SmartPower Stacks™ Spec Sheet

Level 3M: 100 kW DC-AC Inverter

Key Data

3 Phase Inverter Configuration

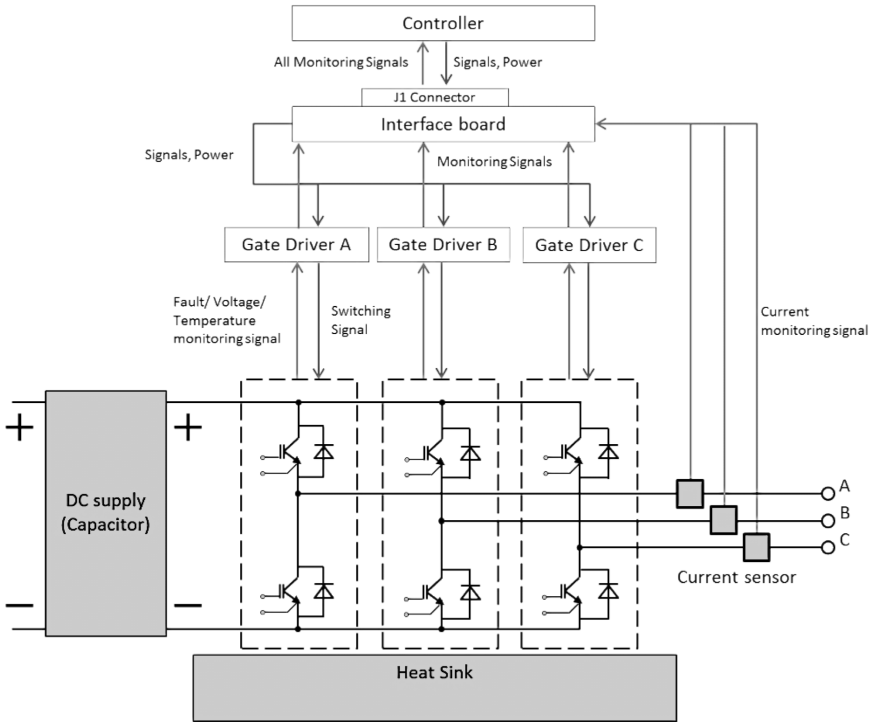
Rated output: 100kW

General Information

Standard configuration includes: (3) IGBT Modules, (3) Gate Drive Boards, (3) Current Sensors, Interface Board, Heat Sink, Integrated DC bus Capacitor, 750uF or 1500uF and Integrated Controller

Topology	3 Phase Inverter (B6I)
Application / Modulation	Inverter / Sine or Custom
Load Type	Resistive, Inductive
Standards	UL certification pending
Cooling	Forced Air (fan optional)
Markets	Solar, Wind, UPS, Battery Storage, Motor Control, Power Conversion Applications.
Current Sensors	LEM – HASS 400-S
IGBT Modules	FUJI – Electric DualXT – 2MBI450VN-120-50
Gate Drive Boards	AgileSwitch – AS2-20D1ANPU-FE450VN12
Interface Board	AgileSwitch – ASI-PS
Heat Sink	Methode – High Performance Extruded
DC Link Capacitors	Methode – Capacitor Bank
Controller	National Instruments – Single-Board RIO General Purpose Inverter Controller (GPIC)

SmartPower Stack Topology



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Note: Typical Operating Conditions:

V_{DC}=700, V_{AC}=480, F_{SW}=5kHz, Cos(φ)= .9, airflow = 485 m^3/hr, air temp = 25°C, I_{AC}=150 A_{RMS}

Electrical Characteristics

DC Link	Notes	Symbol	min	typ	max	unit
DC link Voltage	Continuous Operation	V_{DC}	280		900	V
Max Surge Voltage	2 min, non-operational				1200	V
Overvoltage Shutdown	Configurable		700	900	1000	V
Capacitance	See separate datasheet for details	Methode Capacitor Bank datasheet				
Capacitor ESL	See separate datasheet for details	Methode Capacitor Bank datasheet				

AC Data	Notes	Symbol	min	typ	max	unit
Voltage		V_{AC}	280		900	V_{rms}
Continuous Current	See Typical Operating Conditions	I_{AC}			400	A_{rms}
Power Loss	See Typical Operating Conditions	P_{loss}		~1800		W
Switching Freq[1]	See Typical Operating Conditions Max frequency is @ 50°C	F_{SW}		5	10	kHz
Power Factor	Leading or Lagging	Cos(φ)	0		1	
Surge Current	Max for 10 µS				900	A_{rms}

General Data	Notes	Symbol	min	typ	max	unit
Insulation Test Voltage				4		kV

Heat Sink Air Cooled/Thermal Data

Data	Notes	Symbol	min	typ	max	unit
Airflow	See Typical Operating Conditions	$\Delta V/\Delta t_{Air}$		485		m^3/hr
Air Pressure Drop		ΔP_{Air}		410		Pa
Cooling Air Inlet Temperature	Typical Operating Conditions are supported over this operating range, including Tmax.	T_{inlet}	-25	25	50	°C

Environmental Conditions

Data	Notes	Symbol	min	typ	max	unit
Storage Temp	Non-operational	T_{Stor}	-40		85	°C
Ambient Temp	Continuous Operation Note: different from Tinlet	T_{Amb}	-25		50	°C
Altitude above sea level	Derated operation possible above Alt Max	Alt			1000	m
Air Pressure	Standard Atmosphere	P_{air}	900		1100	hPa
Humidity	Non-condensing	Rel. F	5		85	%
Total Weight	Without capacitor			13		kg
Weight w/o Heat Sink	Without capacitor			7.6		kg
Dimensions	L x W x H (Without capacitor)		280	215	165	mm
Heat Sink Dimensions	L x W x H		280	215	80	mm
Torque at AC terminals		M_{AC}	16		20	Nm

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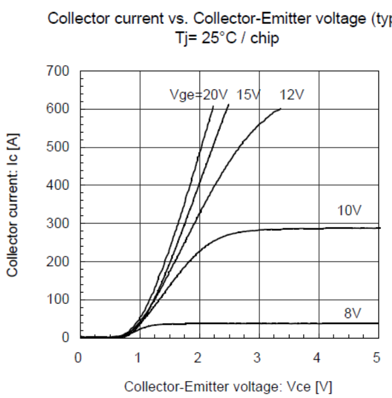
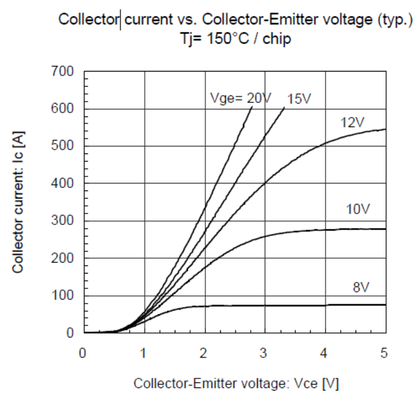
IGBT Module Data – Fuji 2MBI450VN-120-50

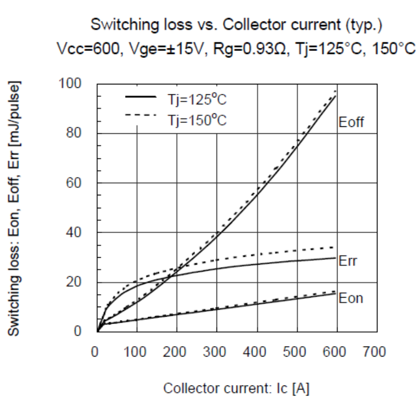
Module Maximum Ratings	Notes	Symbol	min	typ	max	unit
Collector-Emitter Voltage		V_{ces}			1200	V
Gate-Emitter Voltage		V_{ges}			20	V
Collector Current	Continuous	I_c	-300		300	A
Collector Current	Pulse 1ms	I_{c_pulse}	-600		600	A
Collector Power Dissipation	1 Device	P_c			2270	W
Junction Temperature	Maximum / Operating	T_j			175/150	°C
Isolation Voltage	Terminals to baseplate, 1 min	V_{iso}			2500	VAC

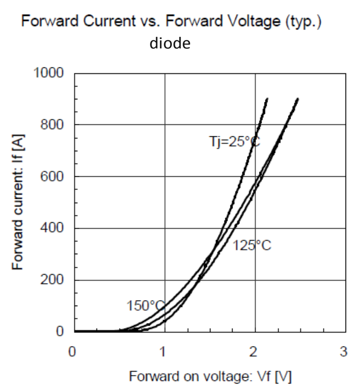
IGBT Data	Notes	Symbol	min	typ	max	unit
Collector-Emitter Saturation voltage	I_c=300A, V_{ge}=15V, T_j = 150°C	V_{ce_sat}		2.7		V
Parameter for linear model	T_j = 25°C	V_{ce1}		1.0		V
Parameter for linear model	T_j = 25°C	R_{ce1}		2.5		mΩ
Parameter for linear model	T_j = 150°C	V_{ce2}		0.95		V
Parameter for linear model	T_j = 150°C	R_{ce2}		3.9		mΩ
Thermal resistance junction to case		R_{thjc}			.094	K/W
Thermal resistance case to heat sink		R_{thch}			.0167	K/W

Diode Data	Notes	Symbol	min	typ	max	unit
Thermal resistance junction to case	For one device	R_{thjc}			.1	K/W
Thermal resistance case to heatsink	For one device	R_{thch}			.0167	K/W









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Controller Interface Data

Data	Notes	Symbol	min	typ	max	unit
Power Voltage Input		V_{in}	13	24	30	V
Power Input	V_{in} = 24V	P_{aux}			30	W
Driver board	See separate datasheet for details	AS2-Econodual Electrical V15 2012-10-26				
Input Signal Logic Hi Level	10kΩ to Gnd, 1nF to GND	V_{in_hi}	11	15	17	V
Input Signal Logic Lo Level		V_{in_lo}	-0.5	.5	2	V
Digital Output Level	Open collector, low=ok, max sink: 15mA	V_{out}	0	-	30	V
Analog Output Format	0-10V, max source 15mA					
DC Voltage Measurement range	DC Voltage Corresponds to 0V to +12V analog range Current Output analog voltage is -12V to +12V, e.g. +6V = 450A, -6V =-450A Temperature output voltage is +7.25V to +8.25V, e.g. 100°C = +8V	V_{dc_range}	0	-	1200	V
AC Current Measurement range		I_{ac_range}	-900	-	+900	A
Temperature Measurement range		T_{range}	-40	-	150	°C

Controller/Power to Interface Board (J1) Connectors Data

J1 Connector PINOUT Descriptions

Pin No	Signal	Pin No	Signal
1	SHIELD	2	BOT-HB1-IN
3	ERROR-HBI-OUT	4	TOP-HB1-IN
5	BOT-HB2-IN	6	ERROR-HB2-OUT
7	TOP-HB2-IN	8	BOT-HB3-IN
9	ERROR-HB3-OUT	10	TOP-HB3-IN
11	OVERTEMP-OUT	12	RESERVED / OPTIONAL RESET
13	VDC-LINK	14	VCC – +24V Supply Voltage
15	VCC – +24V Supply Voltage	16	+15V
17	+15V	18	GND
19	GND	20	TEMP-SENSE-OUT
21	Aux GND	22	I-SENSE1-OUT
23	Aux GND	24	I-SENSE2-OUT
25	Aux GND	26	I-SENSE3-OUT

J1 Connector Hardware

Connector	Type	Manufacturer Part Number
Ribbon Cable	26 Pins	TE Connectivity 1658622-6
Interface Board	26 Pins	TE Connectivity 5499923-6

Protection / Faults

Fault Table

Fault Condition/Action	Generic Sample Default Trigger Values	Action on IGBT if Active
Desat - HI	>7 Volts for 6.1 µs*	Turn off HI side
Desat – LO	>7 Volts 6.1 µs*	Turn off LO side
HV Overshoot – HI	1080 Volts*	Active Clamping occurs
HV Overshoot – LO	1080 Volts*	Active Clamping occurs
UVLO – HI	<12 Volts	Turn off HI side
UVLO - LO	<12 Volts	Turn off LO side
Cross Latch/Shoot Through	Attempt to turn on both IGBTs simultaneously	Does not allow turn on of inactive IGBT until active is off for 2 µs*
DC Link Overvoltage	1000 Volts*	Shut down all IGBTs
Overcurrent	400A	Shut down all IGBTs
Over Temperature	>125C	Shut down all IGBTs

Certain parameters are configurable (noted by *).

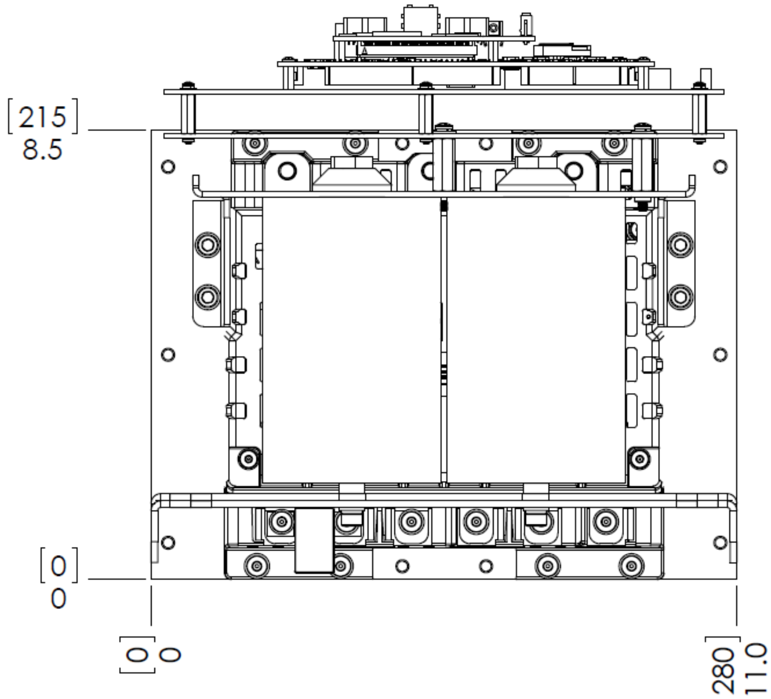
Fault Reporting Pins (Configurable)

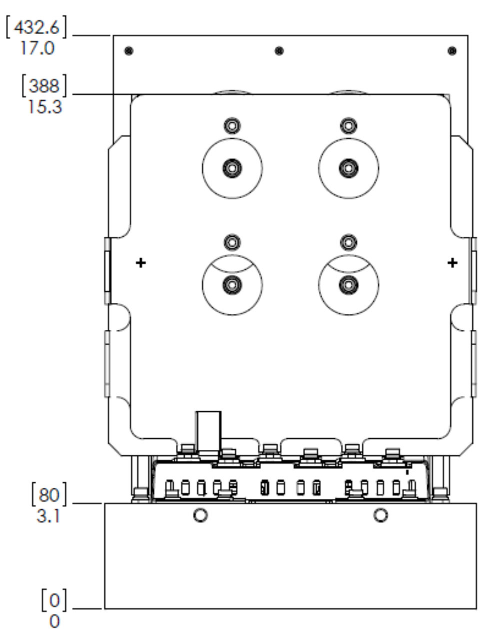
Fault Condition/Action	Pin 3	Pin 6	Pin 9	Pin 11
DSAT HB1	X			
DSAT HB2		X		
DSAT HB3			X	
OVERCURRENT HB1	X	X	X	
OVERCURRENT HB2	X	X	X	
OVERCURRENT HB3	X	X	X	
TEMP	X	X	X	X
DC LINK OV	X	X	X	
UVLO	X	X	X	

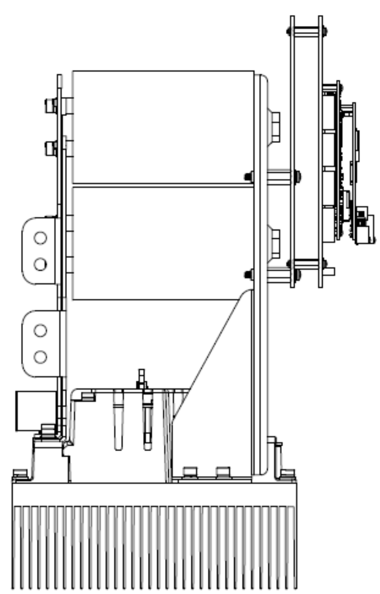
"X" = possible to map this fault to this pin

Note: only 1 fault may be mapped to each pin

Mechanical Dimensions







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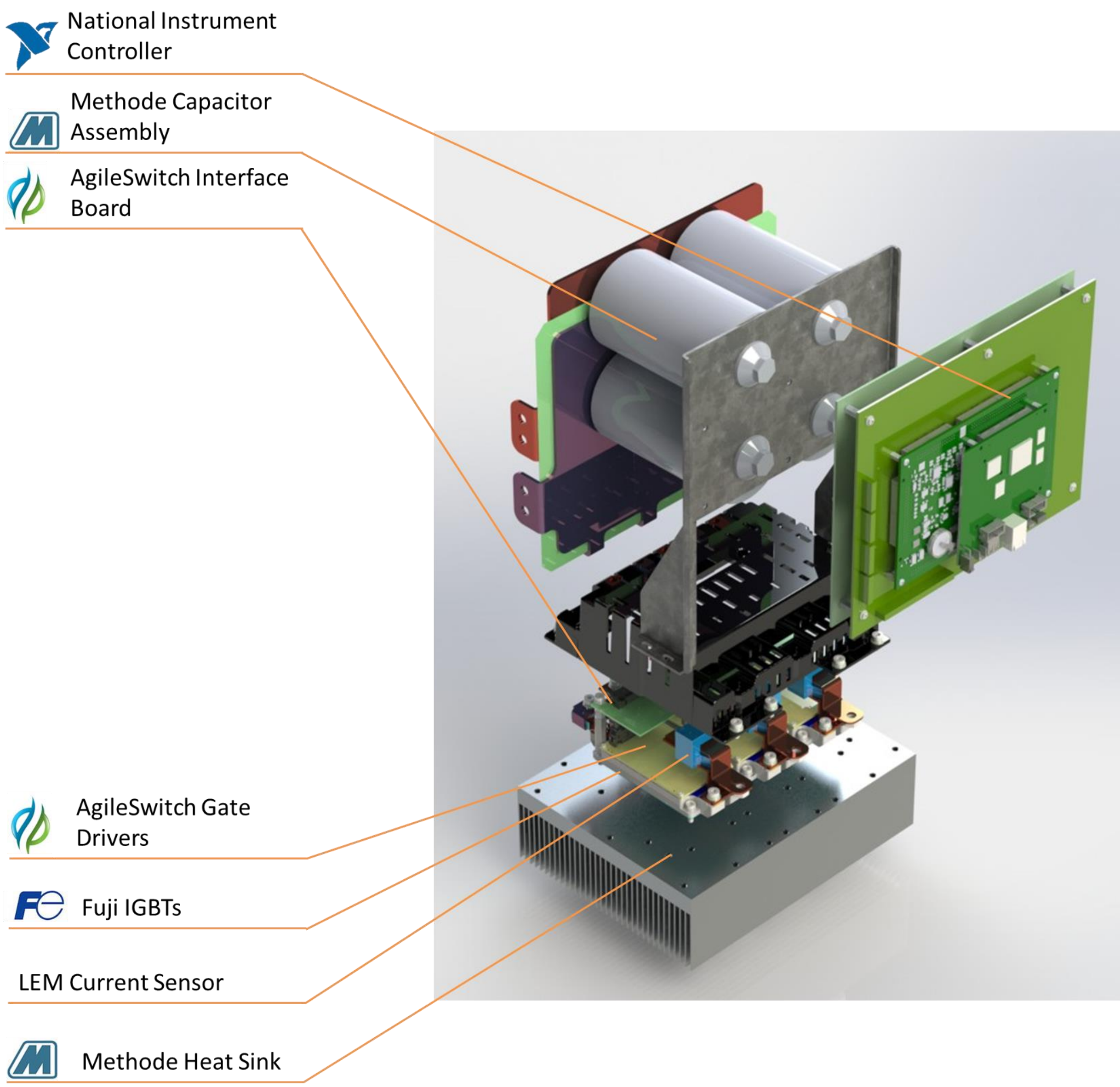
SmartPower Stack™ Components



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SmartPower Stack™ Consortium

The SmartPower Stack Consortium consists of global leaders in controllers, IGBTs, gate drives, capacitors, bus bar architectures and cooling solutions that have joined to create the industry's first fully integrated, deployment-ready commercial embedded system for high-volume solar, photovoltaic, wind, hybrid electric and electric vehicles, as well as high capacity uninterruptible power supply and efficient motor drive applications.

As part of this effort, National Instruments supplies the controller, I/O, simulation and programming toolset, SBE provides new high performance wound film capacitors, Fuji supplies industry leading IGBTs, AgileSwitch offers leading edge IGBT gate drives and Methode offers state-of-the-art bus bar architectures, thermal management solutions, assembly and test capability.

Together, the five companies are creating fully integrated sub-system solutions for the power electronics industry with the highest performance for energy conversion inverters and convertor systems. This effort represents the industry's first collaboration of best-in-class technologies that are tightly integrated to deliver smart, efficient, reliable and long lasting power conversion.

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