SKAI™

HV SKAI

User Manual

For Models:
SKAI 4001GD06-1452W/1452L/1450W/1450L
SKAI 3001GD12-1452W/1452L/1450W/1450L

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1. Introduction

The SKAI modules are a family of products primarily designed for driving 3 phase loads from a DC source. The products are classified by the rated voltage of the semiconductor switching devices within the module - Low Voltage (LV) and High Voltage (HV) SKAI modules. This user manual describes the HV SKAI module and is intended to give the user an understanding of the available configurations, and sufficient information to incorporate the module in a system.

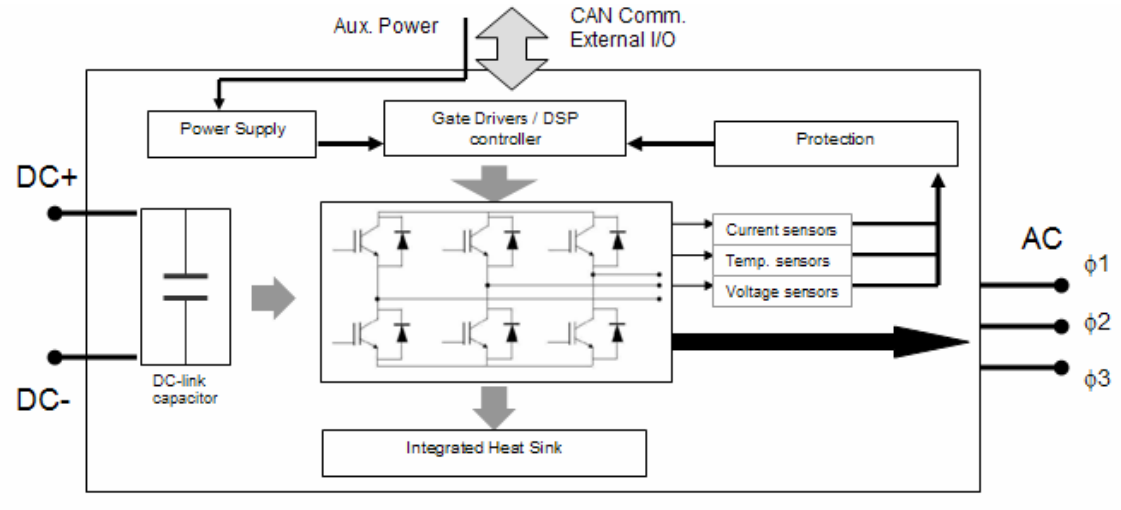


Figure 1 HV SKAI block diagram.

The block diagram on the HV SKAI in Figure 1 shows a 6 pack module with DC-link capacitor, integrated current sensors, and temperature sensors, protection logic, gate drivers and an optional DSP controller all mounted on a heat sink. The SKAI uses SEMIKRON's latest pressure contact technology for compact design, improved thermal performance and high reliability. Integrating the DC-link capacitors in the design reduces internal inductance and allows higher bus voltages to be used. Integrating the DC-link capacitor also allows less capacitance to be used for a smaller, more reliable design. This compact construction technique is extremely rugged making it ideal for applications on mobile platforms.

2. HV SKAI Module Family

The SKAI is a versatile design. It can be configured with the newest generation of 600 volt, or 1200 volt IGBTs. It can be mounted on a liquid cooled heat sink, air cooled heat sink, or customer specified heat sink. The SKAI gives the customer the option of only including the gate drivers and having an external controller drive the module or the SKAI can have an integrated DSP controller. The DSP controller offers complete flexibility with serial communications and EEPROM in a highly integrated unit. Once customer supplied software is downloaded, the SKAI is a complete high performance inverter ready to drive three phase loads.

The module can be identified by locating the label near the output connections as shown in Figure 2. The label indentifies the model number, part number and serial number. The model number is explained in Figure 3. The part number is only meaningful to manufacturing and links a specific bill of materials to the product. The serial number includes the date code and some additional information. For example, s/n 0543203-AD would indicate that the module was assembled in year 2005, work week 43 with series assembly nunber 203 and revision AD. A summary of model numbers in **Table 1** shows the differeces between the various standard models.

Figure 2 Location of the label identifying the module.

Table 1 Standard HV SKAI module configurations

SKAI Model	3001 GD12-1452L	3001 GD12-1452W	3001 GD12-1450L	3001 GD12-1450W	4001 GD06-1452L	4001 GD06-1452W	4001 GD06-1450L	4001 GD06-1450W
600V IGBTs					X	X	X	X
1200V IGBTs	X	X	X	X				
DSP included			X	X			X	X
CAN comm.			X	X			X	X
25pin connector	X	X			X	X		
14pin connector			X	X			X	X
Liquid cooled		X		X		X		X
Air cooled	X		X		X		X	

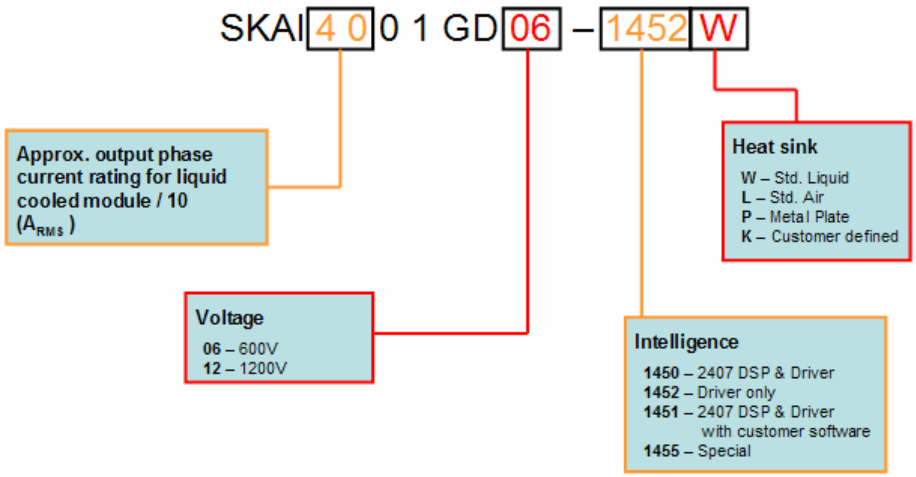


Figure 3 Standard HV SKAI model designations.

3. Connections

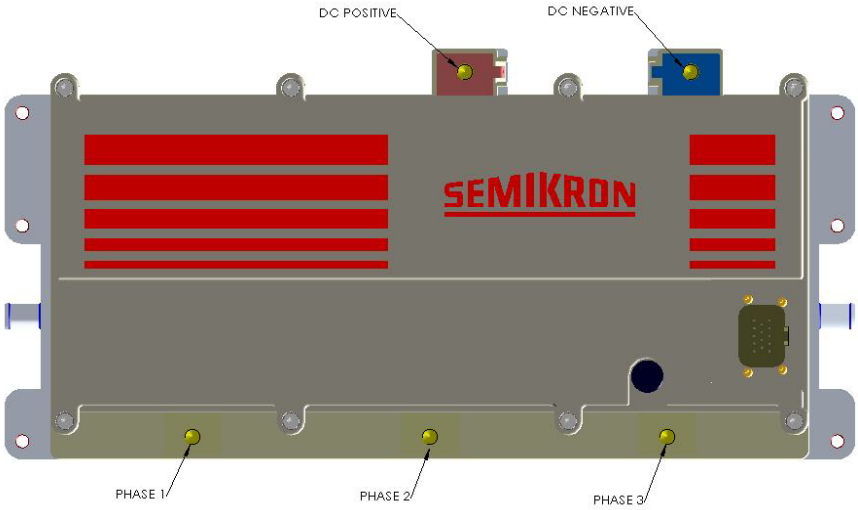


Figure 4 External Power Terminals.

When choosing terminations to connect to the SKAI verify that the terminations will fit given the space from the insert to the cover. The 5 power connections are M8 x 13mm inserts. Rated Torque 9 Nm (80lb-in).

4. Module Components

IGBTs

The IGBTs are mounted on 3 DBCs each in a half bridge configuration. The DBCs can be populated with 600 or 1200 volt IGBTs. The DBC material is ALN (Aluminum Nitride). The ALN provides better thermal conduction for a higher current capability.

The DC Link bus bars have a film capacitor incorporated in the module, which eliminates the need for high frequency snubber capacitors.

Table 2: Module Ratings

Module Ratings	600	1200	**Units**
Silicon Voltage	600	1200	V
IGBT Breakdown Voltage	600	1200	V
Maximum DC Link Voltage	450	900	V
Maximum Continues AC Output Current	400	300	Arms
Peak Current Limit	1000	1000	Apk
DC-Link Trip Voltage	458	917	V
DC-Link Capacitance	1	1	mF

Heatsink

The SKAI can be mounted on a standard water cooler or air cooled heatsink. In addition to the standard solutions offered by Semikron the SKAI can be mounted on a customer specified heatsink.

Liquid Cooled

Liquid cooling offers the highest current rating of any heatsink solution. While 50% ethylene glycol solution is recomended coolant, DI water or other fluids may also be used. It is not recomended that untreated water we used for cooling. Table 3 summarizes the performance of the heat sink over various flow rates.

Table 3: Liquid Cooled Heatsink using 50% Ethylene Glycol / 50% Water as coolant.

R-theta (K/kW)	Flow (Liter /min)	Back pressure (bar)
13.5	5	0.067
10.7	10	0.245
9.3	15	0.583
8.7	20	1.130

Air Cooled

Std. air-cooled HV SKAI modules use an Alcan HKH R400 series heat sink. When used with three 12cm (4“) muffin fans (NMB 4715FS-12T-B50/ 115 VAC) and the appropriate plenum for a total airflow of 110 CFM, the heatsink performance (Rth_{h-a}) was measured to be 0.032 K/W. Figure 5 shows the performance data from the manufacturer at different air flow rates.

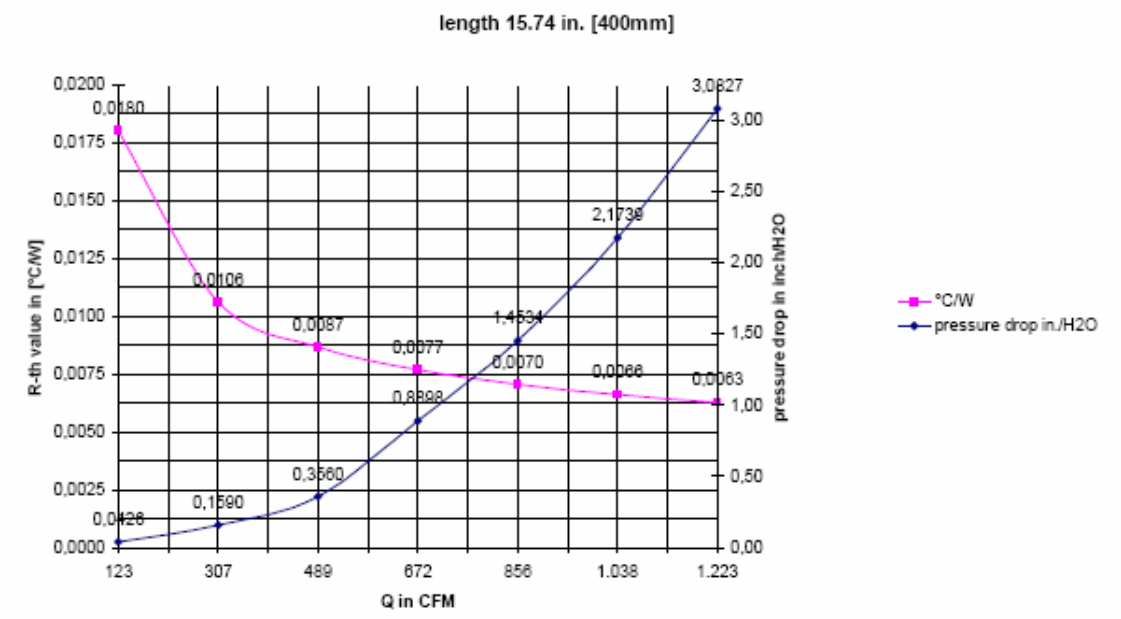


Figure 5 Std. SKAI heat sink performance data.

Csutom Heat Sinks

Contact SEMIKRON to inquire about assembling SKAI modules on customer furnished heat sinks.

Current Sensors

The SKAI has integrated magneto resitive current sensors. The current sensors provide phase current magnitude and polarity for either the driver or controller boards and over current indication for module protection. The over current thresholds are specified in Table 2. The output of the current sensor can be used for measurement and control feedback functions. The output of the current sensors is amplified by circuitry on either the driver or controller board and the scaling is detailed in those sections of the User's Manual. In the standard configuration of the controller board Phase 1 and Phase 3 are populated with current sensors. This configuration is intended for a balanced 3 phase load such as a motor drive. Three current sensor modules (one sensor / phase) can be special ordered. The sensors have an overall accuracy of +/- 8% over the range of the module operating temperature.

5. Agency Standards

The SKAI is designed so that when incorporated in a properly designed system the system will be capable of meeting agency standards UL 840 and EN50178.

Voltage Withstand

The SKAI is designed to be compliant with EN50178 and UL 840 polution degree 3. The module will withstand 3kVac hipot from any power terminals to the heatsink and 3kVac from the low voltage connector pins to five power connections.

Environmental

The SKAI is a dust tight module. The cover forms a dust tight seal to the housing of the SKAI and the connector is a dust tight connector. The interior of the SKAI meets standard IP50. This protects the IGBTs, DC-Link capacitors and bus structures and the controller board electronics from dust and other contaminates. The external power connections are not protected and meet IP00.

6. Driver Board

The SKAI driver board provides all the interface circuitry for gate drives, voltage, current, and temperature measurements, fault protection, and isolation so that the user only needs to provide logic level PWM signals for each switch to operate the SKAI. The SKAI uses a standard D-sub 25 pin connector with the same signals as a SKiiPPACK interface.

The 6 input signals TOP1, BOT1, TOP2, BOT2, TOP3, and BOT3 drive the 6 IGBTs. While the most obvious application is a 3 phase motor drive there are many other possibilities. Since all the switches are controlled independently the module can perform combinations of H-bridge, buck and boost applications, all at different switching frequencies.

Interlock Time

The driver board prevents switch cross conduction by only allowing one switch in a phase to be on at a time and ensuring an interlock time between the turn-off of one switch and the turn-on of the other switch in a phase. The default interlock time between TOP and BOT turn on is set for 2 us. The driver board can be configured, at the factory, for 1, 2, 3, or 4 us interlock time or no cross conduction protection. The interlock time is not simply added to the TOP and BOT signals. If the TOP and BOT signals have greater than the set minimum interlock time then the TOP and BOT signal propagate through with no timing change. The interlock protection only guarantees a minimum interlock time.

Shield Connection

The default configuration is that the shield of the 25 pin D-sub connector is connected to ground through a 0 ohm resistor. This resistor can be depopulated to disconnect the cable shield from driver board ground.

Inputs

Drive Signals

BOT HB 1, TOP HB 1, BOT HB 2, TOP HB 2, BOT HB 3, and TOP HB 3 are input signals that generate the switch commands for the 6 switches. These are positive 5 or 15 V CMOS logic. They can be driven by either 5 volt or 15 volt logic. High equals switch on and low equals switch off. When driven from 5 volt logic the input impedance is 60k. When driven from 15 volt logic the input impedance when driven to logic high is 7k, when driven to a logic low the input impedance is 60k.

Table 4: Drive Signal Input Impedance

Status	Min (V)	Max (V)	Zin
On 5V	4.0	5.5	60k
On 15V	4.0	15.6	7k
Off 0V	-0.7	1.5	60k

Outputs – Analog

The driver board provides analog signals representing the DC link voltage, the heatsink temperature, and phase currents.

UDC analog OUT

Pin 19 of the interface connector is the UDC analog OUT pin. It is an analog signal proportional to the DC link voltage. 9 V is full scale.

Table 5: DC Link Scales

Silicon Voltage	**600**	**1200**
Scale in V_{link}/V_{out}	50	100
DC Link Max Voltage (@ 9 V) (V)	450	900
DC Link fault Voltage (@ 9.18 V) (V)	459	918

Temp analog OUT

Pin 10 of the interface connector is the Temp analog OUT pin. It is an analog signal proportional to the temperature of the SKAI heat sink. The temperature sensor is capable of reporting -40°C to +120°C heat sink temperatures. In the standard configuration, the output voltage is prevented from driving below -0.6 V by a diode. The temperature sensor range is from 20°C to 120°C and generates a 0 to 10 V signal. If the diode is removed and negative voltages allowed the temperature sensor will report down to -40 °C. The full-scale range is -4.2 V to +10 V.

I analog OUT HB

Pins 11, 12, and 13 of the interface connector are the I analog OUT HB 1, 2, and 3 pins respectively. They are the analog signals proportional to the current in each half bridge phase. A positive signal is current out of the phase. A separate reference for each current signal is available at the interface connector for differential measurement.

Table 6: Current Scaling

Phase current (-10V - +10V), 0V = 0A for 6 pack		
Silicon Voltage	600	1200
Scale Iout/Vout (A/V)	100	100
Over current threshold (A)	1000	1000

Error Signals

ERROR OUT

Pins 3, 14, and 17 of the interface connector are the ERROR OUT pins. All 3 pins are tied together so there is only 1 signal. This is an open collector output that must be pulled high by an external pull up resistor. LOW equals no error. This signal reports an error for a V_{CE} fault on any switch, over current on any phase, over voltage of the DC link, under voltage of the +15 V supply, and over temperature of the heat sink. When an error is detected and reported all switching is inhibited and all switches are turned off. In order to reset the control board and start switching again all fault conditions must be removed and all TOP and BOT input signals must be low for at least 9 us.

V_{CE} Fault

If the switch current is excessive the switch will come out of saturation and be detected as a V_{CE} fault and report an error on the ERROR pins.

Over Current

If the current through a phase is excessive an over current event from the current sensor will be detected and report an error on the ERROR pins.

DC-Link Over Voltage

If the DC-Link voltage exceeds 102% of its maximum rating an over voltage event will be detected and report an error on the ERROR pins.

+15 V Supply Under-Voltage Lockout

If the +15 V on the SKAI board falls below 13 V an under voltage event will be detected and report an error on the ERROR pins.

Overtemp OUT

Pin 18 of the interface connector is the Overtemp OUT pin. It is an open collector output that must be pulled high by an external pull up resistor. LOW equals no error. This signal reports an over temperature condition of 115 ^{o}C on the SKAI heat sink. If there is an over temperature error both this pin and the ERROR OUT pins will indicate an error.

Table 7: Driver Board Scaling

Fault Signal		Level	Units
Silicon Voltage	600	1200	V
Vdesat @ 25^{o}C	3000	3000	A
Phase Over Current	1000	1000	A
DC-Link Over Voltage	459	918	V
+15 V Under Voltage	13	13	V
Heatsink Over Temperature	115	115	^{o}C

Driver Board Power Supply

The SKAI driver board must be supplied with +24 V (8 V – 30 V) at 1 A. This is supplied to the +24 VDC IN and GND pins. The integrated DC/DC converter supplies all necessary voltages for the driver and controller. The supply provides 3,000 VAC isolation between interface connector pins and the DC-Link terminals.

Table 8: Interface Connector Pin Assignment Driver D-sub 25 pin

D-sub 25 pin	Ribbon Cable	Signal	Remark
1	1	BOT HB 1 IN	positive 5V - 15V CMOS logic - see Table 4
14	2	ERROR OUT	fault monitoring, LOW = NO ERROR, open collector output, external pull up resistor required, Max 30V/15mA
2	3	TOP HB 1 IN	positive 5V - 15V CMOS logic - see Table 4
15	4	BOT HB 2 IN	positive 5V - 15V CMOS logic - see Table 4
3	5	ERROR OUT	fault monitoring, LOW = NO ERROR, open collector output, external pull up resistor required, Max 30V/15mA
16	6	TOP HB 2 IN	positive 5V - 15V CMOS logic - see Table 4
4	7	BOT HB 3 IN	positive 5V - 15V CMOS logic - see Table 4
17	8	ERROR OUT	fault monitoring, LOW = NO ERROR, open collector output, external pull up resistor required, Max 30V/15mA
5	9	TOP HB 3 IN	positive 5V - 15V CMOS logic - see Table 4
18	10	Over temp OUT	over temperature monitoring, LOW = NO ERROR $Temp_{DBC}$ < 115 +/- 5^{O}C, open collector output, external pull up resistor required, Max 30V / 15mA
6	11	GND	may be used for analog signal reference
19	12	U_{DC} analog OUT	analog voltage proportional to the DC link voltage, see Table 5 for scaling, max output current 5mA
7	13	+24 VDC IN	24V IN (8V – 30V)
20	14	+24 VDC IN	
8	15	+15 VDC OUT	15V OUT +/- 4%
21	16	+15 VDC OUT	
9	17	GND	GND for power supply and digital signals
22	18	GND	
10	19	Temp analog OUT	analog voltage proportional to the DBC temperature, see Table 9 for scaling, max output current 5mA
23	20	REF 1	Reference for Phase 1 current. GND
11	21	I analog OUT HB 1	analog voltage proportional to Phase 1 current, see Table 6 for scaling, max output current 5mA
24	22	REF 2	Reference for Phase 2 current. GND
12	23	I analog OUT HB 2	analog voltage proportional to Phase 2 current, see Table 6 for scaling, max output current 5mA
25	24	REF 3	Reference for Phase 3 current. GND
13	25	I analog OUT HB 3	Analog voltage proportional to Phase 3 current, see Table 6 for scaling, max output current 5mA

Table 9: Heatsink Temperature Table

DBC temp	Temp out (V)	DBC temp	Temp out (V)	DBC temp	Temp out (V)	DBC temp	Temp out (V)
-40	-4.19	1	-1.45	42	1.92	83	5.94
-39	-4.13	2	-1.38	43	2.01	84	6.04
-38	-4.07	3	-1.30	44	2.10	85	6.15
-37	-4.01	4	-1.23	45	2.19	86	6.25
-36	-3.95	5	-1.15	46	2.29	87	6.36
-35	-3.89	6	-1.08	47	2.38	88	6.47
-34	-3.83	7	-1.00	48	2.47	89	6.58
-33	-3.77	8	-0.92	49	2.56	90	6.68
-32	-3.71	9	-0.85	50	2.65	91	6.79
-31	-3.65	10	-0.77	51	2.75	92	6.90
-30	-3.58	11	-0.69	52	2.84	93	7.01
-29	-3.52	12	-0.61	53	2.94	94	7.12
-28	-3.46	13	-0.53	54	3.03	95	7.23
-27	-3.39	14	-0.45	55	3.13	96	7.34
-26	-3.33	15	-0.37	56	3.22	97	7.45
-25	-3.27	16	-0.29	57	3.32	98	7.56
-24	-3.20	17	-0.21	58	3.41	99	7.67
-23	-3.13	18	-0.13	59	3.51	100	7.79
-22	-3.07	19	-0.05	60	3.61	101	7.90
-21	-3.00	20	0.03	61	3.70	102	8.01
-20	-2.94	21	0.11	62	3.80	103	8.12
-19	-2.87	22	0.20	63	3.90	104	8.24
-18	-2.80	23	0.28	64	4.00	105	8.35
-17	-2.74	24	0.36	65	4.09	106	8.47
-16	-2.67	25	0.44	66	4.19	107	8.58
-15	-2.60	26	0.53	67	4.29	108	8.70
-14	-2.53	27	0.61	68	4.39	109	8.81
-13	-2.46	28	0.70	69	4.49	110	8.93
-12	-2.39	29	0.78	70	4.59	111	9.04
-11	-2.32	30	0.87	71	4.69	112	9.16
-10	-2.25	31	0.95	72	4.80	113	9.28
-9	-2.18	32	1.04	73	4.90	114	9.39
-8	-2.11	33	1.13	74	5.00	115	9.51
-7	-2.04	34	1.21	75	5.10	116	9.63
-6	-1.97	35	1.30	76	5.20	117	9.75
-5	-1.89	36	1.39	77	5.31	118	9.87
-4	-1.82	37	1.48	78	5.41	119	9.98
-3	-1.75	38	1.56	79	5.52	120	10.10
-2	-1.68	39	1.65	80	5.62	121	10.22
-1	-1.60	40	1.74	81	5.72	122	10.34
0	-1.53	41	1.83	82	5.83	123	10.46

The shaded area is not available on the standard design. Contact Semikron for extended temperature range reporting.

7. Controller Board

The SKAI controller board provides all the interface circuitry for gate drives, voltage, current, and temperature measurements, fault protection, isolation, and a DSP for complete on board integrated control. The flexibility of the DSP allows one module to perform a multitude of functions in a variety of configurations without the need for hardware changes. The controller board communicates with a high level controller through CAN BUS. The controller board provides a +5V output that can be used to power encoders and inputs for three encoder signals. In addition there is an analog input, a digital input and a digital output available on the controller board connector. Refer to Table 12 for a complete pin out information.

About the Digital Signal Processor (DSP)

The controller board uses a Texas Instruments TMS320LF2407A DSP controller. The DSP clock speed is 40MHz. The DSP contains 32K flash memory, a 16 channel 10 bit ADC, and motor control peripherals. There is 256K by 16 external memory on the board. An SPI Bus to a 64K serial EEPROM provides non volatile storage for the DSP. Communication to the DSP is provided through CAN BUS. The controller board can optionally be configured for RS485 communications.

DSP Analog Inputs

Phase Current

Signals V_I1, V_I2, and V_I3 are the analog voltages that represent the 3 phase currents. 1.65 volts at the DSP analog inputs represents zero current. Voltages less than 1.65 volts represent current out of the phase, voltages greater than 1.65 volts represent current into the phase. See Table 11 for scaling. The signal from each current sensor is filtered by two poles at 16 kHz.

DC Link Voltage

Signal V_BUS is the analog voltage that represents the voltage on the DC input to the module. See Table 11 for scaling.

Heatsink Temperature

Signals T1 and T3 are the analog voltages that represent the temperatures of the heatsink at phase 1 and 3. See Table 13 for PTC characteristics.

External Analog Input

Signal EXT_TEMP is an analog input that can be used to monitor a signal external to the module. It is diode clamped to 0 and 3.3 volts and is buffered by 200 ohms and 0.047uf.

DSP Digital Inputs

Encoder Inputs

The encoder inputs to the board are filtered and inverted and provide a 1k pull up resistor to +5V for open collector outputs. While these inputs are designed to be used with encoder outputs they can be used with any digital signal.

External Digital Input INX

This input is filtered and inverted. It must be driven in both states. It will accept either 5V or 3.3V logic.

Fault Inputs

When a fault occurs, the /PDPINTA signal is asserted. The cause of the fault can then be determined by reading the fault inputs. These faults (see **Table 10**) are created by hardware external to the DSP.

Table 10 Fault input signals.

No.	Fault Signal	Cause
1	/5V	Asserted if the 5 volt supply drops below 4.5 volts
2	/VBAT	Asserted if the input power drops below 7.6 volts
3	/OVI1	Asserted if phase 1 current sensor detects an over current.
4	/OVI2	Asserted if phase 2 current sensor detects an over current.
5	/OVI3	Asserted if phase 3 current sensor detects an over current.
6	/OVBUS	Asserted if the DC Link voltage exceeds the trip threshold.
7	/DESAT	Asserted when one of the IGBTs come out of saturation.
8	/OTEMP	Asserted if the heatsink temperature exceeds the trip threshold.

Table 11: Signal Scaling

Signal	Level		Units
Silicon Voltage	600	1200	V
/5V	<4.5	<4.5	V
/VBAT	<6.6	<6.6	V
/OVI1, /OVI2, /OVI3	1000	1000	A
/OVBUS	458	917	V
/DESAT @ 25°C	3000	3000	A
/OTEMP	115	115	°C
DC-Link scaling	138.9	277.8	V/V
Current sensor scaling	1000	1000	A/V

DSP Digital Outputs

CANL / CANH

The CANL and CANH I/O provide the high level CAN 2.0B communication to the DSP on the controller board. Optionally these signals can be configured for RS485 communication.

External Digital Ouput OUTX1

This output is inverted and level shifted to 5 volts. A 200 ohm resistor provides some impedance protection.

Gate Drives

/T1, /B1, /T2, /B2, /T3, /B3 are the six signals driving the top and bottom gates of the three phases. These signals are level shifted and gated by all the hardware faults.

Control Board Power Supply

The SKAI controller board must be supplied with +12 V or +24 V nominal (8 V – 30 V) at 1A. This is supplied to the PWR and GND pins of the interface connector. The integrated DC/DC converter supplies all necessary voltages for the driver and controller. The supply provides 3,000VAC isolation between interface connector pins and the power terminals.

Interface Connector

The controller board interface connector is an AMPSeal 14 pin water tight locking connector. Connector parts are available from TYCO-AMP.

Connector part number 776262-1
Plug part number 776273-1
Contact socket pin part number 770854-1

Table 12: Interface Connector Pin Assignment Controller Ampseal 14 pin

Pin	Signal	Remark
1	PWR	+12 or +24VDC nominal (8V – 30V) power input. This board requires 1A from +12 volts.
2	GND	Power input return. The other ground pins are also at this potential.
3	BOOT	This pin can be used to boot the DSP from an alternate location. The alternate location is the EEPROM. When Booted from EEPROM the DSP will download code through the CAN lines and program the FLASH. This enables the customer to load their own appication code without disasembling the SKAI. This feature is not implemented yet. Leave this pin floating.
4	ENCODER +5V	Pin 4 of the interface connector is a +5V supply to power external demands. It must be limited externally to 60mA. If the ENCODER +5V is overloaded it will collapse the on board power supply and abnormal operation will result.
5	GND	Pin 5 of the interface connector is another ground connection. It is intended to be used as the return for ENCODER +5V.
6	ENC1	Pins 6, 7, and 8 of the interface connector are digital inputs to the DSP. The pins are buffered specifically for encoders but can be used as an ordinary digital input.
7	ENC2	
8	ENC3	
9	INX	External digital input
10	OUTX1	External digital output (0 – 5V)
11	XTEMP	External analog input (0 – 3.0V)
12	GND	Ground may be used for analog signal reference
13	CANH / RS485A	Pins 13 and 14 are the CAN BUS low and high communication lines. In the optional RS485 configuration they are the A and B signals of RS485. The CAN and RS485 lines are referenced to the controller board ground.
14	CANL / RS485B	

8. Software

No software is included with the module. SEMIKRON can provide schematics of the controller board to support our customer's software development efforts.

JTAG Programming

Header J5 (not accessible from the external connector) is a two row 14 pin programming header keyed on pin 6. The controller board supplies +5V on pin 5 of the programming header so the programming pod need not be self powered. Semikron has verified the use of a Spectrum Digital XDS510pp plus J-TAG emulator to program the DSP.

Programming Jumper

Header J3 applies the programming voltage to the DSP. With a shorting jumper on pins 2 and 3 the DSP can be programmed. With the shorting jumper on pins 1 and 2 the DSP cannot be programmed.

Flash vs. Memory

The DSP can be run out of either the flash on the DSP or the external memory located on the controller board. The placement of a shorting jumper on Header J2 connects the MP/MC pin to 3.3V or ground and determines the mode of operation. With a shorting jumper on pins 1 and 2 the MP/MC pin is tied high and the board runs from external memory. With the shorting jumper on pins 2 and 3 the MP/MC pin is tied low and the board runs from flash.
The external memory is a Samsung part number K6R4016V1D-TI10. This is a 256Kx16 bit static RAM. The memory for both the DSP flash and the external memory is mapped as following:

```
PAGE 0 :    /* program memory */
        VECS: origin = 00000h, length = 00040h
        PASSWD:     origin = 00040h, length = 00004h
        FLASH:      origin = 00044h, length = 07FBCh

PAGE 1 :    /* data memory */
        DARAN_B2:  origin = 00060h, length = 00020h
        DARAM_B0:  origin = 00200h, length = 00100h
        DARAM_B1:  origin = 00300h, length = 00100h
        SARAM:     origin = 00800h, length = 00800h
        Ext_Ram :  origin = 08000h, length = 07E00h
```

EEPROM

The EEPROM is a Microchip part number 25LC640-I/SN. This is a 64K SPI bus serial EEPROM.

Dead Time

In order to prevent both top and bottom IGBTs from being on at the same time and causing a catastrophic failure the DSP must produce a dead time when both top and bottom switches are off. Semikron recommends a 2us dead time.

Password

Once the DSP has been programmed it requires a 4 byte password to be reprogrammed. The factory default password is 0 0 0 0, one digit per byte.

Table 13: PTC resitance and A/D voltage with respect to Temperature for HV SKAI 1450x models.

$R=R_0*(1+a*(T-T_0)+b*(T-T_0)^2)$ $Va/d=3.3*R/(1000+R)$

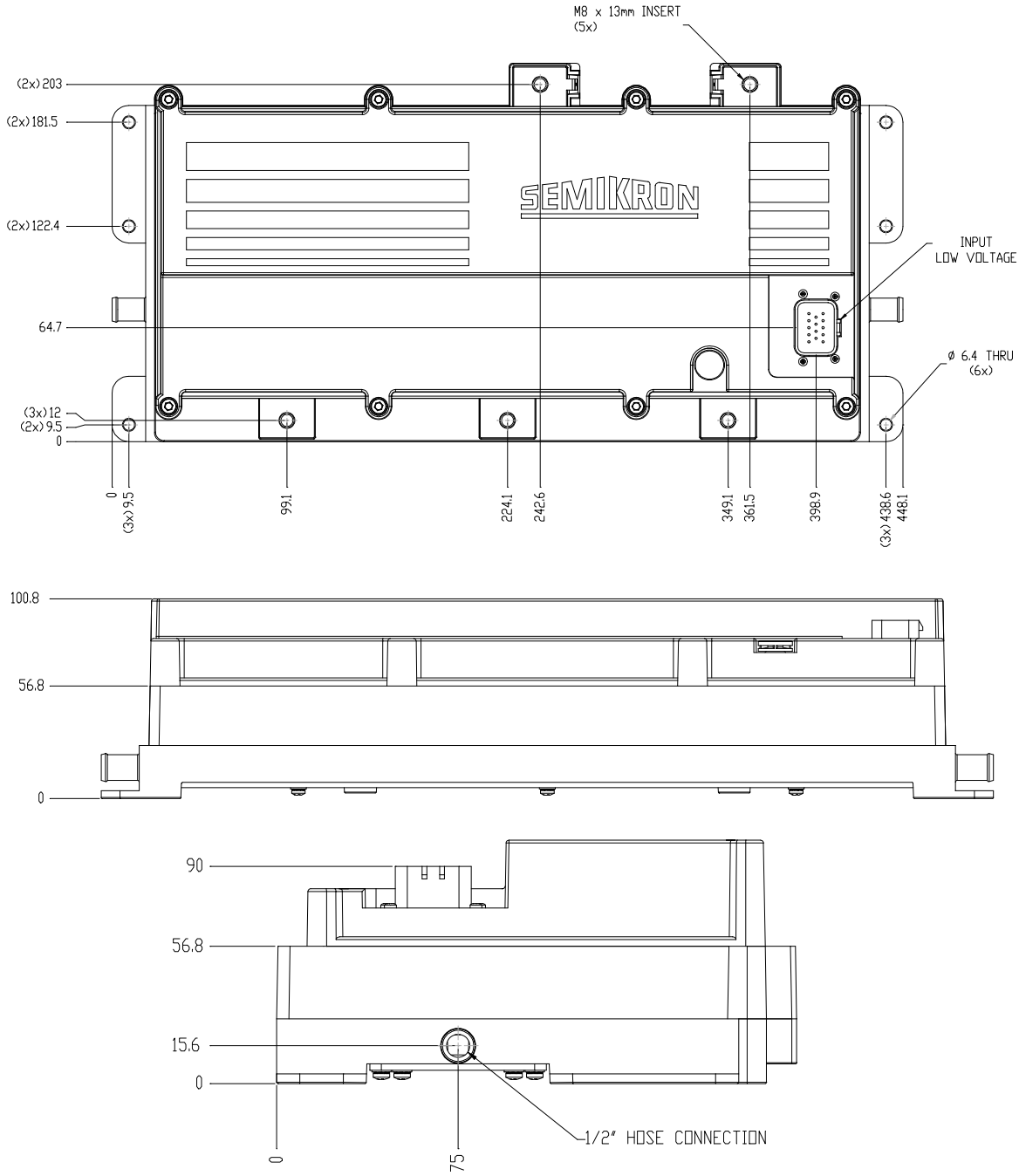
T_0	R_0	a	b
25	1000	7.64E-03	1.73E-05

DBC ^{O}C	PTC Ω	A/D (V)	DBC ^{O}C	PTC Ω	A/D (V)	DBC ^{O}C	PTC Ω	A/D (V)	DBC ^{O}C	PTC Ω	A/D (V)
-40	577	1.207	1	827	1.493	42	1135	1.754	83	1501	1.981
-39	582	1.214	2	834	1.500	43	1143	1.760	84	1511	1.986
-38	588	1.221	3	840	1.507	44	1151	1.766	85	1521	1.991
-37	593	1.228	4	847	1.514	45	1160	1.772	86	1530	1.996
-36	599	1.236	5	854	1.520	46	1168	1.778	87	1540	2.001
-35	604	1.243	6	861	1.527	47	1176	1.784	88	1550	2.006
-34	610	1.250	7	868	1.534	48	1185	1.790	89	1560	2.011
-33	615	1.257	8	875	1.540	49	1193	1.795	90	1569	2.016
-32	621	1.264	9	882	1.547	50	1202	1.801	91	1579	2.021
-31	627	1.271	10	889	1.553	51	1210	1.807	92	1589	2.026
-30	632	1.278	11	896	1.560	52	1219	1.813	93	1599	2.030
-29	638	1.285	12	904	1.566	53	1227	1.818	94	1609	2.035
-28	644	1.292	13	911	1.573	54	1236	1.824	95	1619	2.040
-27	650	1.300	14	918	1.580	55	1245	1.830	96	1629	2.045
-26	656	1.307	15	925	1.586	56	1253	1.836	97	1640	2.050
-25	661	1.314	16	933	1.593	57	1262	1.841	98	1650	2.055
-24	667	1.321	17	940	1.599	58	1271	1.847	99	1660	2.059
-23	673	1.328	18	947	1.605	59	1280	1.852	100	1670	2.064
-22	679	1.335	19	955	1.612	60	1288	1.858	101	1680	2.069
-21	685	1.342	20	962	1.618	61	1297	1.864	102	1691	2.074
-20	691	1.349	21	970	1.625	62	1306	1.869	103	1701	2.078
-19	697	1.356	22	977	1.631	63	1315	1.875	104	1711	2.083
-18	704	1.363	23	985	1.637	64	1324	1.880	105	1722	2.088
-17	710	1.370	24	992	1.644	65	1333	1.886	106	1732	2.092
-16	716	1.377	25	1000	1.650	66	1342	1.891	107	1743	2.097
-15	722	1.384	26	1008	1.656	67	1351	1.897	108	1753	2.101
-14	728	1.391	27	1015	1.663	68	1360	1.902	109	1764	2.106
-13	735	1.398	28	1023	1.669	69	1370	1.907	110	1774	2.110
-12	741	1.405	29	1031	1.675	70	1379	1.913	111	1785	2.115
-11	747	1.412	30	1039	1.681	71	1388	1.918	112	1795	2.119
-10	754	1.418	31	1046	1.687	72	1397	1.923	113	1806	2.124
-9	760	1.425	32	1054	1.694	73	1406	1.929	114	1817	2.128
-8	767	1.432	33	1062	1.700	74	1416	1.934	115	1827	2.133
-7	773	1.439	34	1070	1.706	75	1425	1.939	116	1838	2.137
-6	780	1.446	35	1078	1.712	76	1434	1.944	117	1849	2.142
-5	786	1.453	36	1086	1.718	77	1444	1.950	118	1860	2.146
-4	793	1.460	37	1094	1.724	78	1453	1.955	119	1871	2.150
-3	800	1.466	38	1102	1.730	79	1463	1.960	120	1882	2.155
-2	806	1.473	39	1110	1.736	80	1472	1.965	121	1893	2.159
-1	813	1.480	40	1118	1.742	81	1482	1.970	122	1904	2.163
0	820	1.487	41	1127	1.748	82	1492	1.976	123	1915	2.168

Appendix A Mechanical Drawings

For SKAI 3001GD12-1450W & SKAI 4001GD06-1450W

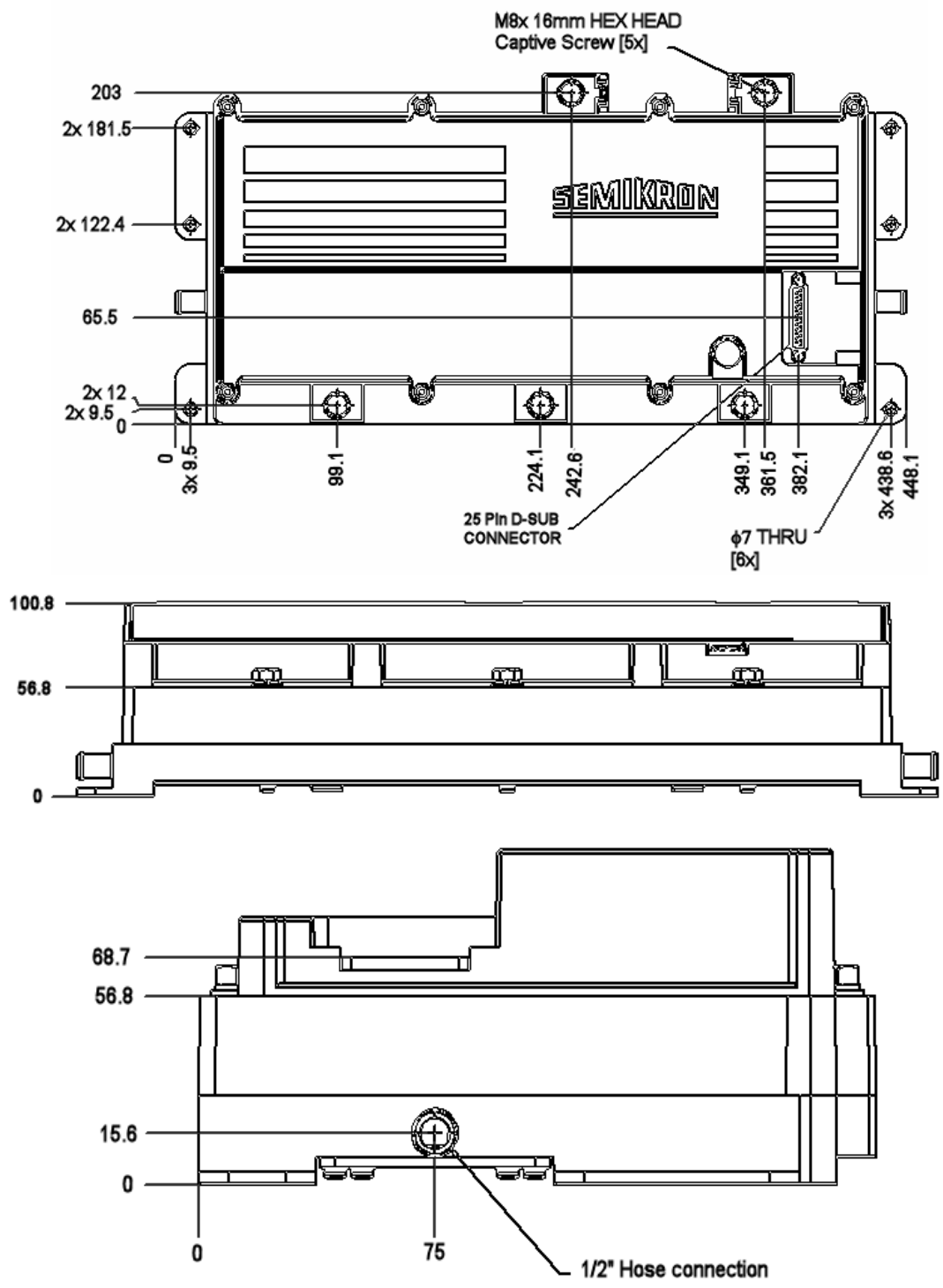
[All units in mm unless otherwise noted]
All images are not shown to scale



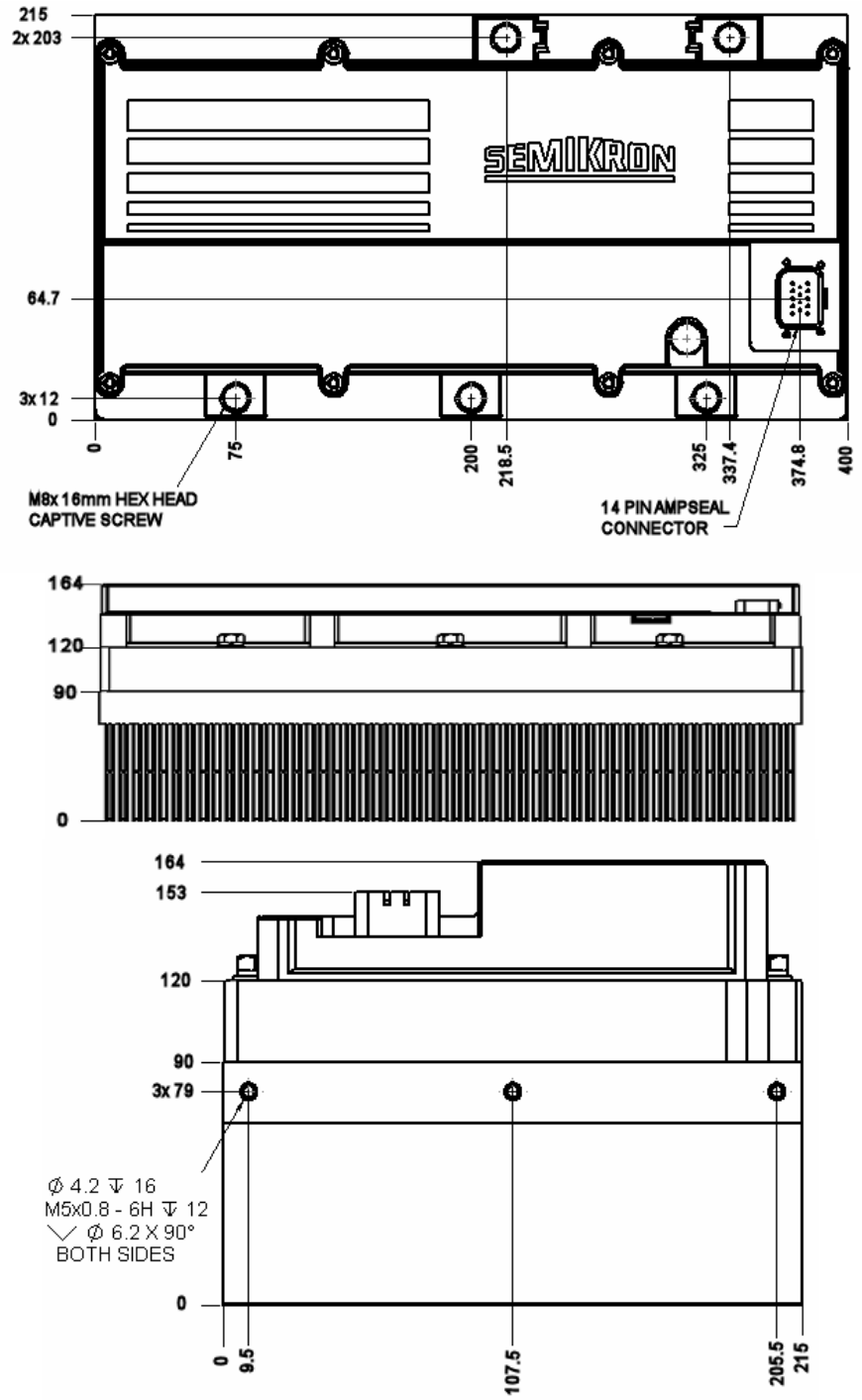
For SKAI 3001GD12-1452W & SKAI 4001GD06-1452W

[All units in mm unless otherwise noted]

All images are not shown to scale



For SKAI 3001GD12-1450L & SKAI 4001GD06-1450L
[All units in mm unless otherwise noted]
All images are not shown to scale



For SKAI 3001GD12-1452L & SKAI 4001GD06-1452L
[All units in mm unless otherwise noted]
All images are not shown to scale