# **Q2PACK Module**

This high-density, integrated power module combines high-performance IGBTs with rugged anti-parallel diodes.

#### **Features**

- Extremely Efficient Trench with Field Stop Technology
- Low Switching Loss Reduces System Power Dissipation
- Module Design Offers High Power Density
- Low Inductive Layout
- Q2PACK Package with Press-Fit Pins
- This is a Pb-Free Device

## **Typical Applications**

- Solar Inverters
- Uninterruptable Power Supplies Systems

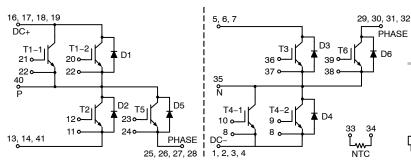


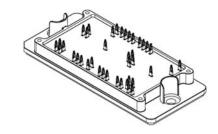
Figure 1. SNXH100M65L4Q2F2P2G Schematic Diagram



## ON Semiconductor®

www.onsemi.com

#### 100 A, 650 V Inverter Module



**Q2PACK** CASE 180AY

#### **DEVICE MARKING**

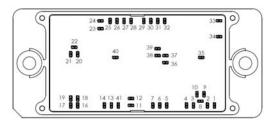


G = Pb-Free Package

= Assembly & Test Site Code ΑT

YYWW = Year and Work Week Code

#### **PIN CONNECTIONS**



# ORDERING INFORMATION

See detailed ordering and shipping information on page 5 of this data sheet.

**Table 1. MAXIMUM RATINGS** 

Rating	Symbol	Value	Unit
IGBT (T1-1, T1-2, T4-1, T4-2)			
Collector-emitter voltage	V <sub>CES</sub>	650	V
Collector current @ Th = 80°C	I <sub>C</sub>	113	А
Pulsed Peak Collector Current @ Tpulse = 1 ms	I <sub>CM</sub>	339	А
Power Dissipation Tj = Tjmax Th = 80°C	P <sub>tot</sub>	226	W
Gate–emitter voltage Positive transient gate–emitter voltage (Tpulse = 5 $\mu$ s, D < 0.10)	V <sub>GE</sub>	±20 30	V
Maximum Junction Temperature (Note 1)	T <sub>Jmax</sub>	175	°C
IGBT (T2, T3)			
Collector-emitter voltage	V <sub>CES</sub>	650	V
Collector current @ Th = 80°C (per IGBT)	I <sub>C</sub>	103	А
Pulsed Peak Collector Current @ Tpulse = 1 ms	I <sub>CM</sub>	309	А
Power Dissipation Tj = Tjmax Th = 80°C	P <sub>tot</sub>	206	W
Gate–emitter voltage Positive transient gate–emitter voltage (Tpulse = 5 $\mu$ s, D < 0.10)	V <sub>GE</sub>	±20 30	V
Maximum Junction Temperature (Note 2)	T <sub>Jmax</sub>	175	°C
IGBT (T5, T6)			
Collector-emitter voltage	V <sub>CES</sub>	650	V
Collector current @ Th = 80°C (per IGBT)	I <sub>C</sub>	263	Α
Pulsed Peak Collector Current @ Tpulse = 1 ms	I <sub>CM</sub>	789	Α
Power Dissipation Tj = Tjmax Th = 80°C	P <sub>tot</sub>	339	W
Gate–emitter voltage Positive transient gate–emitter voltage (Tpulse = 5 $\mu$ s, D < 0.10)	V <sub>GE</sub>	±20 30	V
Maximum Junction Temperature (Note 1)	T <sub>Jmax</sub>	175	°C
INVERSE DIODE (D1, D4)			
Peak Repetitive Reverse Voltage	$V_{RRM}$	650	V
Forward Current, DC @ Th = 80°C	I <sub>F</sub>	69	А
Repetitive Peak Forward Current, Tpulse = 1 ms	I <sub>FRM</sub>	207	А
Power Dissipation $T_J = T_{JMAX}$ $T_h = 80^{\circ}C$	P <sub>tot</sub>	130	W
Maximum Junction Temperature (Note 2)	T <sub>J</sub>	175	°C
INVERSES DIODE (D2, D3, D5, D6)			
Peak Repetitive Reverse Voltage	V <sub>RRM</sub>	650	V
Forward Current, DC @ Th = 80°C	I <sub>F</sub>	88	А
Repetitive Peak Forward Current, Tpulse = 1 ms	I <sub>FRM</sub>	264	Α
Power Dissipation $T_J = T_{JMAX}$ $T_h = 80^{\circ}C$	P <sub>tot</sub>	156	W
Maximum Junction Temperature (Note 2)	TJ	175	°C

Rated per discrete TO247 qualification
 Device characterization was confirmed in Tj 175°C and HTRB test passed at Tj 150°C condition

**Table 1. MAXIMUM RATINGS** 

Table 1. MAXIMOM HATINGS			
Rating	Symbol	Value	Unit
THERMAL PROPERTIES		_	
Operating Temperature under switching condition	T <sub>VJ OP</sub>	-40 to (T <sub>jmax</sub> -25)	°C
Storage Temperature range	T <sub>stg</sub>	-40 to 125	°C
INSULATION PROPERTIES			
Isolation test voltage, t = 1 min, 50/60 Hz	V <sub>is</sub>	2500	V <sub>RMS</sub>
Creepage distance		12.7	mm

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Table 2. ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}C$  unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Тур	Max	Unit
IGBT (T1-1, T1-2, T4-1, T4-2)		-			-	-
Collector-emitter saturation voltage (pin-to-pin)	V <sub>GE</sub> = 15 V, I <sub>C</sub> = 225 A, T <sub>J</sub> = 25°C V <sub>GE</sub> = 15 V, I <sub>C</sub> = 225 A, T <sub>J</sub> = 150°C	V <sub>CE(sat)</sub>	_	1.56 1.76	2.2 -	V
Gate-emitter threshold voltage	$V_{GE} = V_{CE}$ , $I_C = 2.25 \text{ mA}$	V <sub>GE(TH)</sub>	3.1	4.05	5.2	V
Collector-emitter cutoff current	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 650 V	I <sub>CES</sub>	-	_	300	μΑ
Gate leakage current	V <sub>GE</sub> = 20 V, V <sub>CE</sub> = 0 V	I <sub>GES</sub>	-	-	600	nA
Turn-on delay time	Tj = 25°C	t <sub>d(on)</sub>	-	101	_	ns
Rise time	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}$	t <sub>r</sub>	-	36	_	
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_{G(on)}$ = 15 $\Omega$ , $R_{G(off)}$ = 30 $\Omega$	t <sub>d(off)</sub>	-	674	_	
Fall time	2.(3.1)	t <sub>f</sub>	-	63	_	
Turn on switching loss		E <sub>on</sub>	_	3	_	mJ
Turn off switching loss		E <sub>off</sub>	_	2.67	_	
Turn-on delay time	Tj = 125°C	t <sub>d(on)</sub>	_	93	_	ns
Rise time	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}$	t <sub>r</sub>	-	43	_	
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_{G(on)}$ = 15 $\Omega$ , $R_{G(off)}$ = 30 $\Omega$	t <sub>d(off)</sub>	_	710	_	
Fall time	-()	t <sub>f</sub>	_	58	_	
Turn on switching loss		E <sub>on</sub>	_	4	_	mJ
Turn off switching loss		E <sub>off</sub>	_	2.9	_	
Input capacitance	V <sub>CE</sub> = 20 V, V <sub>GE</sub> = 0 V. f = 10 kHz	C <sub>ies</sub>	=	14630	=	pF
Output capacitance		C <sub>oes</sub>	=	230	=	
Reverse transfer capacitance		C <sub>res</sub>	=	64	=	
Gate charge total	$V_{CE}$ = 480 V, $I_{C}$ = 225 A, $V_{GE}$ = ±15 V	$Q_g$	-	452	=	nC
Thermal Resistance – chip-to- heatsink	Thermal grease, Thickness = 2.1 Mil $\pm$ 2%, $\lambda$ = 2.9 W/mK	R <sub>thJH</sub>	_	0.42	_	°C/W
IGBT (T2, T3)				•	•	
Collector-emitter saturation voltage (pin-to-pin)	$V_{GE}$ = 15 V, $I_{C}$ = 150 A, $T_{J}$ = 25°C $V_{GE}$ = 15 V, $I_{C}$ = 150 A, $T_{J}$ = 150°C	V <sub>CE(sat)</sub>	<u>-</u> -	1.65 1.9	2 -	V
Gate-emitter threshold voltage	$V_{GE} = V_{CE}$ , $I_C = 2.4$ mA	V <sub>GE(TH)</sub>	4.6	5.6	6.5	V
Collector-emitter cutoff current	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 650 V	I <sub>CES</sub>	_	_	400	μА
Gate leakage current	V <sub>GE</sub> = 20 V, V <sub>CE</sub> = 0 V	I <sub>GES</sub>	-	-	800	nA

Rated per discrete TO247 qualification
 Device characterization was confirmed in Tj 175°C and HTRB test passed at Tj 150°C condition

Table 2. ELECTRICAL CHARACTERISTICS (T<sub>1</sub> = 25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Тур	Max	Unit
IGBT (T2, T3)						
Turn-on delay time	Tj = 25°C	t <sub>d(on)</sub>	=	68	-	ns
Rise time	V <sub>CE</sub> = 400 V, I <sub>C</sub> = 100 A	t <sub>r</sub>	=	26	=	
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_{G(on)}$ = 5 $\Omega$ , $R_{G(off)}$ = 15 $\Omega$	t <sub>d(off)</sub>	_	552	-	1
Fall time	C(OII)	t <sub>f</sub>	_	42	-	1
Turn on switching loss		E <sub>on</sub>	-	2.8	-	mJ
Turn off switching loss		E <sub>off</sub>	-	2.4	-	
Turn-on delay time	Tj = 125°C	t <sub>d(on)</sub>	-	63	-	ns
Rise time	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}$	t <sub>r</sub>	-	28	-	
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_{G(on)}$ = 5 $\Omega$ , $R_{G(off)}$ = 15 $\Omega$	t <sub>d(off)</sub>	_	585	-	
Fall time		t <sub>f</sub>	-	55	-	
Turn on switching loss		E <sub>on</sub>	-	4	-	mJ
Turn off switching loss		E <sub>off</sub>	-	3	-	
Input capacitance	V <sub>CE</sub> = 20 V. V <sub>GE</sub> = 0 V, f = 10 kHz	C <sub>ies</sub>	-	18784	-	pF
Output capacitance		C <sub>oes</sub>	_	679	-	
Reverse transfer capacitance		C <sub>res</sub>	=	581	=	
Gate charge total	$V_{CE}$ = 480 V, $I_{C}$ = 150 A, $V_{GE}$ = ±15 V	$Q_g$	=	1560	=	nC
Thermal Resistance – chip-to- heatsink	Thermal grease, Thickness = 2.1 Mil $\pm$ 2%, $\lambda$ = 2.9 W/mK	R <sub>thJH</sub>	-	0.34	-	°C/W
IGBT (T5, T6)		•				
Collector-emitter saturation voltage (pin-to-pin)	$V_{GE}$ = 15 V, $I_{C}$ = 300 A, $T_{J}$ = 25°C $V_{GE}$ = 15 V, $I_{C}$ = 300 A, $T_{J}$ = 150°C	V <sub>CE(sat)</sub>	- -	1.15 1.14	1.35 -	V
Gate-emitter threshold voltage	V <sub>GE</sub> = V <sub>CE</sub> , I <sub>C</sub> = 4 mA	V <sub>GE(TH)</sub>	3.1	4.56	5.2	V
Collector-emitter cutoff current	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 650 V	I <sub>CES</sub>		-	160	μΑ
Gate leakage current	V <sub>GE</sub> = 20 V, V <sub>CE</sub> = 0 V	I <sub>GES</sub>	=	-	2	μΑ
Turn-on delay time	Tj = 25°C	t <sub>d(on)</sub>	_	359	_	ns
Rise time	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}$	t <sub>r</sub>	_	51	-	1
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_{G}$ = 20 $\Omega$	t <sub>d(off)</sub>	-	3337	-	1
Fall time		t <sub>f</sub>	-	173	-	
Turn on switching loss		E <sub>on</sub>	-	4.27	-	mJ
Turn off switching loss		E <sub>off</sub>	-	5.1	-	
Turn-on delay time	Tj = 125°C	t <sub>d(on)</sub>	=	300	=	ns
Rise time	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}$	t <sub>r</sub>	=	57	=	
Turn-off delay time	$V_{GE}$ = -8 V to +15 V, $R_G$ = 20 $\Omega$	t <sub>d(off)</sub>	=	3575	=	
Fall time		t <sub>f</sub>	=	205	=	
Turn on switching loss		E <sub>on</sub>	=	5	=	mJ
Turn off switching loss		E <sub>off</sub>	_	5.8	_	
Input capacitance	V <sub>CE</sub> = 20 V. V <sub>GE</sub> = 0 V. f = 10 kHz	C <sub>ies</sub>	=	67524	=	pF
Output capacitance		C <sub>oes</sub>	_	428	-	
Reverse transfer capacitance		C <sub>res</sub>	-	375	-	
Gate charge total	$V_{CE}$ = 480 V, $I_{C}$ = 300 A, $V_{GE}$ = ±15 V	$Q_g$	-	3319	_	nC
Thermal Resistance - chip-to- heatsink	Thermal grease, Thickness = 2.1 Mil $\pm$ 2%, $\lambda$ = 2.9 W/mK	R <sub>thJH</sub>	-	0.28	-	°C/W
IGBT INVERSE DIODE (D1, D4)						
Forward voltage (pin-to-pin)	IF = 150 A, Tj = 25°C IF = 150 A, Tj = 150°C	V <sub>F</sub>	=	1.76 1.78	2.3	V

Table 2. ELECTRICAL CHARACTERISTICS (T<sub>.J</sub> = 25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Min	Тур	Max	Unit
IGBT INVERSE DIODE (D1, D4)	•	•		•	•	•
Reverse recovery time	T <sub>j</sub> = 25°C	T <sub>rr</sub>	_	96	_	ns
Reverse recovery charge	$V_{CE}$ = 400 V, $I_{C}$ = 100 A, $V_{GE}$ = -8 V to +15 V, $R_{G}$ = 5 $\Omega$	Q <sub>rr</sub>	-	1.32	-	μC
Peak reverse recovery current	+13 V, ng = 3 52	I <sub>rrm</sub>	-	45	_	Α
Reverse Peak rate of fall of re- covery current	1	di/dt	-	2313	_	A/μs
Reverse recovery energy	7	Err	-	0.21	-	mJ
Reverse recovery time	T <sub>j</sub> = 125°C	T <sub>rr</sub>	_	113	_	ns
Reverse recovery charge	$V_{CE}$ = 400 V, $I_{C}$ = 100 A, $V_{GE}$ = -8 V to +15 V, $R_{G}$ = 5 $\Omega$	Q <sub>rr</sub>	_	3.03	-	μС
Peak reverse recovery current	- 110 V, Hg = 312	I <sub>rrm</sub>	_	60	-	Α
Reverse Peak rate of fall of re- covery current		di/dt	-	1104	-	A/μs
Reverse recovery energy	7	Err	=	0.47	-	mJ
Thermal Resistance – chip-to- heatsink	Thermal grease, Thickness = 2.1 Mil $\pm$ 2%, $\lambda$ = 2.9 W/mK	R <sub>thJH</sub>	-	0.54	-	°C/W
IGBT INVERSE DIODE (D2, D3, D	5, D6)					
Forward voltage (pin-to-pin)	IF = 225 A, T <sub>j</sub> = 25°C IF = 225 A, T <sub>j</sub> = 150°C	V <sub>F</sub>	- -	1.76 1.78	2.3 -	V
Reverse recovery time	T <sub>j</sub> = 25°C	T <sub>rr</sub>	=	44	-	ns
Reverse recovery charge	$V_{CE} = 400 \text{ V}, I_{C} = 100 \text{ A}, V_{GE} = -8 \text{ V to}$	Q <sub>rr</sub>	=	1.03	-	μC
Peak reverse recovery current	$+15$ V, $R_G$ = 15 $Ω$	I <sub>rrm</sub>	=	48	-	Α
Reverse Peak rate of fall of re- covery current		di/dt	-	2971	-	A/μs
Reverse recovery energy	7	Err	=	0.18	-	mJ
Reverse recovery time	T <sub>j</sub> = 125°C	T <sub>rr</sub>	=	82	=	ns
Reverse recovery charge	$V_{CE}$ = 400 V, $I_{C}$ = 100 A, $V_{GE}$ = -8 V to +15 V, $R_{G}$ = 15 $\Omega$	Q <sub>rr</sub>	=	3.33	-	μC
Peak reverse recovery current	110 V, NG = 10 22	I <sub>rrm</sub>	=	71	-	Α
Reverse Peak rate of fall of re- covery current		di/dt	_	2971	-	A/μs
Reverse recovery energy	7	Err	=	0.52	-	mJ
Thermal Resistance - chip-to- heatsink	Thermal grease, Thickness = 2.1 Mil $\pm$ 2%, $\lambda$ = 2.9 W/mK	R <sub>thJH</sub>	-	0.45	-	°C/W
THERMISTOR CHARACTERISTIC	es					
Nominal resistance	T = 25°C	R <sub>25</sub>	=	22	-	kΩ
Nominal resistance	T = 100°C	R <sub>100</sub>	=	1468	-	Ω
Deviation of R25		DR/R	-5		5	%
Power dissipation		$P_{D}$	_	200	-	mW
Power dissipation constant				2	=	mW/°C
B-value	B(25/50), tol ±3%		=	-	3950	°C
B-value	B(25/100), tol ±3%		=	-	3998	°C
NTC reference			=	_	В	

# **ORDERING INFORMATION**

Orderable Part Number	Marking	Package	Shipping
SNXH100M65L4Q2F2P2G (Q2PACK, Press-fit Pin)	SNXH100M65L4Q2F2P2G	Q2PACK (Pb-Free)	12 Units / Blister Tray

# TYPICAL CHARACTERISTICS - IGBT T1-1, T1-2, T4-1, T4-2 AND DIODE D1, D4

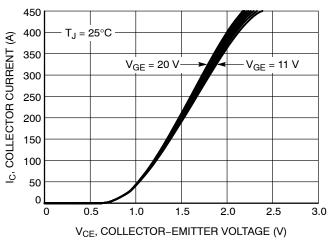
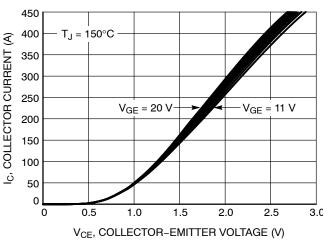


Figure 1. Typical Output Characteristics



**Figure 2. Typical Output Characteristics** 

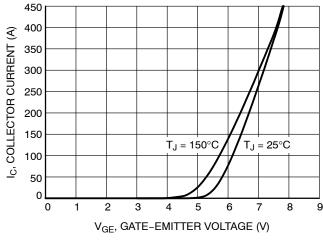


Figure 3. Typical Transfer Characteristics

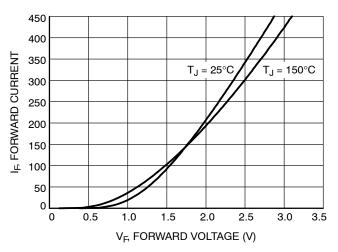


Figure 4. Typical Transfer Characteristics

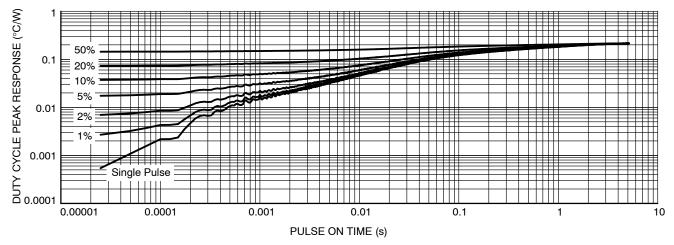


Figure 5. Transient Thermal Impedance (T1, T4)

# TYPICAL CHARACTERISTICS - IGBT T1-1, T1-2, T4-1, T4-2 AND DIODE D1, D4

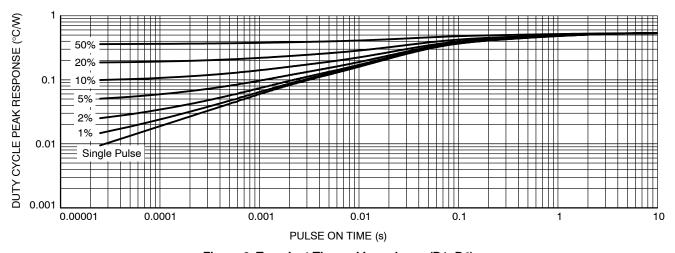


Figure 6. Transient Thermal Impedance (D1, D4)

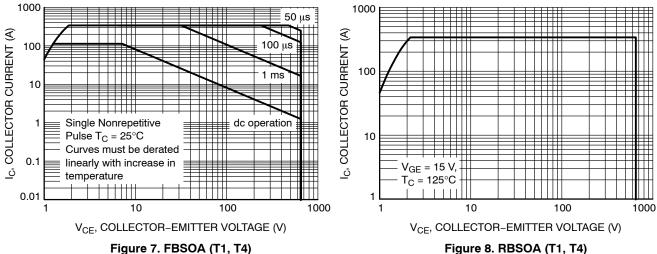


Figure 7. FBSOA (T1, T4)

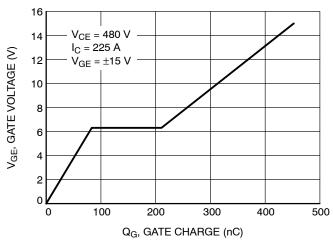


Figure 9. Gate Voltage vs. Gate Charge

# TYPICAL CHARACTERISTICS - IGBT T2, T3 AND DIODE D2, D3

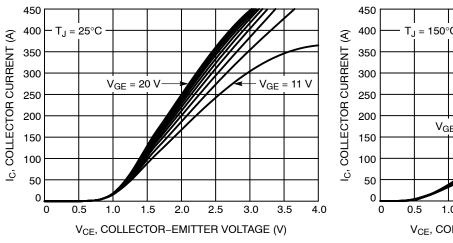


Figure 10. Typical Output Characteristics

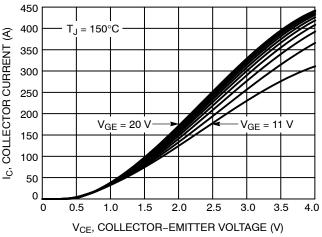


Figure 11. Typical Output Characteristics

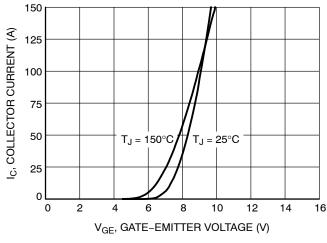


Figure 12. Typical Transfer Characteristics

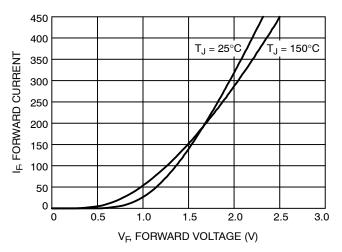


Figure 13. Diode Forward Characteristics

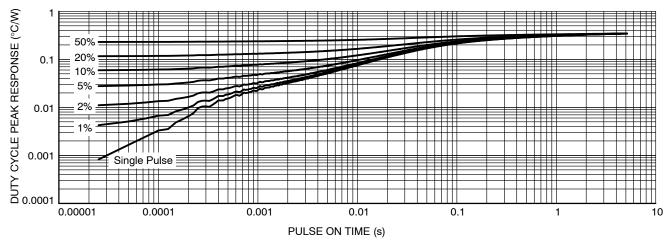


Figure 14. Transient Thermal Impedance (T2, T3)

# TYPICAL CHARACTERISTICS - IGBT T2, T3 AND DIODE D2, D3

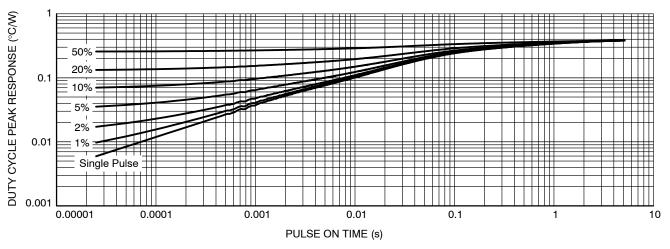


Figure 15. Transient Thermal Impedance (D2, D3)

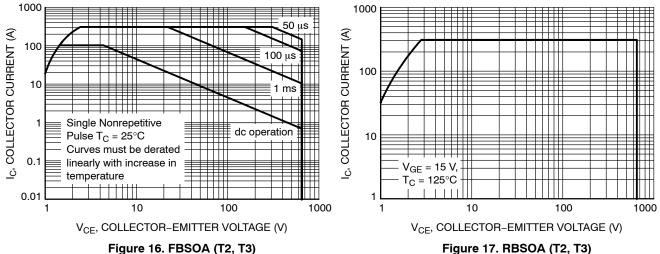


Figure 16. FBSOA (T2, T3)

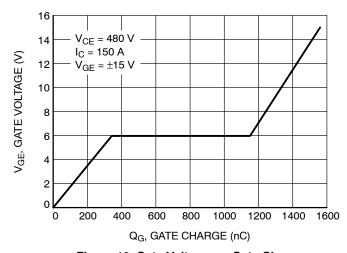


Figure 18. Gate Voltage vs. Gate Charge

## TYPICAL CHARACTERISTICS - IGBT T5, T6 AND DIODE D5, D6

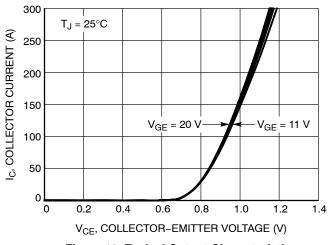


Figure 19. Typical Output Characteristics

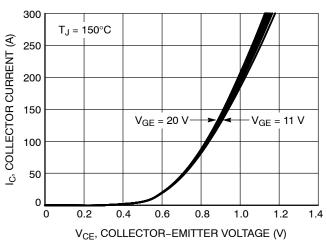


Figure 20. Typical Output Characteristics

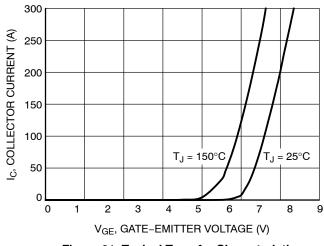


Figure 21. Typical Transfer Characteristics

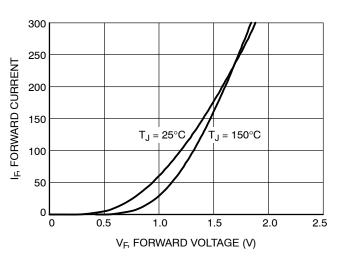


Figure 22. Diode Forward Characteristics

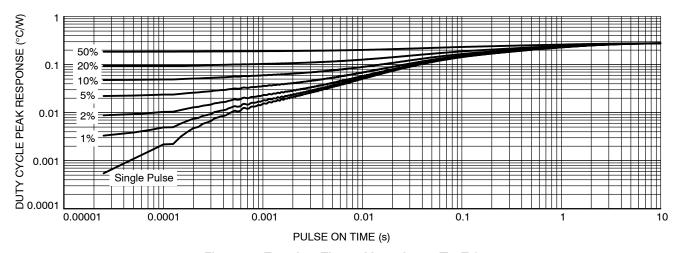


Figure 23. Transient Thermal Impedance (T5, T6)

## TYPICAL CHARACTERISTICS - IGBT T5, T6 AND DIODE D5, D6

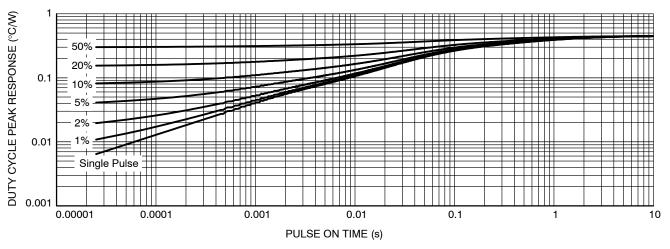


Figure 24. Transient Thermal Impedance (D5, D6)

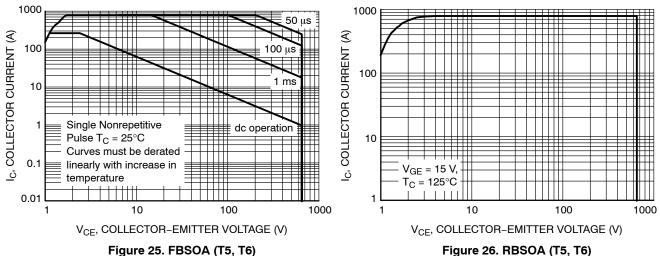


Figure 25. FBSOA (T5, T6)

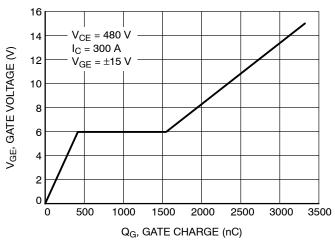
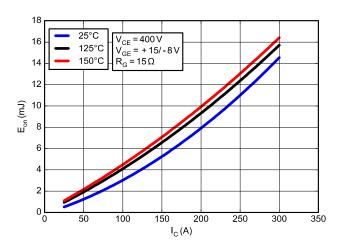


Figure 27. Gate Voltage vs. Gate Charge



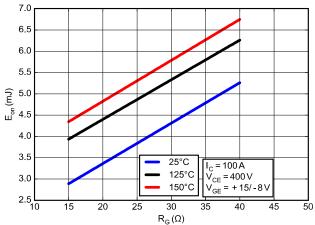
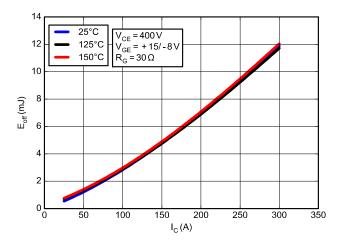


Figure 28. Typical Switching Loss Eon vs. IC

Figure 29. Typical Switching Loss Eon vs. R<sub>G</sub>



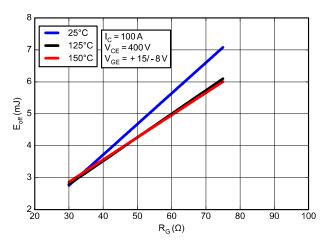
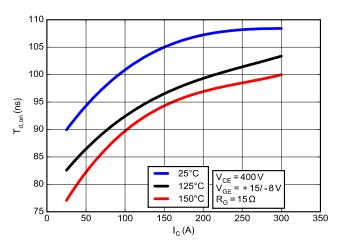


Figure 30. Typical Switching Loss Eoff vs. IC

Figure 31. Typical Switching Loss Eoff vs. R<sub>G</sub>



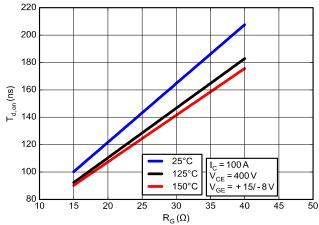
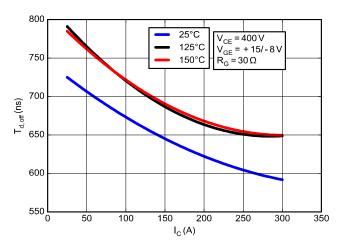


Figure 32. Typical Switching Time Tdon vs. IC

Figure 33. Typical Switching Time Tdon vs. R<sub>G</sub>



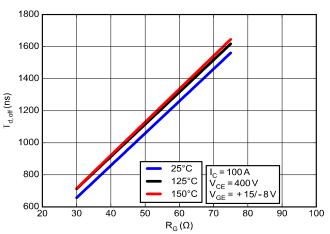
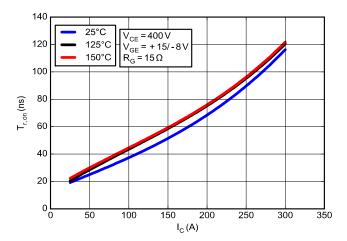


Figure 34. Typical Switching Time Tdoff vs. IC

Figure 35. Typical Switching Time Tdoff vs.  $R_{\mbox{\scriptsize G}}$ 



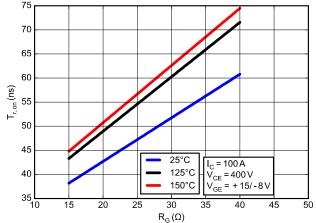
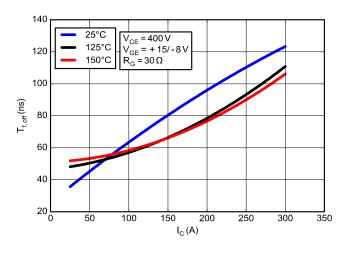


Figure 36. Typical Switching Time Tron vs. IC

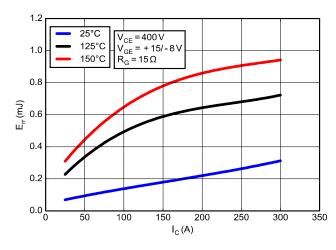
Figure 37. Typical Switching Time Tron vs. R<sub>G</sub>



130 120 110 100 90 80 70 25°C I<sub>C</sub> = 100 A 125°C 60  $V_{CE} = 400 V$ V<sub>GE</sub> = +15/-8V 150°C 50 L 20 60 50 30 40 80  $R_{G}(\Omega)$ 

Figure 38. Typical Switching Time Tf vs. IC

Figure 39. Typical Switching Time Tf vs. R<sub>G</sub>



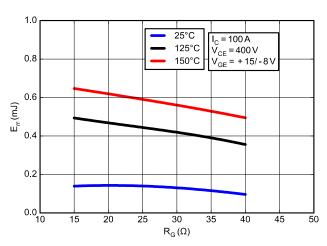
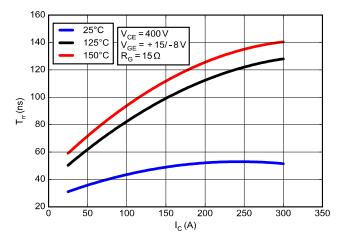


Figure 40. Typical Reverse Recovery Energy vs. IC

Figure 41. Typical Reverse Recovery Energy vs. R<sub>G</sub>



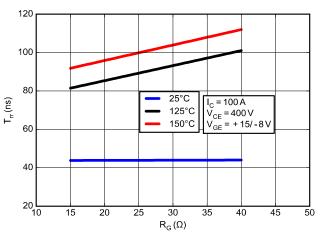


Figure 42. Typical Reverse Recovery Time vs. IC

Figure 43. Typical Reverse Recovery Time vs.  $$\rm R_{\rm G}$$ 

## TYPICAL CHARACTERISTICS - T1/T4 IGBT COMUTATES D2/D3 DIODE

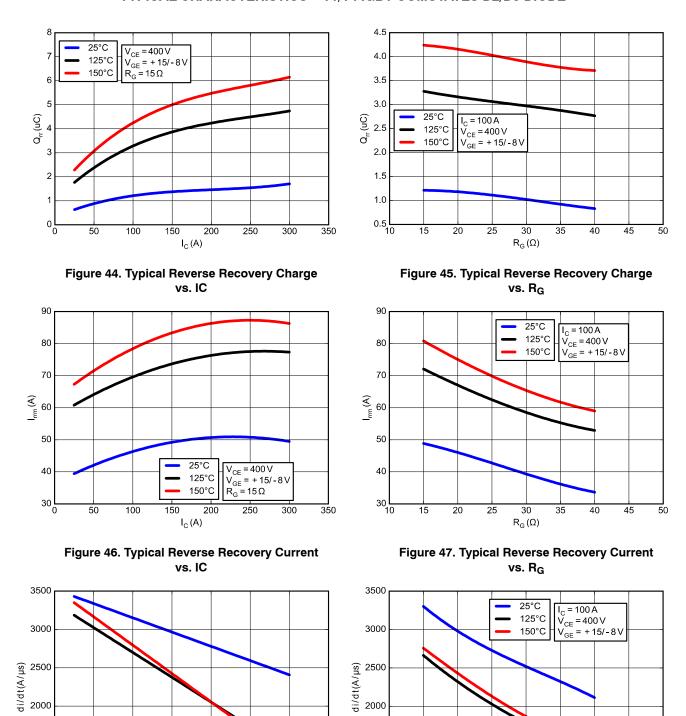


Figure 48. Typical di/dt vs. IC

 $I_{C}(A)$ 

200

250

300

1500

1000

25°C

125°C

150°C

50

 $V_{CE} = 400 V$ 

 $R_G = 15 \Omega$ 

 $V_{GE} = +15/-8V$ 

150

Figure 49. Typical di/dt vs. R<sub>G</sub>

30

 $R_G(\Omega)$ 

35

40

45

350

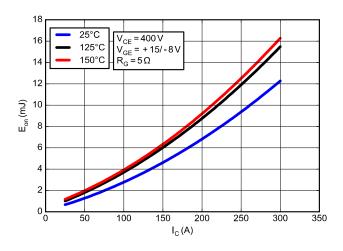
1500

1000 L

15

20

25



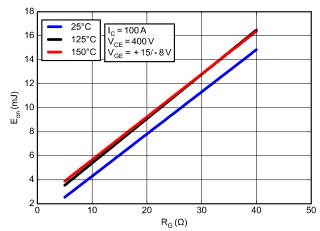
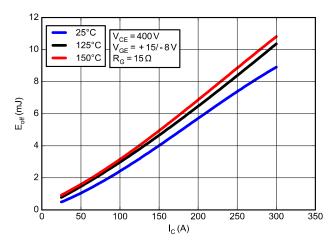


Figure 50. Typical Switching Energy Eon vs. IC

Figure 51. Typical Switching Energy Eon vs.  $$\rm R_{\rm G}$$ 



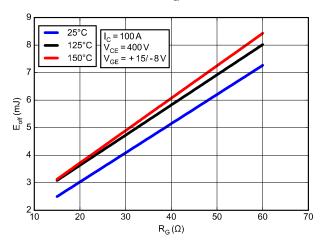
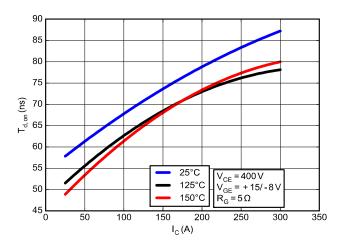


Figure 52. Typical Switching Energy Eoff vs. IC

Figure 53. Typical Switching Energy Eoff vs.  $$R_{\mbox{\scriptsize G}}$$ 



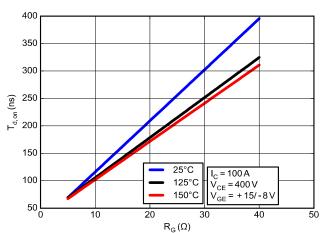
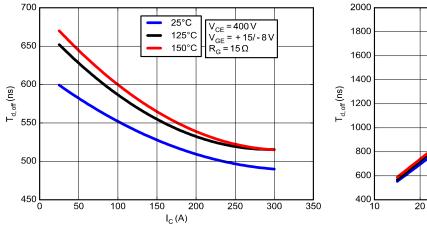


Figure 54. Typical Switching Time Tdon vs. IC

Figure 55. Typical Switching Time Tdon vs. R<sub>G</sub>



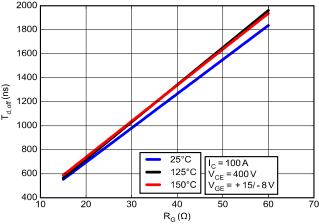
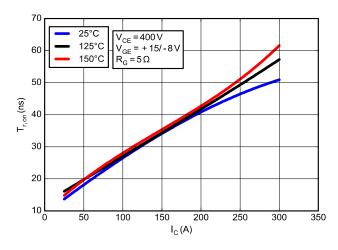


Figure 56. Typical Switching Time Tdoff vs. IC

Figure 57. Typical Switching Time Tdoff vs.  $R_{\mbox{\scriptsize G}}$ 



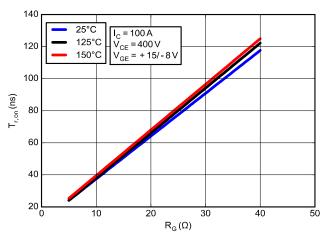
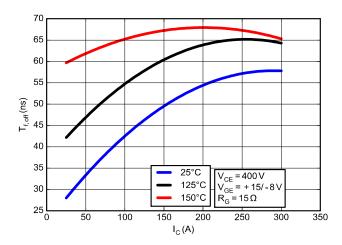


Figure 58. Typical Switching Time Tr vs. IC

Figure 59. Typical Switching Time Tr vs.  $R_{\mbox{\scriptsize G}}$ 



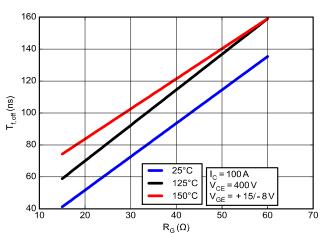


Figure 60. Typical Switching Time Tf vs. IC

Figure 61. Typical Switching Time Tf vs. R<sub>G</sub>

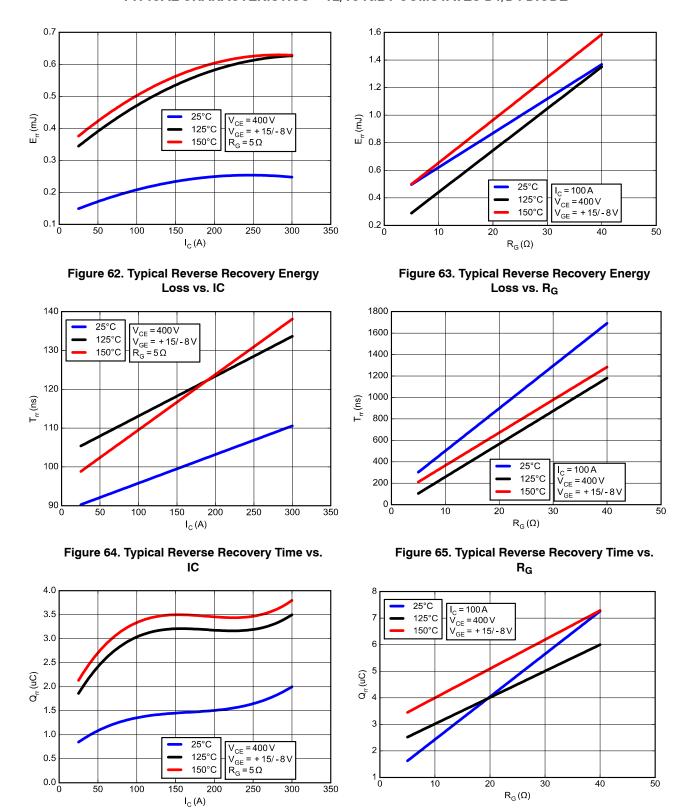
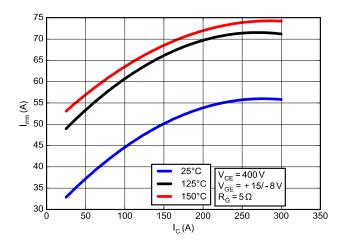


Figure 66. Typical Reverse Recovery Charge vs. IC

Figure 67. Typical Reverse Recovery Charge vs. R<sub>G</sub>

# TYPICAL CHARACTERISTICS - T2/T3 IGBT COMUTATES D1/D4 DIODE



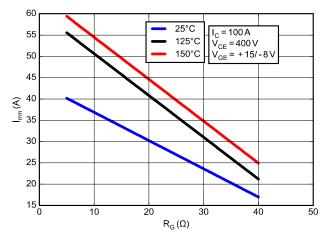
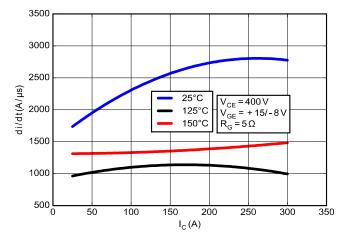


Figure 68. Typical Reverse Recovery Current vs. IC

vs. R<sub>G</sub> 1400 25°C I<sub>C</sub> = 100 A 1200 125°C  $V_{CE} = 400 \text{ V}$  $V_{GE}^{CE} = +15/-8V$ 150°C

Figure 69. Typical Reverse Recovery Current



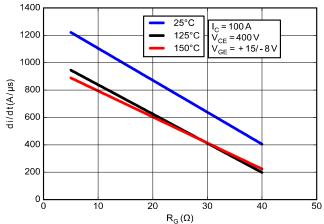
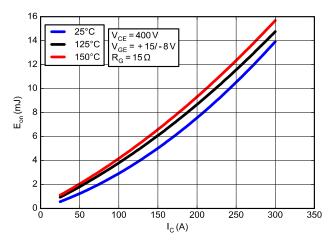


Figure 70. Typical di/dt vs. IC

Figure 71. Typical di/dt vs. R<sub>G</sub>



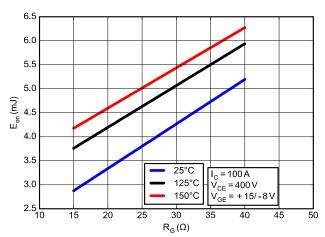
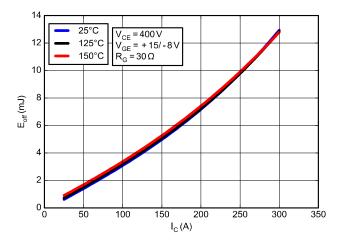


Figure 72. Typical Switching Energy Eon vs. IC





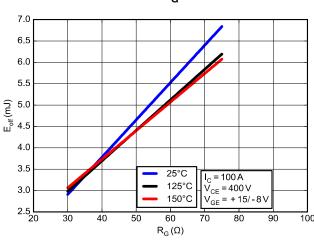
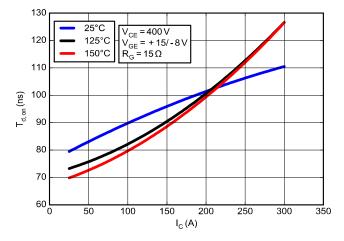


Figure 74. Typical Switching Energy Eoff vs.

Figure 75. Typical Switching Energy Eoff vs.



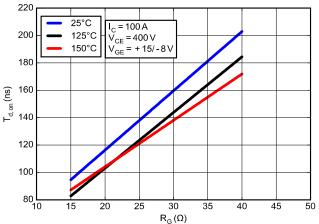


Figure 76. Typical Switching Time Tdon vs. IC

Figure 77. Typical Switching Time Tdon vs. R<sub>G</sub>

## TYPICAL CHARACTERISTICS - T1/T4 IGBT COMUTATES D5/D6 DIODE

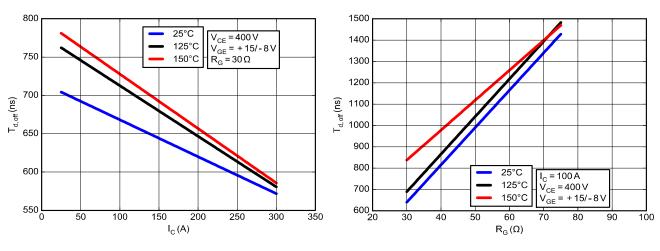


Figure 78. Typical Switching Time Tdoff vs. IC



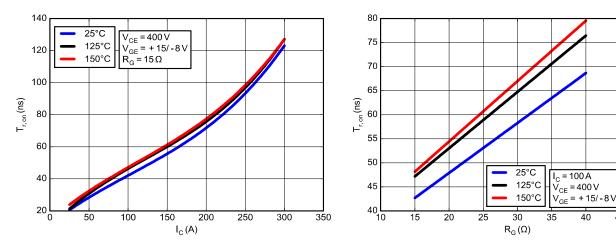


Figure 80. Typical Switching Time Tr vs. IC

120

110

100

90

80

70

60

50

40

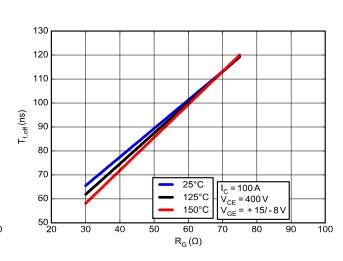


Figure 81. Typical Switching Time Tr vs. R<sub>G</sub>

125°C  $V_{GE} = +15/-8V$ 150°C  $R_G = 30 \Omega$ 30 L 100 150 200 300  $I_{C}(A)$ 

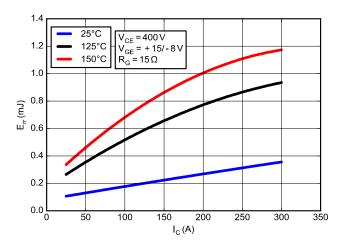
25°C

V<sub>CE</sub> = 400 V

Figure 82. Typical Switching Time Tf vs. IC

Figure 83. Typical Switching Time Tf vs. R<sub>G</sub>

## TYPICAL CHARACTERISTICS - T1/T4 IGBT COMUTATES D5/D6 DIODE



8.0 0.7 0.6 0.5 25°C 0.4 E 0.4 I<sub>C</sub> = 100 A V<sub>CE</sub> = 400 V 125°C V<sub>GE</sub> = +15/-8V 150°C 0.3 0.2 0.1 0.0 L 10 15 20 25 30 35 40 45  $R_G(\Omega)$ 

Figure 84. Typical Reverse Recovery Energy vs. IC

 $V_{CE} = 400 V$ 

 $V_{GE} = +15/-8V$  $R_{G} = 15\Omega$ 

200

180

160

140 120

100

60

40

20 L

25°C

125°C

150°C

50

100



350

Figure 85. Typical Reverse Recovery Energy vs. R<sub>G</sub>

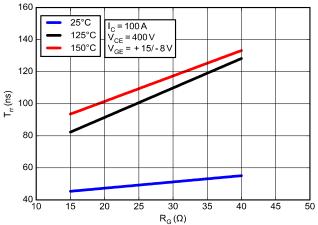


Figure 86. Typical Reverse Recovery Time vs. IC

 $I_{C}(A)$ 

200

250

300

150

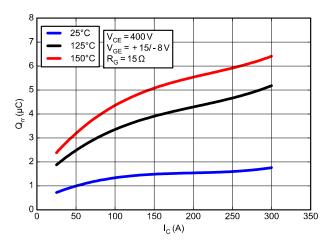


Figure 87. Typical Reverse Recovery Time vs.

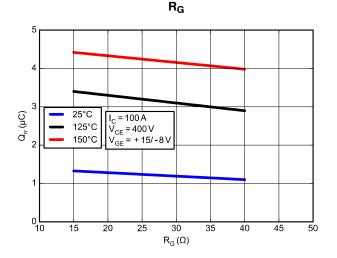
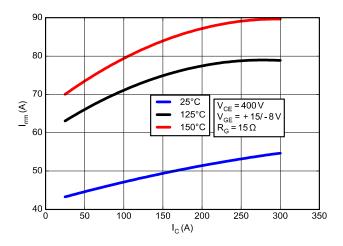


Figure 88. Typical Reverse Recovery Charge vs. IC

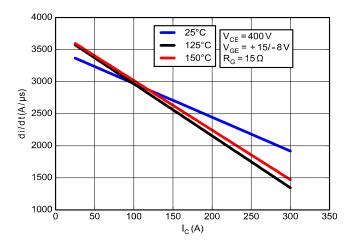
Figure 89. Typical Reverse Recovery Charge vs. R<sub>G</sub>



90 I<sub>C</sub> = 100 A V<sub>CE</sub> = 400 V 25°C 125°C 80 150°C  $V_{GE} = +15/-8V$ 70 € 60 50 40 30 L 10 15 35 45 20 25 30 40  $R_G(\Omega)$ 

Figure 90. Typical Reverse Recovery Current vs. IC

Figure 91. Typical Reverse Recovery Current vs.  $R_{\rm G}$ 



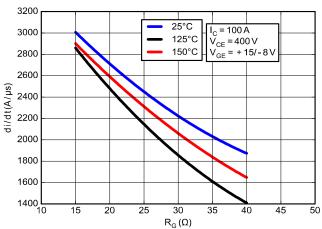
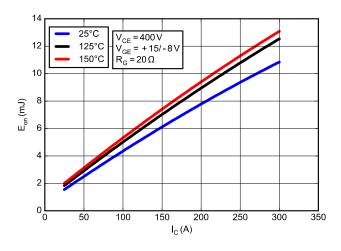


Figure 92. Typical di/dt vs. IC

Figure 93. Typical di/dt vs. R<sub>G</sub>



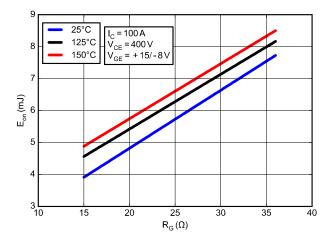
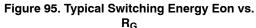
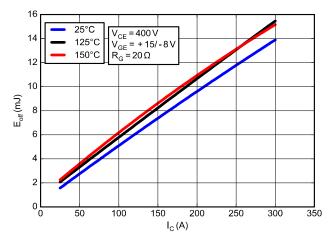


Figure 94. Typical Switching Energy Eon vs. IC





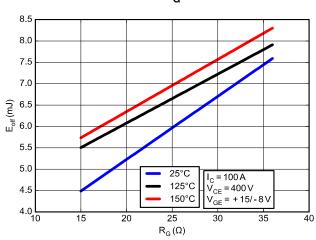
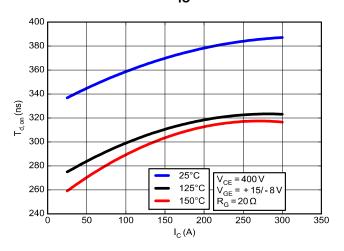


Figure 96. Typical Switching Energy Eoff vs.

Figure 97. Typical Switching Energy Eoff vs.  $$\rm R_{\rm G}$$ 



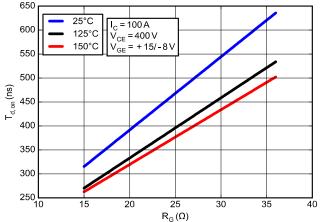


Figure 98. Typical Switching Time Tdon vs. IC

Figure 99. Typical Switching Time Tdon vs. R<sub>G</sub>

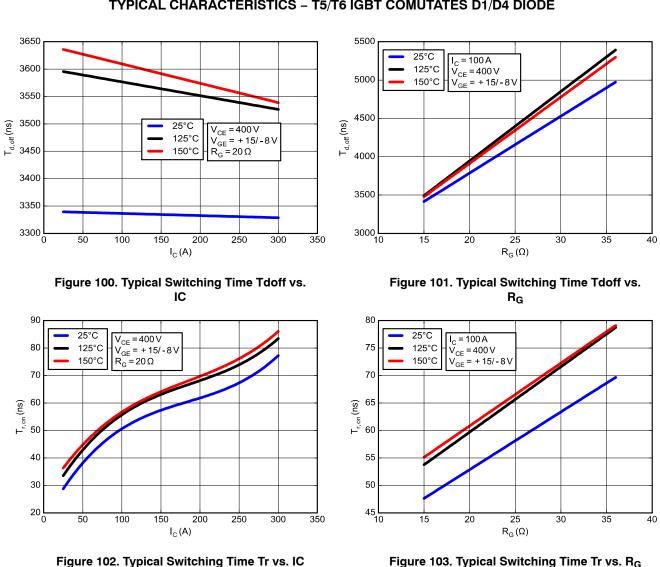


Figure 102. Typical Switching Time Tr vs. IC

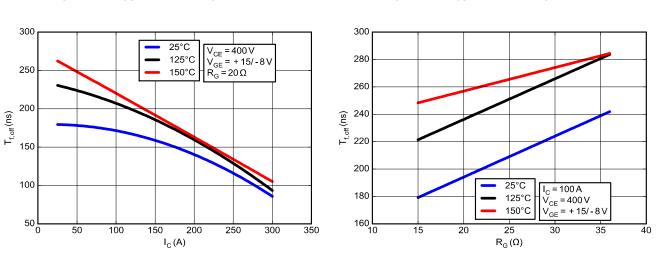
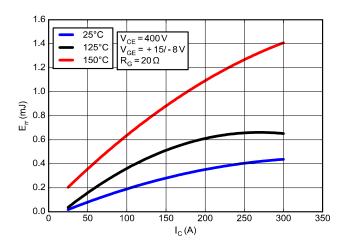


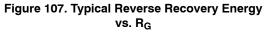
Figure 104. Typical Switching Time Tf vs. IC

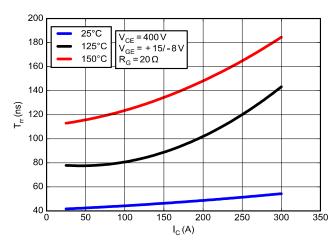
Figure 105. Typical Switching Time Tf vs. R<sub>G</sub>



1.0 25°C I<sub>C</sub> = 100 A V<sub>CE</sub> = 400 V 125°C 8.0 150°C  $V_{GE} = +15/-8V$ 0.6 0.4 0.2 0.0 L 10 15 20 30 25 35  $R_G(\Omega)$ 

Figure 106. Typical Reverse Recovery Energy vs. IC





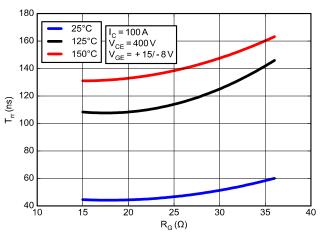
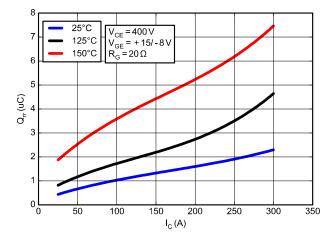


Figure 108. Typical Reverse Recovery Time vs. IC

Figure 109. Typical Reverse Recovery Energy vs. R<sub>G</sub>



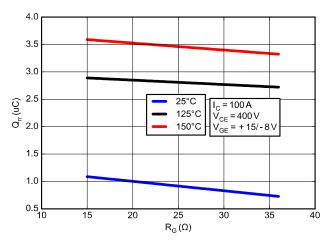
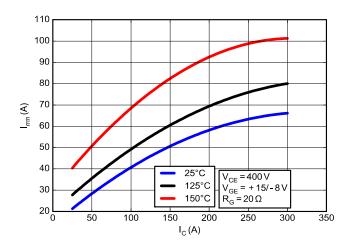


Figure 110. Typical Reverse Recovery Charge vs. IC

Figure 111. Typical Reverse Recovery Charge vs. R<sub>G</sub>



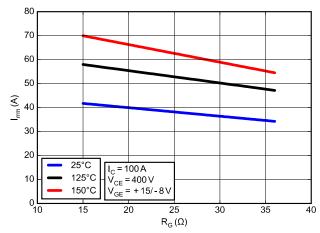
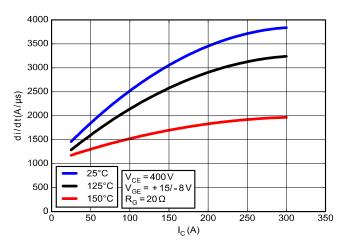


Figure 112. Typical Reverse Recovery Current vs. IC

Figure 113. Typical Reverse Recovery Current vs. R<sub>G</sub>



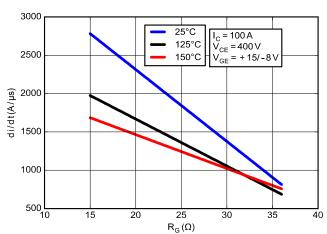
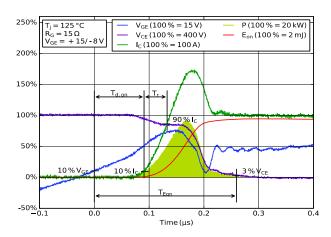


Figure 114. Typical di/dt vs. IC

Figure 115. Typical di/dt vs. R<sub>G</sub>

# TYPICAL SWITCHING DEFINITION - T1/T4 IGBT COMUTATES D2/D3 DIODE



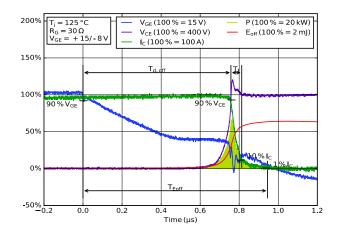


Figure 116. Turn-On Switching Definition Waveform

Figure 117. Turn-Off Switching Definition Waveform

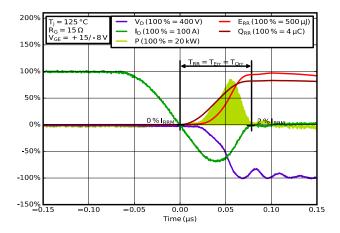
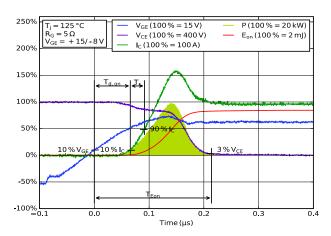


Figure 118. Reverse Recovery Switching Definition Waveform

# TYPICAL SWITCHING DEFINITION - T2/T3 IGBT COMUTATES D1/D4 DIODE



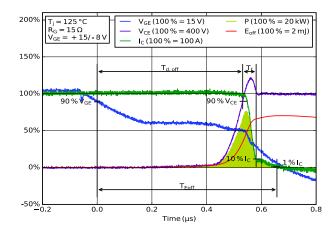


Figure 119. Turn-On Switching Definition Waveform

Figure 120. Turn-Off Switching Definition Waveform

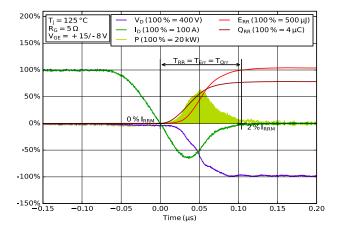
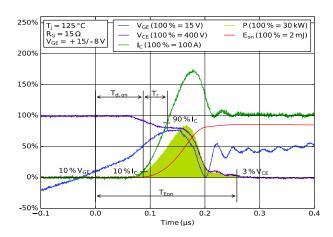


Figure 121. Reverse Recovery Switching Definition Waveform

# TYPICAL SWITCHING DEFINITION - T1/T4 IGBT COMUTATES D5/D6 DIODE



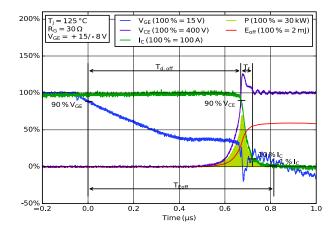


Figure 122. Turn-On Switching Definition Waveform

Figure 123. Turn-Off Switching Definition Waveform

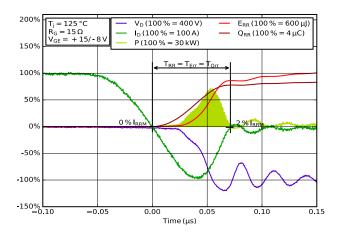
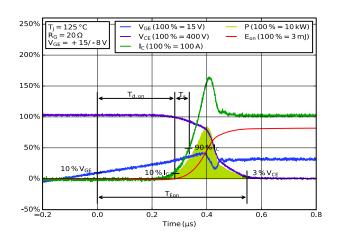


Figure 124. Reverse Recovery Switching Definition Waveform

# TYPICAL SWITCHING DEFINITION - T5/T6 IGBT COMUTATES D1/D4 DIODE



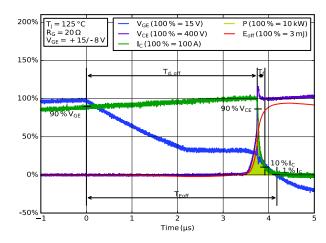


Figure 125. Turn-On Switching Definition Waveform

Figure 126. Turn-Off Switching Definition Waveform

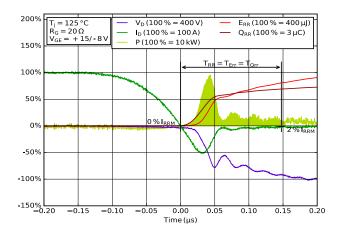
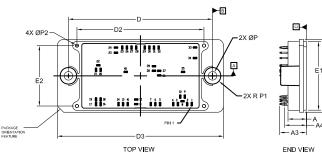


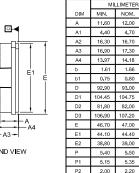
Figure 127. Reverse Recovery Switching Definition Waveform

#### PACKAGE DIMENSIONS

#### PIM41, 93x47 (PRESS FIT)

CASE 180AY **ISSUE O** 





OTES:	

5.00

17,70

0.85

93.10

82,20

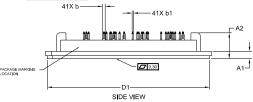
107.50

44.70

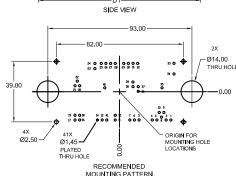
39.20

5.60

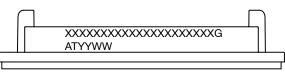
- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
- 2. CONTROLLING DIMENSION: MILLIMETERS
- 3. DIMENSIONS 6 AND 61 APPLY TO THE PLATED TERMINALS AND ARE MEASURED AT DIMENSION A4.
- POSITION OF THE CENTER OF THE TERMINALS AND MOUNTING HOLES IS DETERMINED FROM DATUM B THE CENTER OF DIMENSION D, X DIRECTION, AND FROM DATUM A, Y DIRECTION. POSITIONAL TO FRANCE AS NOTED IN DRAWING APPLIES TO BOTH TERMINALS AND MOUNTING HOLES IN BOTH DIRECTIONS.
- 5. PACKAGE MARKING IS LOCATED AS SHOWN ON THE SIDE OPPOSITE THE PACKAGE ORIENTATION FEATURES.
- 6 MOUNTING RECOMMENDATION IS SHOWN AS VIEWED FROM THE PCB TOP LAYER LOOKING DOWN TO SUBSEQUENT LAYERS.



**♦** 0.80**⑤** C A B



	PIN POSITION			PIN PC	SITION
PIN	Х	Υ	PIN	Х	Υ
1	33.15	-18.25	23	-15.85	14.90
2	30.15	-18.25	24	-15.85	18,25
3	24.15	-18.25	25	-11.75	18.25
4	21.15	-18.25	26	-8.75	18.25
5	12.65	-18.25	27	-5.75	18.25
6	9,65	-18.25	28	-2.75	18,25
7	6.65	-18.25	29	2.75	18.25
8	27,15	-16.40	30	5.75	18,25
9	28.65	-13.40	31	8.75	18.25
10	25.65	-13.40	32	11.75	18.25
11	-2.75	-18.25	33	35.20	18.30
12	-2.75	-15.25	34	35.20	11.45
13	-11.20	-18.25	35	27.50	2.50
14	-14.20	-18.25	36	12.10	0.25
15	n/a	n/a	37	12.10	3.25
16	-25.70	-18.25	38	8.70	3.25
17	-28.70	-18.25	39	8.70	6.25
18	-25.70	-15.25	40	-9.50	2,50
19	-28.70	-15.25	41	-8.20	-18.25
20	-25.70	3.85			
21	-28.70	3,85			
22	-27.20	6.85			



XXXXX = Specific Device Code

G = Pb-Free Package

= Assembly & Test Site Code YYWW = Year and Work Week Code

ON Semiconductor and in are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at <a href="https://www.onsemi.com/site/pdf/Patent-Marking.pdf">www.onsemi.com/site/pdf/Patent-Marking.pdf</a>. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages.

Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

#### **PUBLICATION ORDERING INFORMATION**

#### LITERATURE FULFILLMENT

Literature Distribution Center for ON Semiconductor 19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free

Europe, Middle East and Africa Technical Support:

Phone: 421 33 790 2910

ON Semiconductor Website: www.onsemi.com

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative