Document Title:	Avid Application Note How to check current sharing between AEI modules.
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Approvals

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1. Background

- DELTA modules are prone to a specific fault that causes the negative half-cycle of output current to be lost due to a failure in the SKiiP gate driver that causes the lower IGBT devices not to turn on.
- To help users identify this issue, a number of test-points were added to the Delta Interface Board (DIB) to allow the individual output currents for a DELTA to be analyzed on an oscilloscope.
- Siemens and/or GE also developed a specific tool to assist in fault-finding this issue.
- The Avid Extreme Inverter modules are not susceptible to this fault, and sharing issues are highly unlikely to occur.
- If necessary, the sharing between AEI modules can be checked using either the 2-digit LED display, or via the MODBUS communication capability.
- The following explanations are extracted from the AEI data sheets.

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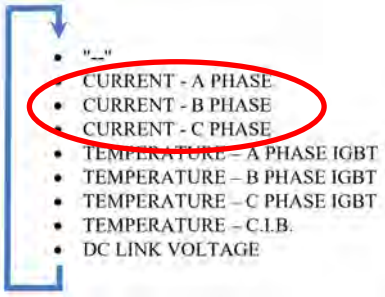
2. Using the LED Display

- When no trip condition is present, the two-digit LED display cycles around eight operational values:

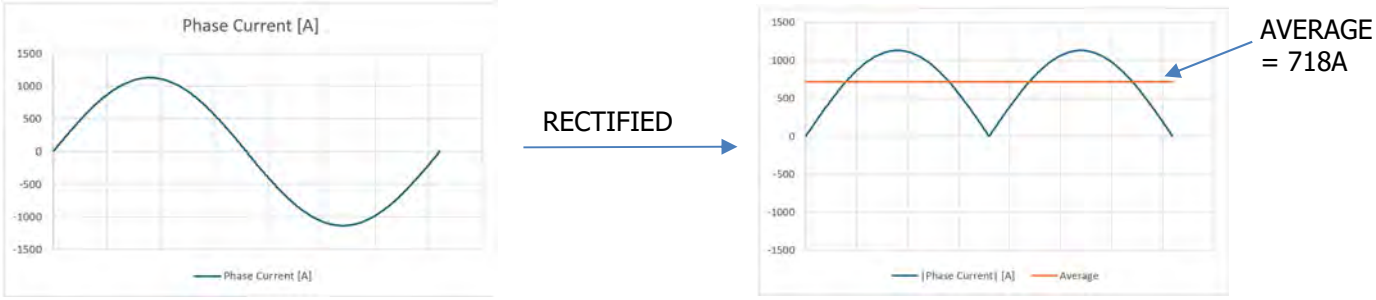


- As can be seen, the three individual phase currents are displayed.

- Because these are displayed on a 2-digit LED display, the currents are rectified, scaled and averaged before displaying. The following is extracted from the Data Sheets:

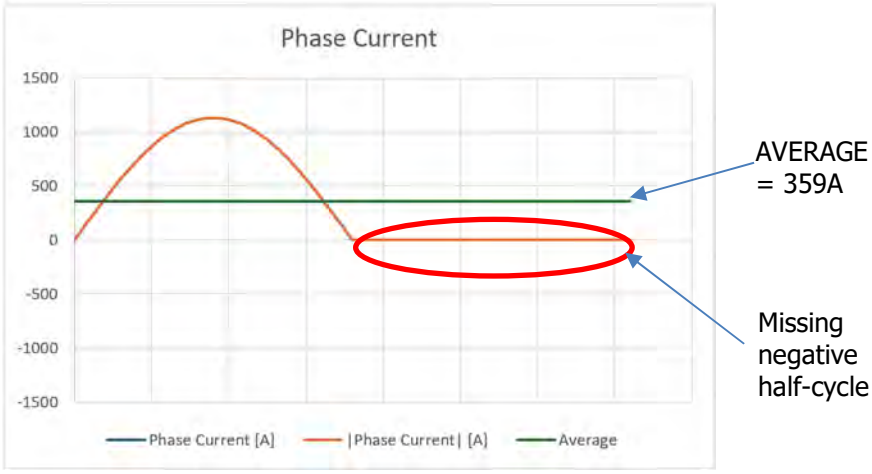
Signal Type	Explanation & Scaling
Current	• 100% output is equivalent to 2500A • The formula for the indication is: ○ % CURRENT = 100% x AVERAGE$_{1s}$ (|Phase Current|) / 2500A • Or, in words, the formula is ***the absolute current averaged over 1s, expressed as a percentage of 2500A*** • This will produce fluctuating display values at lower power frequencies as the 1s average period beats with the current waveform • For reference, the relationship between AVERAGE OF MEAN and RMS values for a sinusoid is AVERAGE = 0.90 X RMS

- To give an example, if a phase current is 800Arms, then the LED indication for that phase is 29%. This is explained in the following figures:



- 718A is 28.7% of 2500A, hence the displayed value will be 29%.

- If the negative half-phase were missing (like the common fault with DELTA modules), the value displayed would be 14%, as explained in the following figures



- 359A is 14.4% of 2500A, so the LED displays 14%.
- Obviously if the sharing error is caused by external wiring faults or component failures, different examples would apply.
- Since each significant digit of the LED display corresponds to 25A, sharing errors of about 50A will be identifiable using this method.

3. Using the MODBUS Communication Port

- The MODBUS port can be used to monitor the phase currents with much greater resolution than the LED display: 1A per least-significant-bit compared to 25A.
- Since the MODBUS port cannot be accessed quickly enough to determine the actual current waveform, the AEI keeps track of the maximum positive current, maximum negative current and average of the rectified current between subsequent accesses to the MODBUS port.
- The following table is extracted from the AEI Data Sheet, and shows the registers used to monitor the phase currents:

REG.	NAME	TYPE	NOTES
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	

- So, for an 800Arms phase current, we would expect 1131 as the max. positive, -1131 as the max. negative and 718 as the average (rectified) current.

4. Revision History

Rev.	Date	Author(s)	Changes
00	Jul 22 2024	Gary Pace	Document Created