TECHNICAL DATA
DATASHEET 5504, REV A

THREE-PHASE POWER MODULE
600V/50A

FEATURES:

• 600VDC Rating.
• 50Amp DC Rating
• 90A peak Phase Current with 300V Maximum Bus Voltage
• Package Size 3.0" x 2.1" x 0.39"
• 6 Step Trapezoidal Drive or Three-Phase Modulation Capability.
• Isolated Upper and Lower Gate Drivers.
• Logic Input to Power Stage, 600V DC Isolation
• Temperature Range -55°C TO +125°C
• Designed for Commercial, Industrial and Aerospace Applications.
• Total Weight 3.65 oz.

APPLICATIONS:

- Servo positioning systems
- Actuation systems
- Hoists

DESCRIPTION:

SPM6G050-060D-H is a completely self-contained power module that can be used for 4-quadrant motor controllers. Built in cross conduction dead time between high and low side signals protects the output stage from shoot-through. The module includes a floating gate driver for each high and low side transistor. The power stage is rated at 600V, 50A. The module is capable of delivering over 15 KW at 300V dc bus.

The small size of this complete module makes it ideal for high reliability commercial, aerospace, and military applications.

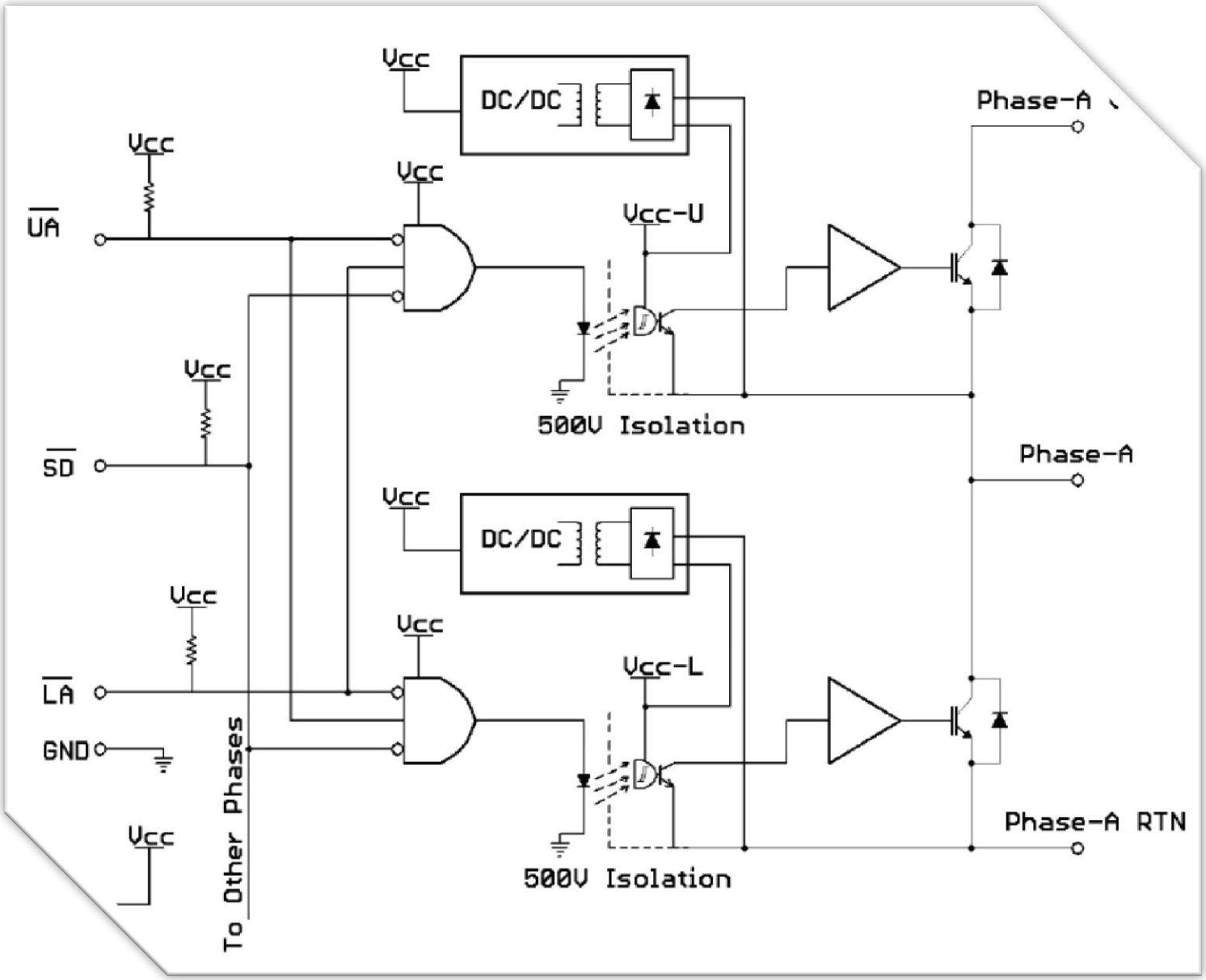

Fig. 1 Block Diagram Per Phase

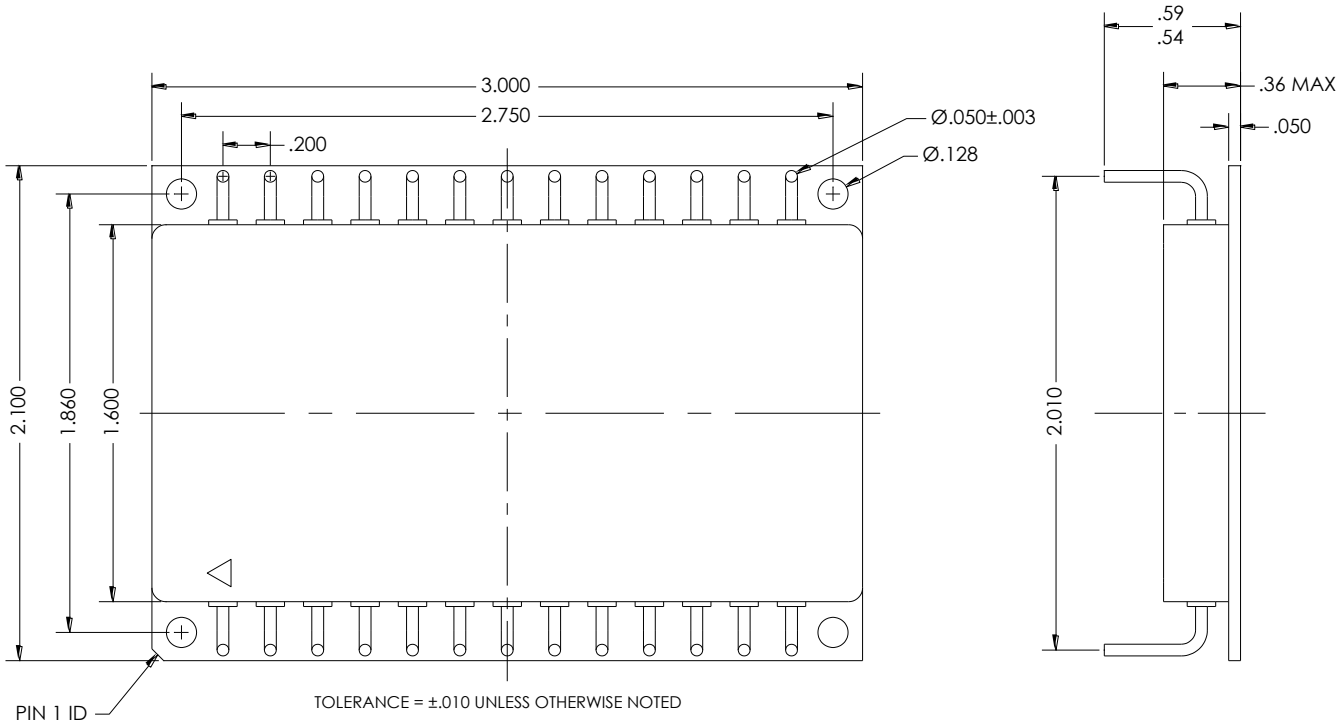

Fig. 2 Package Outline

INPUT - OUTPUT TRUTH TABLE

This table shows the Phase Output state versus the state of the logic inputs.

LOGIC INPUTS							PHASE OUTPUTS		
$\overline{UA}$	$\overline{UB}$	$\overline{UC}$	$\overline{LA}$	$\overline{LB}$	$\overline{LC}$	$\overline{SD}$	A	B	C
1	1	0	1	0	1	0	Hi-Z	RtnB	V+C
1	1	0	0	1	1	0	RtnA	Hi-Z	V+C
1	1	0	0	0	1	0	RtnA	RtnB	V+C
1	0	1	1	1	0	0	Hi-Z	V+B	RtnC
1	0	1	0	1	1	0	RtnA	V+B	Hi-Z
1	0	1	0	1	0	0	RtnA	V+B	RtnC
1	0	0	0	1	1	0	RtnA	V+B	V+C
1	0	0	0	1	0	0	RtnA	V+B	Hi-Z
1	0	0	0	0	1	0	RtnA	Hi-Z	V+C
0	1	1	1	1	0	0	V+A	Hi-Z	RtnC
0	1	1	1	0	1	0	V+A	RtnB	Hi-Z
0	1	1	1	0	0	0	V+A	RtnB	RtnC
0	1	0	1	0	1	0	V+A	RtnB	V+C
0	1	0	1	0	0	0	V+A	RtnB	Hi-Z
0	1	0	0	0	1	0	Hi-Z	RtnB	V+C
0	0	1	1	1	0	0	V+A	V+B	RtnC
0	0	1	1	0	0	0	V+A	Hi-Z	RtnC
0	0	1	0	1	0	0	Hi-Z	V+B	RtnC
1	1	1	1	1	1	0	Hi-Z	Hi-Z	Hi-Z
1	1	1	0	0	0	0	RtnA	RtnB	RtnC
0	0	0	1	1	1	0	V+A	V+B	V+C
X	X	X	X	X	X	1	Hi-Z	Hi-Z	Hi-Z

Note: Hi-Z= High Impedance State (off), X= Don't Care, 1 = Logic High, 0 = Logic Low

ORDERING INFORMATION

Part Number	Screening
SPM6G050-060D-H	**Operating Temperature Range -55°C to +125°C. Screened to the individual test methods of MIL-STD-38534. Class H**
SPM6G050-060D	**Commercial Flow, 25°C testing only**

ABSOLUTE MAXIMUM RATINGS

(T_C=25 °C) unless otherwise noted

Characteristic	**Symbol**	**Maximum**
DC Bus Supply Voltage, Operating	V+A to RtnA, V+B to RtnB, V+C to RtnC	400V
Peak DC Bus Voltage, No PWM Signals	V+A to RtnA, V+B to RtnB, V+C to RtnC	600V
+15V Supply Voltage, referenced to GND	Vcc	+19 V
PWM Switching Frequency	F_{SW}	20kHz
Output Current Continuous, Tc = 25 °C Pulsed, pulse width <10msec Current Rating is limited by package leads. IGBT Die is rated at 75A continuous Diode Die is rated at 75A continuous	IOF IOFP	50 A 90 A
IGBT Junction-Case Thermal Resistance	$R_{thjC\text{-}IGBT}$	0.45 °C /W
Diode Junction-Case Thermal Resistance RthjC	$R_{thjC\text{-}DIODE}$	0.85 °C /W
Lead Soldering Temperature, 5 seconds maximum, 0.125” from case	Ts	250 °C
Junction Temperature Range	Tj	-55 to 150 °C
Case Operating Temperature	Tc	-55 to 125 °C
Case Storage Temperature Range	Tcs	-55 to 150 °C
Logic Input Voltage, referenced to GND	$\overline{UA}$, $\overline{LA}$, $\overline{UB}$, $\overline{LB}$, $\overline{UC}$, $\overline{LC}$, $\overline{SD}$	-0.3 V to +Vcc

RECOMMENDED OPERATING CONDITIONS

(T_C=25 °C, Vcc=+15V) unless otherwise noted

PARAMETER SYMBOL CONDITIONS	MIN.	TYP.	MAX.	UNITS
INPUT STAGE (Referenced to GND)				
Input Supply Current Icc at Vcc=+15V supply without PWM Signals One input PWM at 10KHz Three Inputs PWM at 10KHz	 65 70 90	 75 87 110	 95 110 130	mA
VCC Input Supply Voltage Range	14.25	15	15.75	V
Positive-Going Input Threshold (Logic Low Output Voltage) $\overline{UA}$, $\overline{LA}$, $\overline{UB}$, $\overline{LB}$, $\overline{UC}$, $\overline{LC}$, $\overline{SD}$	6.5	-	11	V
Negative-Going Input Threshold (Logic High Output Voltage) $\overline{UA}$, $\overline{LA}$, $\overline{UB}$, $\overline{LB}$, $\overline{UC}$, $\overline{LC}$, $\overline{SD}$	3.8	-	7.6	V
Input Hysteresis Window	1.5	3.5	5.2	V
Logic Low Input Current for $\overline{UA}$, $\overline{LA}$, $\overline{UB}$, $\overline{LB}$, $\overline{UC}$, $\overline{LC}$, $\overline{SD}$, Vin =0V	-	-2	-3	mA
Logic High Input Current for $\overline{UA}$, $\overline{LA}$, $\overline{UB}$, $\overline{LB}$, $\overline{UC}$, $\overline{LC}$, $\overline{SD}$, Vin=Vcc	-	1	100	uA
POWER OUTPUT STAGE				
Output Current Continuous	-	-	50	A
Operating DC Bus Supply Voltage V+A to RtnA, V+B to RtnB, V+C to RtnC	0	270	350	V
Output Voltage Drop (Each IGBT) VCE at 10A VCE at 20A VCE at 30A VCE at 40A VCE at 50A VCE at 70A VCE at 90 A	 - 	 0.96 1.13 1.27 1.40 1.52 1.77 2.02	 1.20 1.80 	V
Output Voltage Drop (Each Diode) VF at 10A VF at 20A VF at 30A VF at 40A VF at 50A VF at 70A VF at 90 A	 - 	 1.04 1.17 1.26 1.33 1.42 1.53 1.64	 1.20 1.60 	V

PARAMETER SYMBOL CONDITIONS	MIN.	TYP.	MAX.	UNITS
Reverse Recovery Time (Flyback Diode Die) trr **(2)** 30V, di/dt=200 A/µsec, IF=1A (This test is done at the die level for evaluation), **Refer to Fig. 3**	-	31	-	nsec
Reverse Recovery Time (Flyback Diode) trr **(2)** 270V, 800 A/µsec, IF=40A, **Refer to Fig. 4**	-	55	90	nsec
Reverse Leakage Current **(1)** V+A to PhA, V+B to PhB, V+C to PhC, PhA to RtnA, PhB to RtnB, PhC to RtnC Tc = 25°C at 600V Tc = 125°C at 480V	-	-	 0.5 5	mA
ISOLATION				
Pin-to-Case Voltage Isolation, at Room Conditions, all pins shorted together Leakage less than 10µA	1000	-	-	VDC
Logic Input to Power Stage Isolation Pins 1 to 11 shorted together Pins 12 to 26 shorted together Test between Pin1 and Pin26 Leakage less than 10µA	600	-	-	
SWITCHING CHARACTERISTICS (2) **At 270V, Iout = 40A, Control Logic rise and fall time <100 nsec, Refer to Fig. 5, Fig. 6, Fig. 7, Fig. 8**				
Turn-on propagation delay, Upper or Lower IGBT , tdon Measured from Logic input crossing 50% to IC rising to 90%	-	1400	1650	nsec
Turn-off propagation delay, Upper or Lower IGBT, tdoff Measured from Logic input crossing 50% to IC falling to 10%	-	1000	1200	nsec
Shut-down propagation delay, Upper or Lower IGBT, tsoff Measured from Logic input crossing 50% to IC falling to 10%	-	1000	1200	nsec
Turn-on Transition Time, Upper or Lower IGBT, tri IC rising from 10% to 90%	-	50	150	nsec
Turn-off Transition Time, Upper or Lower IGBT, tfi IC falling from 90% to 10%	-	130	250	nsec
DEAD TIME (indirectly calculated as tdon - tdoff), Refer to Fig. 5 Recommended minimum DEAD Time	300	500	800	nsec
SWITCHING ENERGY LOSSES, AT 270V, Iout = 40A (2) (3) (4)				
Turn-on Energy, Eon. Refer to Fig. 6	-	0.57	1.0	mJ
Turn-off Energy, Eoff, Refer to Fig. 7	-	1.1	1.7	mJ
Diode Switching Loss, Refer to Fig. 8, Fig. 9	-	0.14	-	mJ

NOTES:
1. Pulse Test: Pulse Width < 300 µSec, Duty Cycle < 2%. Not to exceed TJ of +150°C.
2. Guaranteed by design, tested in verification, not tested in production

3. Eon is the integral of VCE × IC × dt. Integral time starts from the 98 % fall point of VCE and ends at the specified low VCE point, the 2 % point of off level.
4. Eoff is the integral of VCE × IC × dt. Integral time starts from the 2 % rise point of VCE and ends at the specified low IC point, the 2 % point of IC before turn-off.

PIN OUT

PIN NUMBER	NAME	DESCRIPTION
1	RTN C	Return for High Voltage Bus, Phase C
2	PHASE C	Output to motor winding Phase C
3	V+C	High Voltage D.C. Bus, Phase C
4, 10, 13, 14, 15,16	NC	No connection Internally
5	RTN B	Return for High Voltage Bus, Phase B
6	PHASE B	Output to motor winding Phase B
7	V+B	High Voltage D.C. Bus, Phase B
8	RTN A	Return for High Voltage Bus, Phase A.
9	PHASE A	Output to motor winding Phase A
11	V+A	High Voltage D.C. Bus, Phase A
12	Vcc	+15V_{DC} input required to power logic inputs and isolated gate drive supplies of all three phases.
17	$\overline{\mathbf{LA}}$	Digital input to Phase A lower transistor
18	$\overline{\mathbf{UA}}$	Digital input to Phase A upper transistor
19, 22, 26	GND	Reference for LOGIC supply, +15V supply, and digital inputs.
20	$\overline{\mathbf{LB}}$	Digital input to Phase B lower transistor
21	$\overline{\mathbf{UB}}$	Digital input to Phase B upper transistor
23	$\overline{\mathbf{SD}}$	Digital shut-down input to enable / disable all six gate drives
24	$\overline{\mathbf{LC}}$	Digital input to Phase C lower transistor
25	$\overline{\mathbf{UC}}$	Digital input to Phase C upper transistor
Case		Isolated From All Pins

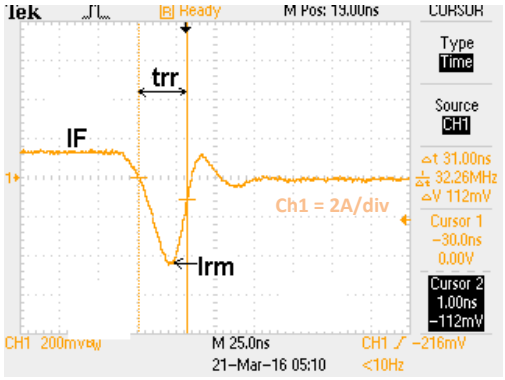

Fig. 3 Diode Die Reverse Recovery at IF=1A, Reverse Voltage 30V, di/dt= 200A/usec

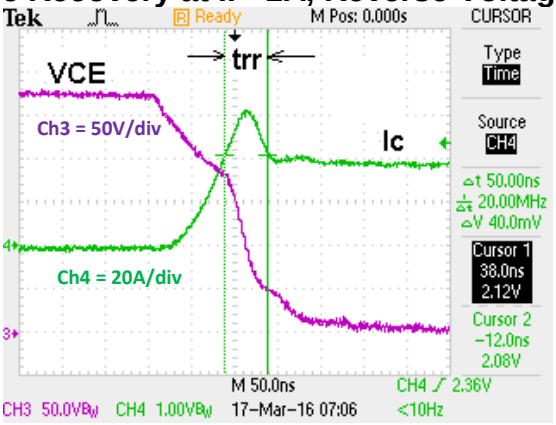

Fig. 4 IGBT Turn On and Diode Reverse Recovery In Real Application

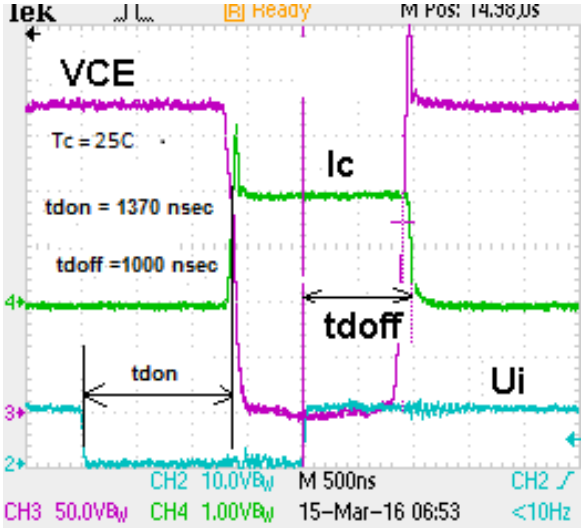

Fig. 5 Typical Logic Input to Phase Output Turn-On and Turn-Off Delay Times (Ch2 = 10V/div, Ch3 = 50V/div, Ch4 = 20A/div)

IGBT and Diode Switching Characteristics and Waveforms

1- Test Conditions: VCE=270V, IC= 40A
Current Scale is 20A/div, **Voltage Scale** is 50V/div, **Power Loss Scale** is 2000Watt/div
Test Results: Current Rise time tri= 50 nsec, Current Fall time tfi= 130 nsec, including tail at Tc=25°C

Turn On Switching Loss = 0.57 mJ at Tc=25°C, = 0.8 mJ at Tc=125°C

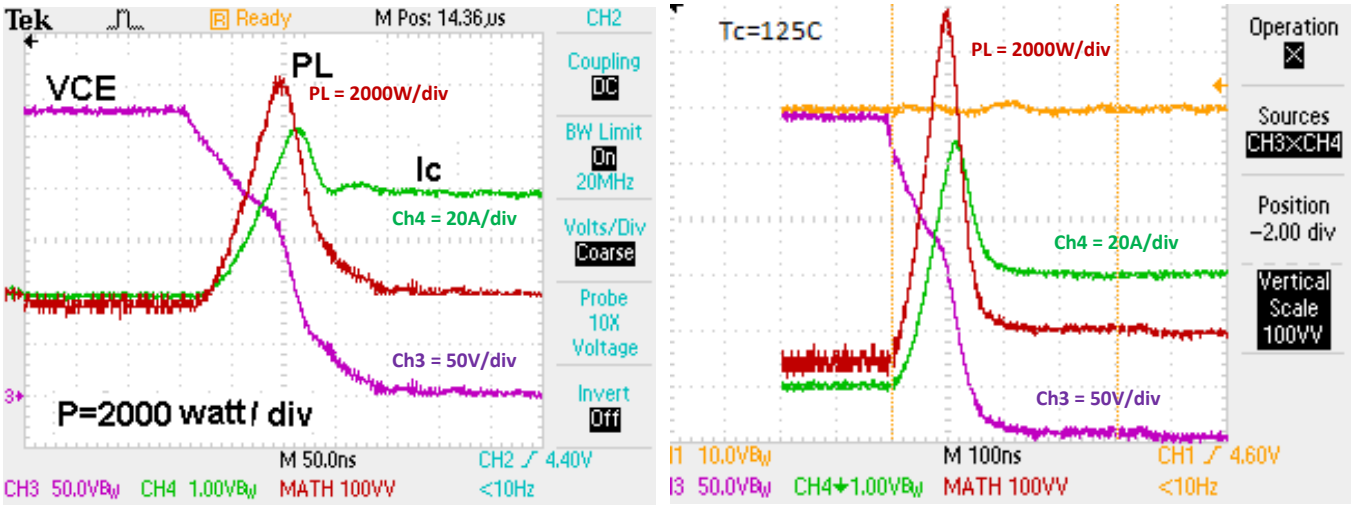

Fig. 6: IGBT Turn-On Switching Performance

Test Results: Current Rise time tri= 60 nsec, Current Fall time tfi= 190 nsec, including tail at Tc=125°C

Turn off Switching Loss = 1.1 mJ at Tc=25°C**,** = 1.2 mJ at Tc=125°C

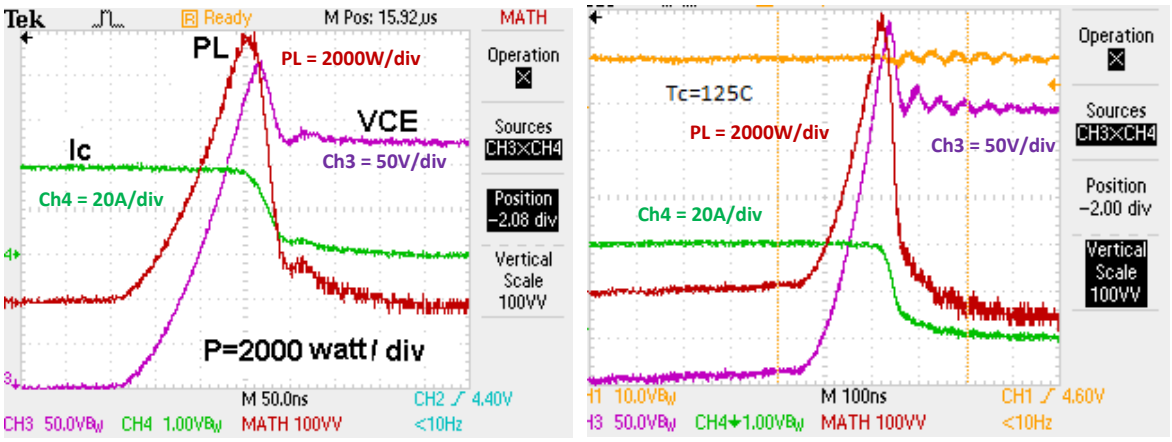

Fig. 7: IGBT Turn-Off Switching Performance

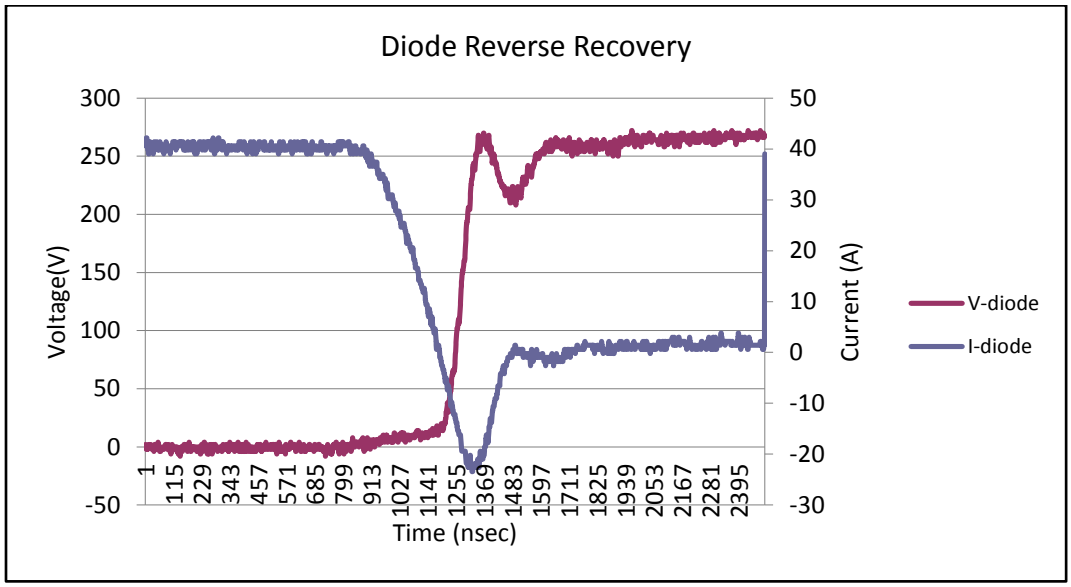

Fig. 8: Diode Switching Performance

Diode Switching Energy Loss = 0.14 mJ

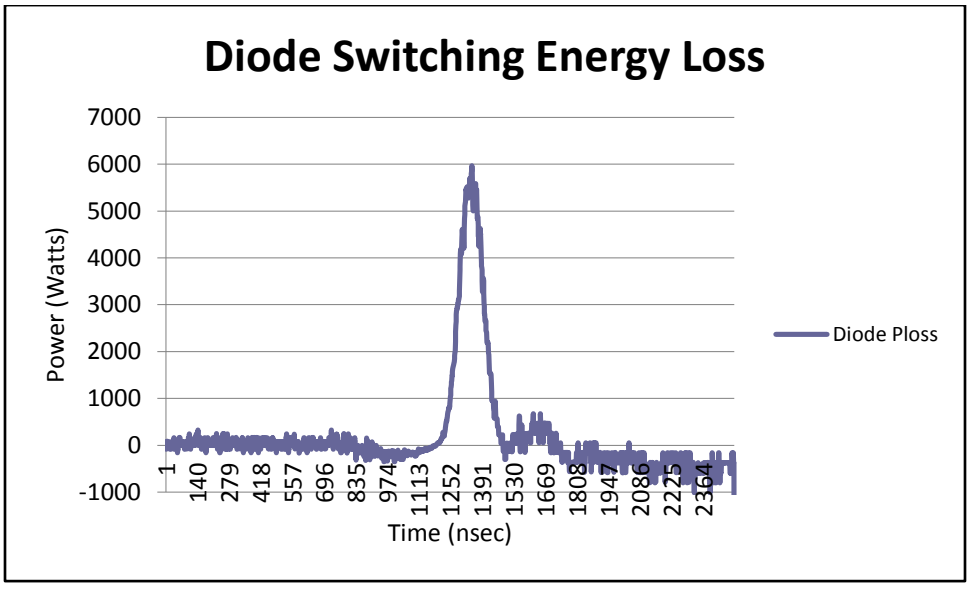

Fig. 9: Diode Switching Energy Loss

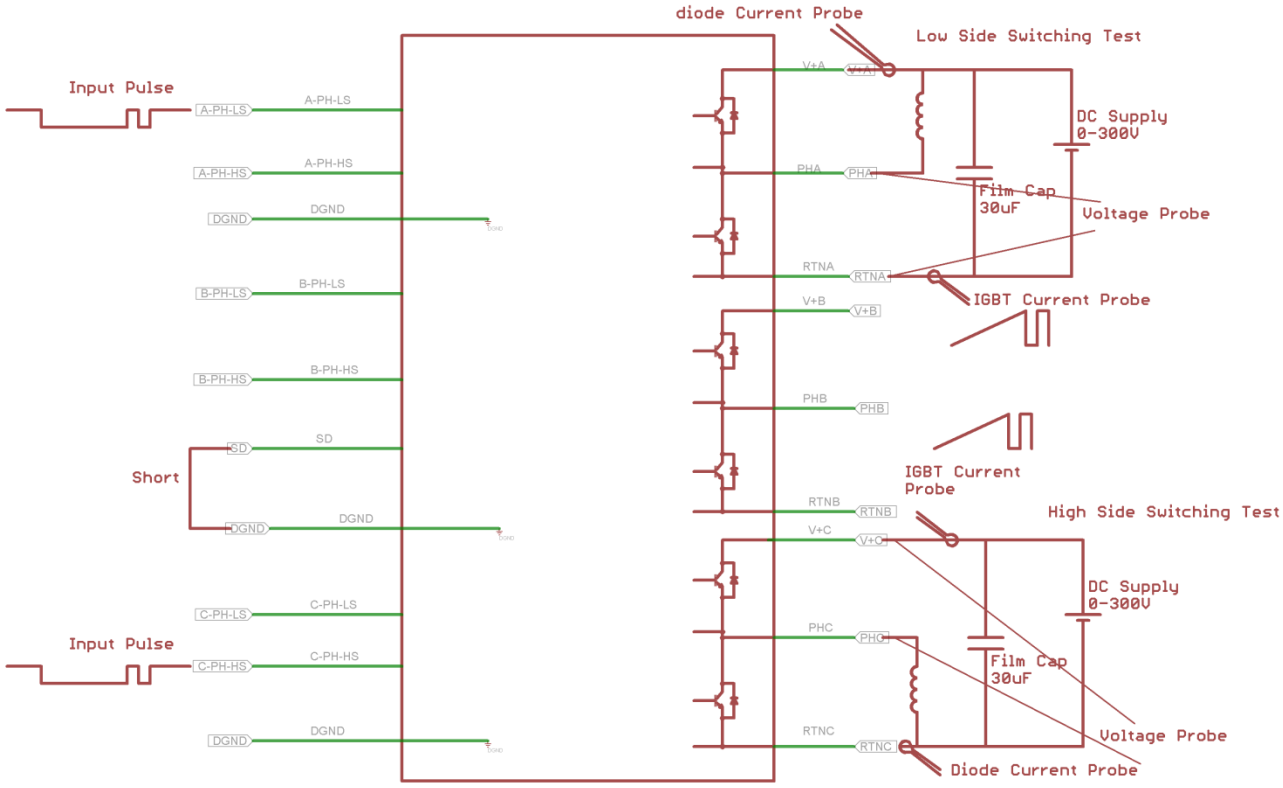

Fig. 10: Switching Test Setup for Low Side or High Side IGBT/Diode (Double Pulse Testing)

- The value of load inductance L shall be high enough to maintain the specified IC within 90% of the peak value, for the whole duration of the measuring pulse. A typical value is 100uH.

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