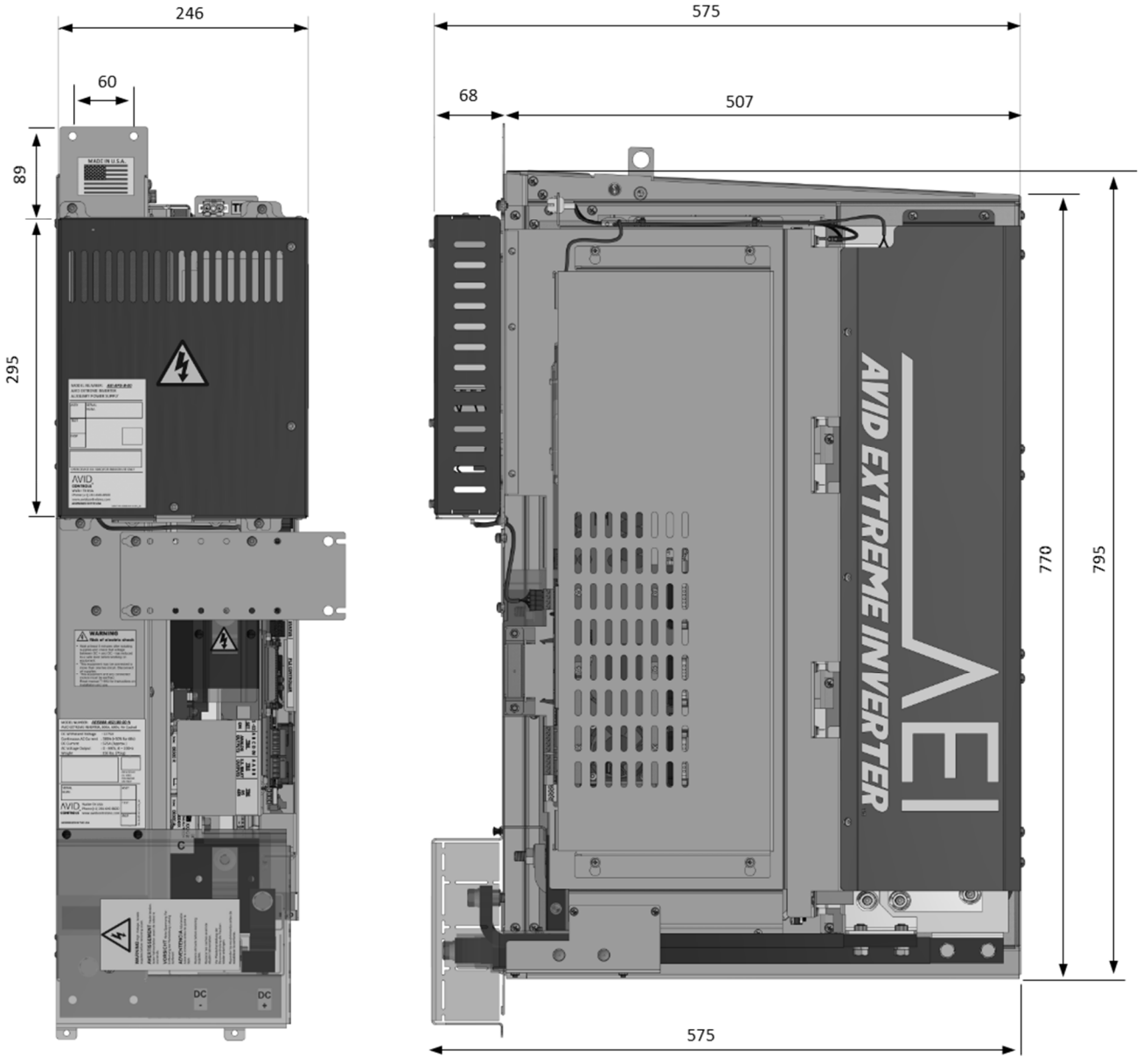
Specification	*Value*
Ambient Temperature (Internal cabinet temperature) - Operating	0 to 50°C
Temperature – Storage or Transport	-13°F to 131°F (-25 to +55°C)
Altitude – Operating	Up to 3280ft. (1000m) ASL. Between 3280ft. (1000m) and 6551ft. (2000m) apply derating of 7.5% per 3280ft. (1000m).
Altitude – Storage	Up to 9842ft. (3000m) ASL
Altitude - Transport	Will withstand air transport
Vibration – Transport	IEC 60721-3-2:1997 Class 2M1, in transport packaging.
Humidity – Operating, Storage or Transport	5% to 95% RH, Non-condensing.
Cabinet air – Operating	Pollution Degree 2 as per IEC60664-1, UL 840 & CSA C22.2 No. 0.2-93 i.e. clean, free from dust, condensation and conductive or corrosive gases. Maximum chemicals 15ppm H_2S, 25ppm NO_2, 25ppm SO_2

3.7 Electrical Supply

Specification	*Value*
Supply Network	TN or TT (grounded neutral) or IT Network IT Network must be isolated from the public supply using a transformer and have transient protection together with ground fault monitoring.
Voltage to Ground	Recurring peak must not exceed 1600V
Standards	EN/UL61800-5-1

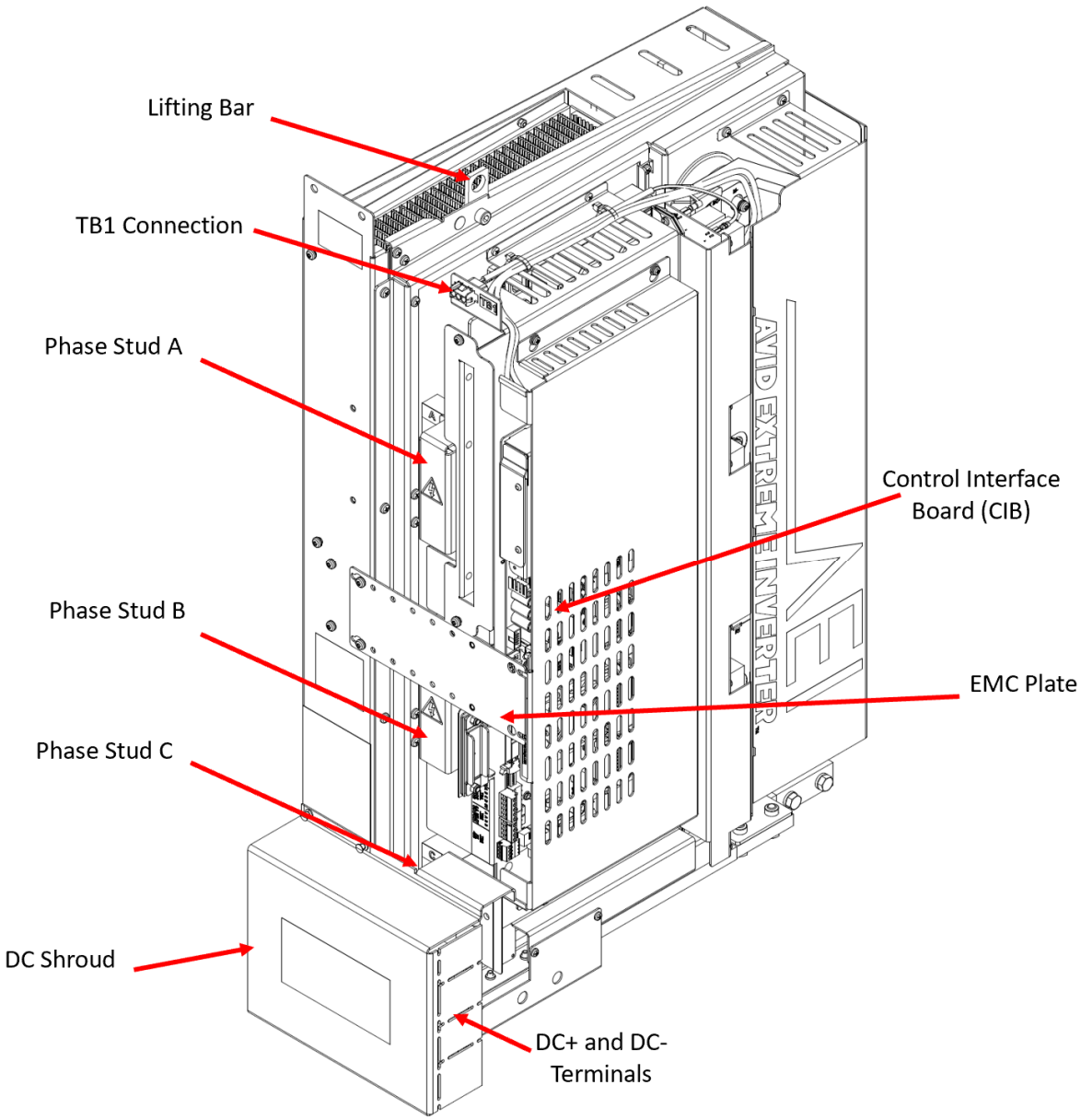
3.8 Mechanical

Specification	*Value*
Dimensions	246mm W x 875mm H x 507mm D [575mm with APU and shrouds] (9.7” W x 34.4” H x 20” D [22.6” with APU and shrouds])
Enclosure	IP00 (IEC 60529:1989; BS EN 60529:1992) NEMA 1 Must always be installed within suitable enclosure with restricted access
Mass	71kg (156 lb.)
3D File	3D Step file can be downloaded from http://avidcontrolsinc.com/step-files/



All dimensions to nearest mm
APU is shown fitted

3.9 Mechanical Layout



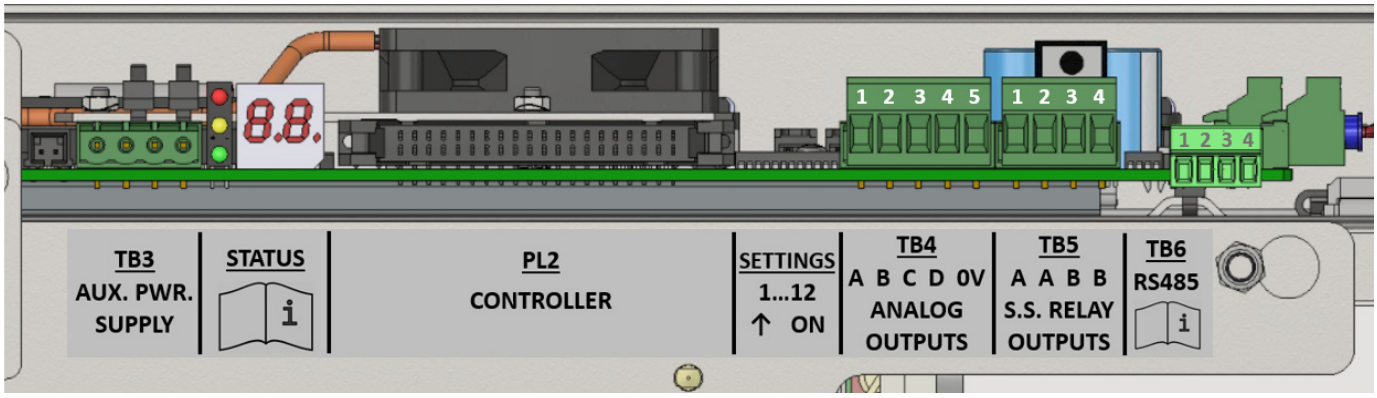
4. High Voltage / Power Connections

Connection	***Details***
AC Power Terminals	1 x M10 studs per phase Maximum cable size per stud is120mm^2
DC Power Terminals	1 x M10 studs each for DC+ and DC- Maximum cable size per stud is120mm^2
Ground Connection	1 x M10 bolt

5. Low Voltage / Control Connections

5.1 Overview

- All control connections are made to terminals and plugs on the ***Controller Interface Board*** (hereinafter referred to as the ***C.I.B.***) as shown in the following image (left hand side is towards the top of the unit when installed):



- The terminal blocks may not be physically numbered – pin one is always towards the top of the unit when installed.

- The pin numbers for TB3 are not shown since the cable and header are pre-made as part of the Auxiliary Power Unit assembly.

- The recommended wire sizes for TB4, TB5 and TB6 are from 0.5mm^2 (20 AWG) to 1.5mm^2 (16 AWG).

- The recommended fastening torque is 0.6Nm (5.3 in-lbs.)

5.2 Plugs for TB3, TB4 & TB5

- The pluggable part of TB3 is part of the Auxiliary Power Unit assembly, hence no plug is provided or needed in the AEI module for this connector.

- The functions of TB4 (analog outputs) and TB5 (solid-state relays) are rarely used in AEI applications, and in certain Delta module replacement applications can cause a fitment issue.To avoid any fitment issues, and to avoid the wasteful fitting of these plugs, AEI modules ship from Avid without these plugs.

- If you wish to use these features, the following table lists some of the widely available options for these plugs:

Plug	Description	Approved Parts
TB4	Five pin 0.2” Horizontal Entry Plug	TE Connectivity: Part Number 796634-5 Molex: Part Number 395305005 Phoenix Contact: Part Number 1757048 Wurth: Part Number 691351500005 Amphenol: Part Number TJ0551530000G
TB5	Four pin 0.2” Horizontal Entry Plug	TE Connectivity: Part Number 796634-4 Molex: Part Number 395305004 Wurth: Part Number 691351500004 Amphenol: Part Number TJ0451530000G

- These plugs may also be obtained by contacting Avid Controls Inc.

5.3 TB3 – Auxiliary Power Supply

- Auxiliary power is generally provided to the AEI unit from an Avid Auxiliary Power Unit.
- For reference, the following gives more details of TB3:

Terminals	Function	Specifications and Notes
1	CONTROL POWER SUPPLY [+]	• Provides power for controller interface and IGBT drivers • 24V DC, +/-5%, 5A maximum load • Voltage transients during power on/off must be monotonic • Supply must meet application power loss ride-through requirements. • [-] terminals are connected to system 0V [GROUND] on the C.I.B.
3	CONTROL POWER SUPPLY [-]	
2	FAN POWER SUPPLY [+]	• Provides power for AEI internal cooling fans (when fitted) • 24V DC, +/-10%, 10A maximum load • Negative supply must be externally connected to system 0V [GROUND]
4	FAN POWER SUPPLY [-]	

- Customers wishing to provide their own auxiliary power should contact Avid Controls for further information and approval of proposed power supply equipment and connections. Customers ***MUST NOT*** use an unapproved auxiliary power scheme, doing so will void the product warranty.

5.4 TB4 – Analog Outputs

Terminals	Function	Specifications and Notes
1, 2, 3, 4	ANALOG OUTPUT A, B, C, D	• Analog outputs for user diagnostic monitoring • See section 6.3 for details on selecting specific signals to be output via analog outputs. • Range is +/-10V • Maximum load current is 5mA • Output source impedance is 100Ω • Maximum error at all outputs is +/- 1% of full range with zero load • Pin 5 (0V – GND) is connected to system 0V [GROUND] on the C.I.B.
5	0V (GND)	

5.5 TB5 – Solid State Relays

Terminals	Function	Specifications and Notes
1, 2	SS RELAY A	• Inverter module fault indication • Relay energized indicates no fault condition • Relay de-energized indicates a fault condition
3, 4	SS RELAY B	• Internal cooling fan fail indication on liquid cooled units. • Unused on AEI500A products
		• Maximum operating voltage is 60Vdc / 40Vac (rms) • Maximum load current is 0.4A • Typical ON resistance is 0.5 Ω • NOT overload (short-circuit) or overvoltage protected • For reference, on-board device is ***Panasonic AVQ202A*** or ***AVQ252GA*** solid-state relay.

5.6 TB6 – RS485

- The AEI inverter has a single, non-isolated, 2-Wire RS485 (5V) port at TB6.
- See section 0,

- MODBUS Communications for a complete functional description of the operation of the RS485 port.
- If bus termination is required, an internal 120 Ω resistor can be connected across the DATA wires by connecting pins 1 & 2 of TB6.
- This port is fully isolated and has its own reference zero volts. ***Note that the isolation is provided for signal integrity and is not specified as a safety isolation barrier. All conductors on the RS485 connector must be maintained at safe low voltages***. For signal integrity purposes, the isolation is rated at a minimum of 1500VDC.

- The pin out of this is:

Terminal	Function	Notes
1	TERM+	• One end of a 120 Ω resistor • The other end is internally connected to the DATA- signal • To terminate the RS485 bus at an AEI unit, connect this terminal to the DATA+ terminal (connect together pins 1 & 2)
2	DATA+	• RS485 (5V) 2-Wire data
3	DATA-	
4	RS485 0V	• This is the reference ground of the RS485 signals • It is not connected to system 0V (GROUND) • All RS485 0V connections (including the master device) should be connected for correct operation of the RS485 network

5.7 PL2 – Controller Connection

- Standard 40-way ribbon cable header for connection to a CDC.

6. User Selectable Options

6.1 Overview

- There are a number of options for the inverter unit that must be configured.
- These are configured using a set of 12 DIP switches on the C.I.B.
- These switches are numbered from 1 to 12, the ON position is towards the PCB itself, and the OFF position is towards the edge of the board.
- An additional set of 4 DIP switches is located adjacent to TB6 to configure the RS485 communications port. See section 0 for details.
- The DIP switches are very small, so a fine point instrument is needed to set them correctly.
- The default options are identified in the following descriptions.

6.2 Over-volts Trip Mode (SW1 to SW4)

- The overvoltage thresholds and delays are configured by **SW1** to **SW4**.
- The following table defines the operation of these switches:

SWITCH SETTINGS				DC Link Voltage Trip Instant	DC Link Voltage Trip Delayed	Delay Time	Notes
SW 1	**SW 2**	**SW 3**	**SW 4**				
OFF	OFF	OFF	OFF	1188 Vdc	None	N/A	Legacy behavior for non-renewable energy systems
OFF	OFF	OFF	ON	1262 Vdc	1188 Vdc	0.5s	Units configured in one of these modes are used in position 1 of the system. ***Default is 1s delay.***
OFF	OFF	ON	OFF			1.0s	
OFF	OFF	ON	ON			1.5s	
OFF	ON	OFF	OFF			2.0s	
OFF	ON	OFF	ON			2.5s	
OFF	ON	ON	OFF			3.0s	
OFF	ON	ON	ON			3.5s	
ON	OFF	OFF	OFF			4.0s	
ON	OFF	OFF	ON			4.5s	
ON	OFF	ON	OFF			5.0s	
ON	OFF	ON	ON			5.5s	
ON	ON	OFF	OFF			6.0s	
ON	ON	OFF	ON			6.5s	
ON	ON	ON	OFF			7.5s	
ON	ON	ON	ON	1290 Vdc	None	N/A	This mode is used in positions 2 to 6 of a parallel inverter system.

6.3 Analog Output Mode (SW5 and SW6)

- The unit provides four analog outputs for system monitoring / debugging.
- See section 5.4 for electrical specifications.
- Scaling of different signal types is as follows:

Signal Type	Scaling
Current	• +/- 10 V output is equivalent to +/- 2500A • Positive values are defined as positive current OUT of the AC terminals of the unit. • When the output mode is rectified phase currents, only positive values will be output. • The formula for rectified mode is: Output = MAXIMUM (|Ia|, |Ib|, |Ic|).
DC Link Voltage	• 0 to +10V is equivalent to 0 to 1500 Vdc
Temperature	• 0 to +10V is equivalent to 0 to 150°C • Note that due to the nature of the internal temperature sensor, any temperature below 30°C will be indicated as 30°C.

- The signals that are output are controlled by DIP switches **SW5** & **SW6**:

Switch Positions		Mode	Analog Channel Outputs			
SW5	**SW6**		A	B	C	D
OFF	OFF	MIXED	Full wave rectified AC currents	Maximum IGBT module temperature	Minimum IGBT module temperature	DC Link Voltage
ON	OFF	CURRENTS	A phase AC current	B phase AC current	C phase AC current	
OFF	ON	TEMPS.	A phase IGBT module temperature	B phase IGBT module temperature	C phase IGBT module temperature	
ON	ON	UNUSED	Undefined value between -10V and +10V			

- ***The default mode is MIXED***.

6.4 Compatibility Rating Mode (SW7)

- Certain models of Avid Extreme Inverter may be configured to report a lower rating to the controller than that of which they are actually capable.
- This feature is provided to support compatibility with legacy systems and to increase flexibility in different applications.
- Not all Avid Extreme Inverter units support a compatibility rating.
- Compatibility Rating Mode is enabled by setting DIP switch **SW7** to the ON position (its ***default is OFF***).
- ***There is currently no Compatibility Rating for the AEI550A***

6.5 MODBUS Address Setup Switches (SW8 to SW10)

- These three switches set the MODBUS Slave Address of the AEI.
- These are SW1 to SW3 on the small DIP switch bank adjacent to TB6. Like the main DIP switch bank, these are numbered SW1 to SW4 from top to bottom when the unit is installed vertically in a cabinet.
- The functions are as follows:

SWITCH SETTINGS			MODBUS SLAVE ADDRESS	Notes
SW1 (RS485)	**SW2 (RS485)**	**SW3 (RS485)**		
OFF	OFF	OFF	1	As can be seen, the MODBUS slave address is ***1 + SW[]*** ***The default is OFF OFF OFF:*** Slave Address = 1
OFF	OFF	ON	2	
OFF	ON	OFF	3	
OFF	ON	ON	4	
ON	OFF	OFF	5	
ON	OFF	ON	6	
ON	ON	OFF	7	
ON	ON	ON	8	

- See section 0 for details of the MODBUS communication function.

6.6 MODBUS Sample Mode

SW4 (RS485)	Sample Mode	Notes
OFF (Default)	Standard Sample Mode	See section 6.6 for details
ON	Simultaneous Sample Mode	

6.7 Unused Switches

- SW8 through SW12 of the main switch bank currently have no assigned functions.
- ***They should be left in the OFF position to ensure compatibility with any future upgrades.***

7. LEDs and Fault Indication

- The unit has two discrete LEDs (red and green) and a two-digit LED display.
- The discrete LEDs indicate the operational state of the unit and the numeric display may either indicate various feedback signals or all active faults.

7.1 Discrete LEDs

- OFF - ON - FLASHING

RED LED	GREEN LED	Meaning
		Auxiliary supply is not present
		Internal error present on C.I.B. or auxiliary supply is out of tolerance
		Unit healthy (not tripped) and disabled (IGBT's not switching)
		Unit healthy (not tripped) and enabled (IGBT's switching)
		Unit faulted. Fault codes will be displayed on 2-digit display, appropriate fault codes sent to controller (as supported – see section 7.5)
		Controller is attempting a reset cycle

7.2 Discrete YELLOW LED

- When illuminated, this indicates that an internal FAN FAIL condition exists – not applicable on this model.

7.3 Program Version Display

- When the auxiliary power is applied, the 2-digit LED displays the C.I.B. program version for three seconds.

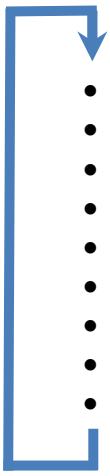
- This version is also displayed on a small label on the front of the unit. This information will be required by Avid when providing technical assistance.

7.4 LED Feedback Indication

- After power up, when the unit is not faulted, the 2-digit LED display cycles through indications of several operational feedbacks.

- Each feedback is displayed for 1s, before the display cycles to the next feedback. A "--" pattern is used to indicate the start of the cycle.

- The cycle is:



  - "--"
  - CURRENT - A PHASE
  - CURRENT - B PHASE
  - CURRENT - C PHASE
  - TEMPERATURE – A PHASE IGBT
  - TEMPERATURE – B PHASE IGBT
  - TEMPERATURE – C PHASE IGBT
  - TEMPERATURE – C.I.B.
  - DC LINK VOLTAGE

- In a similar manner to the analog outputs, most values are displayed as the percentage of a defined value. The exception is the C.I.B. temperature which is displayed in °C:

Signal Type	Explanation & Scaling
Current	• 100% output is equivalent to 2500A • The formula for the indication is: ○ % CURRENT = 100% x $AVERAGE_{1s}$ (|Phase Current|) / 2500A • Or, in words, the formula is ***the absolute current averaged over 1s, expressed as a percentage of 2500A*** • This will produce fluctuating display values at lower power frequencies as the 1s average period beats with the current waveform • For reference, the relationship between AVERGAGE OF MEAN and RMS values for a sinusoid is AVERAGE = 0.90 X RMS
DC Link Voltage	• Average over 1s expressed as percentage of 1500 Vdc
IGBT Temperature	• Expressed as percentage of 150°C (0°C = 0%, 150°C = 100%) • Note that due to the nature of the internal temperature sensor, any temperature below 30°C will be indicated as 20%.
C.I.B. Temperature	• This is displayed in °C • Note due to absence of negative sign any value below 0°C will be displayed as ‘00’

7.5 Fault Codes

- When the unit has a fault, the 2-digit LED display cycles through a list of all active faults.
- Each fault that the unit recognizes is encoded into a compatible fault code for indication by the controller.
- The Avid unit can identify many more and different faults than the controller can recognize, so some rationalization has been necessary.
- The following table describes each fault code on the unit, together with the fault code that is transmitted to the controller for each of the faults recognized by the C.I.B.:

Fault Code on LED Display	Meaning	Trip Code Transmitted to Controller[*1]
1	A Phase IGBT Self-Protect Fault	31
2	B Phase IGBT Self-Protect Fault	33
3	C Phase IGBT Self-Protect Fault	35
4	A Phase Heatsink Over Temperature Fault	32
5	B Phase Heatsink Over Temperature Fault	34
6	C Phase Heatsink Over Temperature Fault	36
7	A Phase Silicon Over Temperature Fault	32
8	B Phase Silicon Over Temperature Fault	34
9	C Phase Silicon Over Temperature Fault	36
10	Over Voltage (DC Link)	38
11	External Trip Fault	37
12	Internal Fan 1 Failure (on units where this fan is fitted)	243
13	Internal Fan 2 Failure (on units where this fan is fitted)	243
14	Internal Fan 3 Failure (on units where this fan is fitted)	243
15	External Fan Failure (on units where this fan is fitted)	243
16	Incoming Power Supply Fault	240
17	Internal Power Supply Fault (+15V)[*2]	241
18	Internal Power Supply Fault (-15V)[*2]	242
19	Internal Power Supply Fault (IGBT)[*2]	240
20	Internal Power Supply Fault (+3V5)[*2]	240
21	Internal PWM Deadtime Fault (A Phase)[*2]	247
22	Internal PWM Deadtime Fault (B Phase)[*2]	248
23	Internal PWM Deadtime Fault (C Phase)[*2]	249

Fault Code on LED Display	Meaning	Trip Code Transmitted to Controller[*1]
24	Internal PWM Frequency Fault (A Phase)[*2]	244
25	Internal PWM Frequency Fault (B Phase)[*2]	245
26	Internal PWM Frequency Fault (C Phase)[*2]	246
27	A Phase Positive Instantaneous Overcurrent	31
28	A Phase Negative Instantaneous Overcurrent	31
29	B Phase Positive Instantaneous Overcurrent	33
30	B Phase Negative Instantaneous Overcurrent	33
31	C Phase Positive Instantaneous Overcurrent	35
32	C Phase Negative Instantaneous Overcurrent	35
33	DC Link Feedback Fault[*2]	212
34	Internal Fault[*2]	212
35	Interface Board Over Temperature (65°C)	212
36	Internal Data Error [*3]	212

***1:** The fault code for a unit connected to position 1 of the controller system is given. For units in other positions the equivalent fault code will be displayed by the controller.
***2:** These faults indicate a fault within the inverter unit. They do not occur in normal operation and user fault-finding is generally not possible. In the unlikely event that these faults are experienced, contact Avid Controls for support.

***3:** This fault can happen if the connected CDC (controller) makes an incomplete attempt to reprogram the internal data. Reprogramming is possible with access to the controller's maintenance features.

8. MODBUS[1] Communications

8.1 Introduction

- The AEI implements a small subset of the MODBUS RTU SLAVE PROTOCOL via the 2-wire (plus ground) RS485 port on TB6.
- The port has the following electrical and data specifications:
    - Electrical Levels: TIA/EIA RS485, 5V
    - Isolation: Fully isolated for signal integrity
      Maximum isolation voltage (***not for safety***) is 1500V
    - Baud Rate: 115200 bits per second
    - Parity: None
    - Data Bits: 8
    - Stop Bits: 1
    - Termination: An internal120Ω termination resistor may be connected across the RS485 data wires by linking TB6/1 to TB6/2

8.2 MODBUS_TIMER

- The AEI maintains a 1ms timer, ***MODBUS_TIMER***, that counts continuously and overflows from 65535 to 0 every 65.536 seconds.
- The value of ***MODBUS_TIMER*** is one of the diagnostic fields that is provided via the MODBUS link.
- The following MODBUS function is used to synchronize ***MODBUS_TIMER*** between all AEIs connected to the MODBUS network:
    - MODBUS Address: 00 (Global Address)
    - MODBUS Function: 06 – Write Single Register
    - Register Address: 0
    - Write Data: The required value for ***MODBUS_TIMER***.
      Data is loaded immediately (< 1ms) into ***MODBUS_TIMER*** by all AEIs that validate the received message

8.3 Diagnostic Data

- The AEI will transmit 32 words of diagnostic data in response to a MODBUS query.
- The following MODBUS function is used to read diagnostic data from the AEI:
    - MODBUS Slave Address: 01 to 08, switch selectable
    - MODBUS Function: 03 – Read Holding Registers
    - Base Register Address: 0
    - Read Length: 32

[1] MODBUS is a is a registered trademark of Schneider Automation Inc.

- The following table defines the diagnostic data that is transmitted:

REG.	NAME	TYPE	NOTES
0	SER_NUM	UNSIGNED	This is the AEI serial number. Does not change.
1	TIMER	UNSIGNED	Free running ***1ms*** timer that can be written using MODBUS Global Address – see section 8.2. Sampled when read.
2	FAULT_1_16	BIT FIELD	Bit 0 is FAULT_1 Bit 15 is FAULT_16 Each bit of these ***bit fields*** indicates if the fault designated by the equivalent code is active. See section 7.5 for list of fault codes. Sampled when read.
3	FAULT_17_32	BIT FIELD	Bit 0 is FAULT_17 Bit 15 is FAULT_32
4	FAULT_33_48	BIT FIELD	Bit 0 is FAULT_33 Bit 15 is FAULT_48
5	FAN_1_SPEED	UNSIGNED	The speed, in ***RPM***, of the internal cooling fans. Sampled when read. Note that the AEI detects a fault if these speeds fall below safe values (the exact value varies based upon a number of factors). These are provided to allow the user to compare speeds ***between*** AEIs and with ***historical*** values, giving the possibility of identifying a unit with a fan problem prior to failure.
6	FAN_2_SPEED	UNSIGNED	
7	FAN_3_SPEED	UNSIGNED	
8	MAX_POS_CURRENT_A	SIGNED	The maximum positive current, in ***AMPS***, of each output phase of the AEI, since the diagnostic data was last transmitted. This will be a positive value.
9	MAX_ POS_CURRENT_B	SIGNED	
10	MAX_ POS_CURRENT_C	SIGNED	
11	MAX_NEG_CURRENT_A	SIGNED	The maximum negative current, in ***AMPS***, of each output phase of the AEI, since the diagnostic data was last transmitted. This will be a negative value.
12	MAX_ NEG_CURRENT_B	SIGNED	
13	MAX_ NEG_CURRENT_C	SIGNED	
14	AVG_CURRENT_A	SIGNED	The average absolute current, in ***AMPS***, of each output phase of the AEI, since the diagnostic data was last transmitted. Note that the current is first rectified before the average is calculated, so that positive or negative output currents are not differentiated. Note that (due to storage limits) the evaluation of average is suspended after 32767 PWM periods of evaluation (13s at 2.5kHz PWM). So, to utilize this data, it must be accessed at least this often.
15	AVG_CURRENT_B	SIGNED	
16	AVG_CURRENT_C	SIGNED	
17	IGBT_TEMP_A	SIGNED	The temperature, in ***0.1°C*** units, of the IGBT temperature feedback devices. Sampled when read.
18	IGBT_TEMP_B	SIGNED	
19	IGBT_TEMP_C	SIGNED	
20	MAX_IGBT_TEMP_A	SIGNED	The maximum temperature, in ***0.1°C*** units, of the IGBT temperature feedback devices since the diagnostic data was last read.

REG.	NAME	TYPE	NOTES
21	MAX_IGBT_TEMP_B	SIGNED	
22	MAX_IGBT_TEMP_C	SIGNED	
23	CIB TEMPERATURE	SIGNED	The CIB temperature in ***1°C*** units. Sampled when read.
24	DC_VOLTS	SIGNED	The current value, in ***0.1V*** units, of the measured DC link voltage. Sampled when read.
25	MAX_DC_VOLTS	SIGNED	The maximum value, in ***0.1V*** units, of the measured DC link voltage since the diagnostic data was last read.
26	STATUS	BIT FIELD	BIT 0: TRIPPED / BIT 1: ENABLED / BIT 2: FAN FAIL / OTHER BITS: ZERO
27	SENSOR 1	UNSIGNED	The AEI has three internal sensors, CURRENTLY UNUSED, able to measure 0-10V signals from a variety of optional sensors. These registers give the sensor values, in ***1mV*** units. Sampled when read.
28	SENSOR 2		
29	SENSOR 3		
30	UNUSED	UNSIGNED	These words are stuck at ZERO.
31			

8.4 MODBUS Sample Mode

Standard Mode (RS485 SW4 OFF)

- In this mode, the data to be transmitted in response to a MODBUS query is sampled as soon as a valid query, addressed to the slave address set by SW1 to SW3, is received.
- Once sampled, data is transmitted immediately.

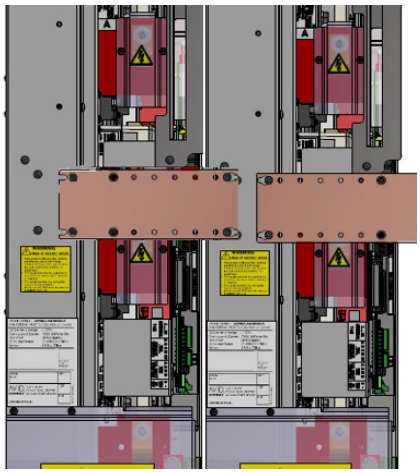
Simultaneous Sample Mode (RS485 SW4 ON)

- In this mode, the data to be transmitted is sampled when a valid MODBUS query ***addressed to slave address 01*** is detected, independent of the slave address set by SW1 to SW3.
- The sampled data is not transmitted until a valid MODBUS query, addressed to the slave address set by SW1 to SW3, is received.

- In this mode, all AEIs on a single bus will sample their data simultaneously.
- Things to note:
    - This switch has no effect on the AEI configured to be slave address 01.
    - If slave address 01 is not polled by the MODBUS master, then no data will be sampled by any unit on the bus.
    - If a data error occurs on one of the units being commanded to sample, it will not do so but no MODBUS exception will be created. This circumstance should be vanishingly rare and may be detected by incoherent MODBUS TIMER data in the transmitted response.

9. EMC Bonding for Electromagnetic Compatibility

- Electromagnetic Compatibility (EMC) is a property of electrical/electronic equipment that allows it to operate in proximity to other electrical/electronic equipment without interfering with the other equipment.
- In a drive, control equipment can be adversely affected by the switching noise of the IGBTs.
- To reduce this interference low voltage components e.g., controller, I/O units, communications modules etc. should be mounted in a segregated or separated part of the enclosure from the high-power rectifier/AEI modules (normally separated by a grounded steel panel).
- In addition to the grounding (earthing) of metalwork for safety reasons, additional measures are needed to reduce the effects of electromagnetic noise. Cables used for safety grounding do not provide a low impedance path for high frequency noise signals due to the inductive impedance of the conductors. Therefore, bonding is required to ensure that all grounded metalwork is at the same potential with respect to these high frequency interference signals. Bonding is usually achieved via thin, wide sheets of metalwork fixed at multiple points between two units.
- The EMC linking plates provide equipotential, high frequency bonding between the AEI modules. This ensures that the 0 volts of each AEI is at the same potential and the effects of switching noise are minimized.
- This bonding also applies to all the cable gland plates to the enclosure. The screening effectiveness of screened or armored cables is achieved by bonding to the ground plate by a 360°-degree connection. This gland plate must then be connected directly to the enclosure walls.
- This bonding is required in addition to any electrical safety bonding and applies to both control and power cabling gland plates.



Bonding plates linking adjacent AEI Modules

9.1 Shielded Ribbon Cables

- The control ribbon cables must be screened/shielded to prevent EMC interference.
- The cable should be routed below the APU units across the connected steel A and B phase shrouds.
- The screened ribbon should be secured via cable ties through the bridge punches on the metalwork.
- The screened ribbon cable should be secured at each end with a metal ribbon clamp ensuring that the clamp contacts the exposed copper braid of the ribbon cable.

9.2 Enclosure

- This module is of IP00 construction and must be installed into an enclosure.

9.2.1 Enclosure Requirements

- When designing the enclosure, the following essential requirements must be taken into account:
  - Prevent unauthorized access to the enclosure and provide warning signs.
  - Electric shock hazards – provide shrouding/insulation for exposed live parts.
  - High temperature hazards – items such as heatsinks, busbars, cables etc. will become hot.
  - Stored Energy – the AEI module stores energy at a lethal voltage after power is removed. Wait at least 5 minutes after removal of power and check the voltage has decayed to a safe level.
  - Cooling fans – may continue to rotate for a while after power off.

- The enclosure should also be designed to be mechanically robust and protected from ingress of dust, water and other substances. Do not allow the buildup of condensation in the enclosure.

10. Spares and Service

The AEI contains no user serviceable parts. For repairs and replacement product contact:

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11. Document Revision History

Rev.	Date	Author	Changes
00	Mar 22 2019	Mark Woods	Document created
01	Aug 15 2024	Gary Pace	Note about not-fitted TBs on CIB added.
02	May 14 2025	Mark Woods	Fan types changed. General update on document.