

Powering Up the CRD200DA12E: High Performance SiC Three-Phase Inverter Evaluation Kit

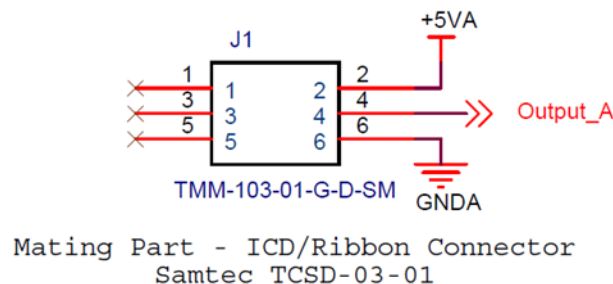
1. **Gate Drive PWM Signal Connection:** From your system controller, connect Phase A, B, and C PWM signals to connector JT2 on the gate driver (reference *CRD200DA12E Power Circuit, Current & Voltage Sensing, and Gate Drive Connection Schematics*). The recommended dead time at 20 kHz PWM switching is 500 ns, which must be set by the controller. If the PWM switching frequency is going to be changed from the default value of 20 kHz, the dead time can be adjusted and dead time compensation should be adopted, to keep the required output waveform fidelity and power quality.
2. **Three-Phase Current Feedback Signals:** Connect the three-phase current feedback signal to the controller enabling closed-loop current control and overcurrent protection (reference *CRD200DA12E Power Circuit, Current & Voltage Sensing, and Gate Drive Connection Schematics*). The rated continuous current of the inverter is 300 A_{rms} at 25°C coolant temperature and the current sensor is capable of measuring up to ±700 A peak (495 A_{rms}). The customer must determine and set the overcurrent protection limit, based on the rated current of the application.
3. **DC Bus Sense Feedback Signal:** Connect the DC bus voltage sense feedback signal to your controller (reference *CRD200DA12E Power Circuit, Current & Voltage Sensing, and Gate Drive Connection Schematics*) enabling DC bus voltage feedback, as well as the DC bus overvoltage and undervoltage protection. The voltage threshold limits will have to be determined by the customer depending on the application. The nominal continuous DC bus voltage is rated at 800 V_{DC}; the maximum DC bus voltage should not exceed 900 V_{DC}, with appropriate derating.
4. **Ground Bar Connection for Safety:** Connect earth ground to the grounding bar underneath the enclosure.
5. **Connection to Three-Phase Load:** Connect the Phase A, B, and C outputs to the three-phase load with correct amperage power cables (recommended 2 × 2 AWG or 1 × 4/0).
6. **DC Bus Connection:** Connect a DC supply to DC+ and DC- of the inverter using correct amperage power cables (recommended 2 × 2 AWG or 1 × 4/0).
7. **Ramping Up the DC Bus Voltage:** It is highly recommended that the unit be powered up with very low DC bus voltage (e.g., 10-20 V DC) to begin with, until it is confirmed that the controller is working correctly and has sufficient EMI- and high-frequency noise- immunity. Once the controller operation is confirmed, then gradually increase the DC bus voltage to higher levels.

Current Sensors

The current sensors use only a +5 V and ground lines (i.e., pins 2, 4, and 6 on the connector); it is acceptable to share a single +5 V supply with all three (3) current sensors. The current sensor PCB does not use the ±10.4 V and +2.5 V signal pins. The +5 V source should be a regulated supply since the Melexis MLX91208 sensors are ratiometric. The sensor is a non-contact planar Hall effect device, which is entirely isolated from the AC bus bars, with a current draw measured at ~14 mA. The sensor datasheet indicates a 7 mA minimum, 12 mA typical, and 14 mA maximum current rating. The sensor board output is a voltage on the range 0 to +5.0 V with +2.5 V indicating 0 A. Signal scaling depends on the width of the concentrator shield according to the equation:

$$B = 1.25 \times \left(\frac{I}{w} \right)$$

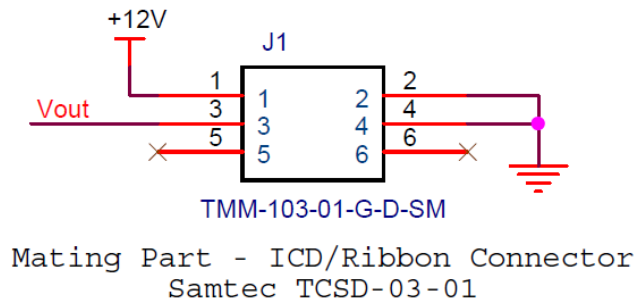
where B is the field strength in milli-Tesla, I is the peak current in Amps, and w is the width of the ferromagnetic shield in millimeters, respectively. The MLX91208 sensor is linear over ±20 mT and will have a nonlinear roll-off up to a maximum field of ±25 mT. The schematic lists a 35 mm width, which would imply a linear range of ±560 A peak, equating to 396 A_{rms} for a ±20 mT field. The maximum range would be ±700 A peak equating to 495 A_{rms} for a ±25 mT field. This should result in a resolution of 1400 A / 5 V or 280 A per 1 V; thus, 3.5 mV is 1 A.



Cree Fayetteville has not fully characterized the nonlinear region for this setup; however, prior experiments confirm that the nonlinear range is repeatable and does not suffer from hysteresis. Therefore, it should be possible to use a table lookup or polynomial approximation to linearize data from that range.

DC Bus Voltage Sensor

The DC bus voltage sensor board requires 12 V, ground, and signal connections. The output is a voltage on the range 0 V to +5.0 V corresponding to a range of 0 V to 800 V on the DC bus. A single “voltage present” LED indicator is also present on the PCB as a safety precaution; the LED will illuminate when 20 V or more is present on the DC bus. There should be no problem with sharing power supplies between the voltage and current sense boards. The DC bus voltage sensor utilizes a Samtec TMM-103-01-G-D-SM connector.



Protection Against EMI

The SiC MOSFET module switches at speeds beyond what is customarily associated with IGBT-based modules. Therefore, special precautions are required to realize the best performance. The interconnection between the gate driver and module housing needs to be as short as possible. This will afford the best switching time and avoid the potential for device oscillation. It is strongly recommended to use twisted pair cabling or shielded ribbon cables that go to the current sensors and DC bus voltage sensors. Grounding for the shield should only occur at the entrance to the controller enclosure. EMI-mitigating copper foil tape should be placed around any non-shielded cabling and terminated to the enclosure, making 360° metal-to-metal contact. The controller enclosure should be bonded to ground through a low impedance path; it is recommended that this enclosure is an EMI-mitigating Hoffman-type, made of mild steel with a wide lip and an EMI gasket.