NPT Series N-Channel IGBT with Anti-Parallel Hyperfast Diode

43 A, 1200 V

HGTG11N120CND

ON Semiconductor®

www.onsemi.com

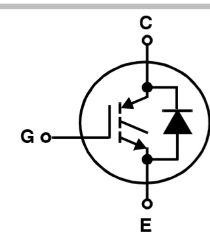
The HGTG11N120CND is a **N**on− **P**unch **T**hrough (NPT) IGBT design. This is a new member of the MOS gated high voltage switching IGBT family. IGBTs combine the best features of MOSFETs and bipolar transistors. This device has the high input impedance of a MOSFET and the low on−state conduction loss of a bipolar transistor. The IGBT used is the development type TA49291. The Diode used is the development type TA49189.

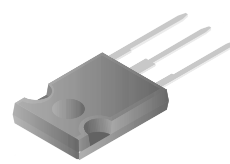
The IGBT is ideal for many high voltage switching applications operating at moderate frequencies where low conduction losses are essential, such as: AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

Formerly Developmental Type TA49303.

Features

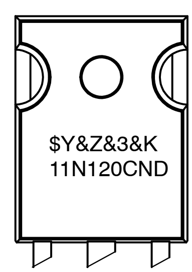
- 43 A, 1200 V, $T_C = 25^{\circ}C$
- 1200 V Switching SOA Capability
- Typical Fall Time: 340 ns at $T_J = 150^{\circ}C$
- Short Circuit Rating
- Low Conduction Loss
- Thermal Impedance SPICE Model www.onsemi.com
- This is Pb−Free Device





TO−247−3LD
CASE 340CK

MARKING DIAGRAMS



$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Data Code (Year & Week)
&K	= Lot
11N120CND	= Specific Device Code

ORDERING INFORMATION

Part Number	Package	Brand
HGTG11N120CND	TO−247	11N120CND

NOTE: When ordering, use the entire part number.

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C, Unless Otherwise Specified)

Description	Symbol	HGTG11N120CND	Units
Collector to Emitter Voltage	BV_{CES}	1200	V
Collector Current Continuous At T_C = 25°C At T_C = 110°C	 I_{C25} I_{C110}	 43 22	 A A
Collector Current Pulsed (Note 1)	I_{CM}	80	A
Gate to Emitter Voltage Continuous	V_{GES}	±20	V
Gate to Emitter Voltage Pulsed	V_{GEM}	±30	V
Switching Safe Operating Area at T_J = 150°C (Figure 2)	SSOA	55 A at 1200 V	
Power Dissipation Total at T_C = 25°C Power Dissipation Derating T_C > 25°C	P_D	298 2.38	W W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	−55 to 150	°C
Maximum Lead Temperature for Soldering	T_L	260	°C
Short Circuit Withstand Time (Note 2) at V_{GE} = 15 V	t_{SC}	8	μs
Short Circuit Withstand Time (Note 2) at V_{GE} = 12 V	t_{SC}	15	μs

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.

1. Pulse width limited by maximum junction temperature.
2. $V_{CE(PK)}$ = 840 V, T_J = 125°C, R_G = 10 Ω.

ELECTRICAL SPECIFICATIONS (T_J = 25, °C Unless Otherwise Specified)

Parameter	Symbol	Test Conditions		Min	Typ	Max	Units
Collector to Emitter Breakdown Voltage	BV_{CES}	I_C = 250 μA, V_{GE} = 0 V		1200	–	–	V
Collector to Emitter Leakage Current	I_{CES}	V_{CE} = 1200 V	T_C = 25°C	–	–	250	μA
			T_C = 125°C	–	300	–	μA
			T_C = 150°C	–	–	3.5	mA
Collector to Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C = 11 A, V_{GE} = 15 V	T_C = 25°C	–	2.1	2.4	V
			T_C = 150°C	–	2.9	3.5	V
Gate to Emitter Threshold Voltage	$V_{GE(TH)}$	I_C = 90 μA, V_{CE} = V_{GE}		6.0	6.8	–	V
Gate to Emitter Leakage Current	I_{GES}	V_{GE} = ±20 V		–	–	±250	nA
Switching SOA	SSOA	T_J = 150°C, R_G = 10 Ω, V_{GE} = 15 V, L = 400 μH, $V_{CE(PK)}$ = 1200 V		55	–	–	A
Gate to Emitter Plateau Voltage	V_{GEP}	I_C = 11 A, V_{CE} = 600 V		–	10.4	–	V
On−State Gate Charge	$Q_{G(ON)}$	I_C = 11 A, V_{CE} = 600 V	V_{GE} = 15 V	–	100	120	nC
			V_{GE} = 20 V	–	130	150	nC
Current Turn−On Delay Time	$t_{d(ON)I}$	IGBT and Diode at T_J = 25°C, I_{CE} = 11 A, V_{CE} = 960 V, V_{GE} = 15 V, R_G = 10 Ω, L = 2 mH, Test Circuit (Figure 20)		–	23	26	ns
Current Rise Time	t_{rI}			–	12	16	ns
Current Turn−Off Delay Time	$t_{d(OFF)I}$			–	180	240	ns
Current Fall Time	t_{fI}			–	190	220	ns
Turn−On Energy	E_{ON}			–	0.95	1.3	mJ
Turn−Off Energy (Note 3)	E_{OFF}			–	1.3	1.6	mJ
Current Turn−On Delay Time	$t_{d(ON)I}$	IGBT and Diode at T_J = 150°C, I_{CE} = 11 A, V_{CE} = 960 V, V_{GE} = 15 V, R_G = 10 Ω, L = 2 mH, Test Circuit (Figure 20)		–	21	24	ns
Current Rise Time	t_{rI}			–	12	16	ns
Current Turn−Off Delay Time	$t_{d(OFF)I}$			–	210	280	ns
Current Fall Time	t_{fI}			–	360	400	ns
Turn−On Energy	E_{ON}			–	1.9	2.5	mJ
Turn−Off Energy (Note 3)	E_{OFF}			–	2.1	2.5	mJ
Diode Forward Voltage	V_{EC}	I_{EC} = 11 A		–	2.6	3.2	V
Diode Reverse Recovery Time	t_{rr}	I_{EC} = 11 A, dI_{EC}/dt = 200 A/μs		–	60	70	ns
		I_{EC} = 1 A, dI_{EC}/dt = 200 A/μs		–	32	40	ns
Thermal Resistance Junction To Case	$R_{\theta JC}$	IGBT		–	–	0.42	°C/W
		Diode		–	–	1.25	°C/W

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. Turn−Off Energy Loss (E_{OFF}) is defined as the integral of the instantaneous power loss starting at the trailing edge of the input pulse and ending at the point where the collector current equals zero (I_{CE} = 0 A). All devices were tested per JEDEC Standard No. 24−1 Method for Measurement of Power Device Turn−Off Switching Loss. This test method produces the true total Turn−Off Energy Loss.

TYPICAL PERFORMANCE CHARACTERISTICS

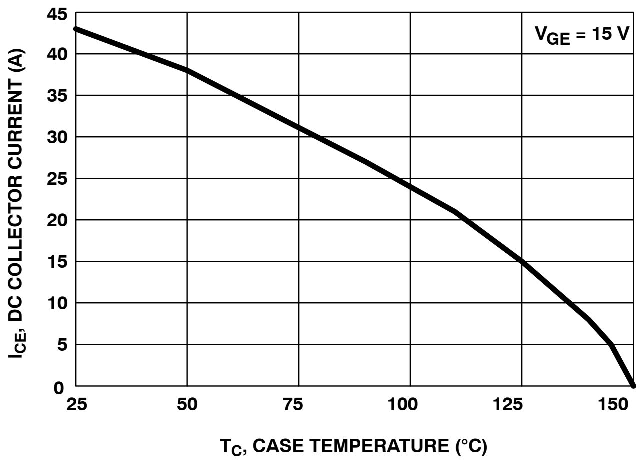


Figure 1. DC COLLECTOR CURRENT vs CASE TEMPERATURE

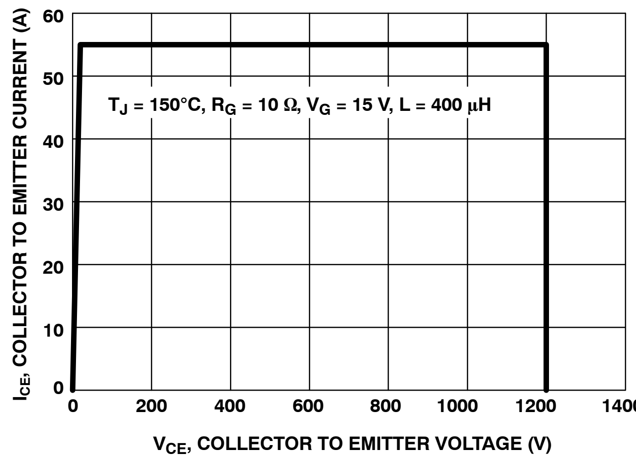


Figure 2. MINIMUM SWITCHING SAFE OPERATING AREA

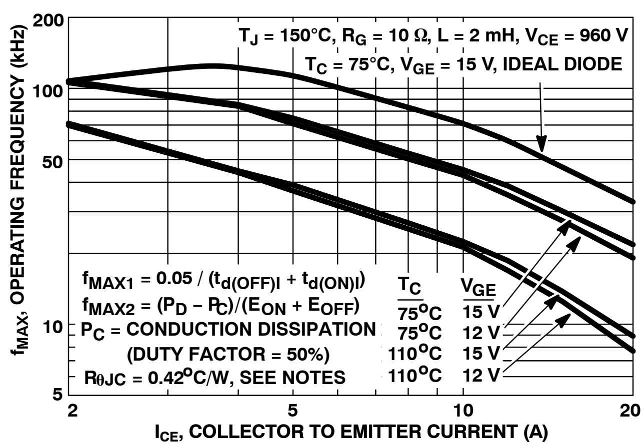


Figure 3. OPERATING FREQUENCY vs COLLECTOR TO EMITTER CURRENT

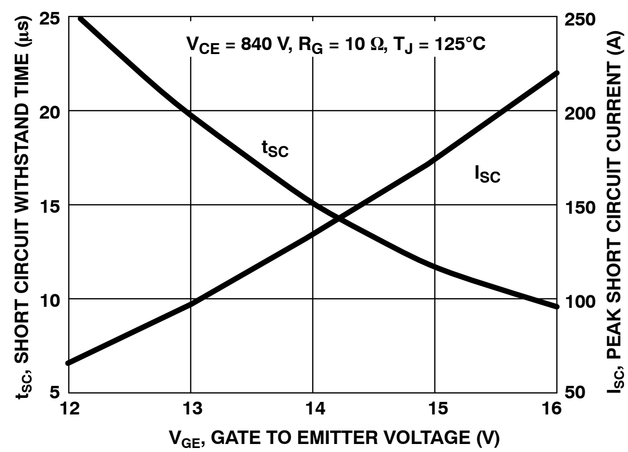


Figure 4. SHORT CIRCUIT WITHSTAND TIME

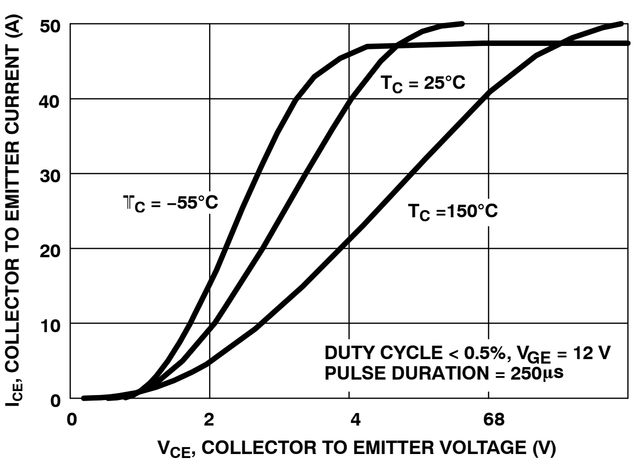


Figure 5. COLLECTOR TO EMITTER ON−STATE VOLTAGE

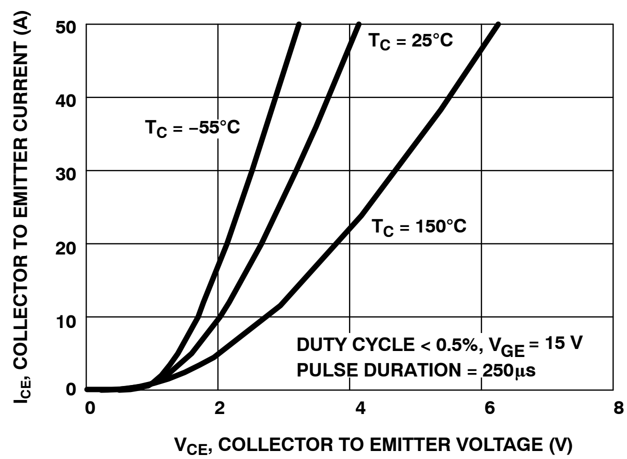


Figure 6. COLLECTOR TO EMITTER ON−STATE VOLTAGE

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

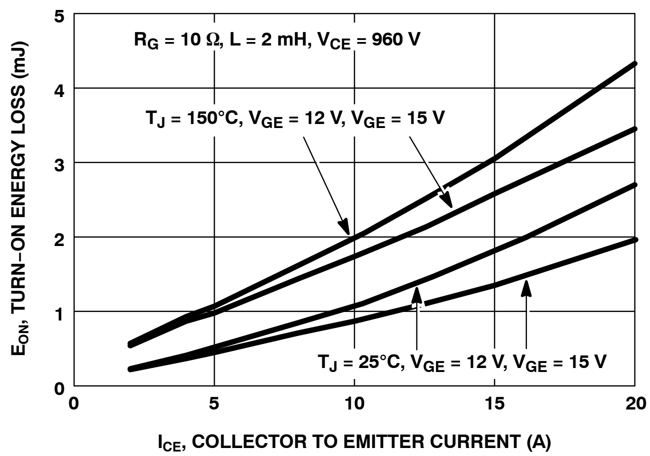


Figure 7. TURN-ON ENERGY LOSS vs COLLECTOR TO EMITTER CURRENT

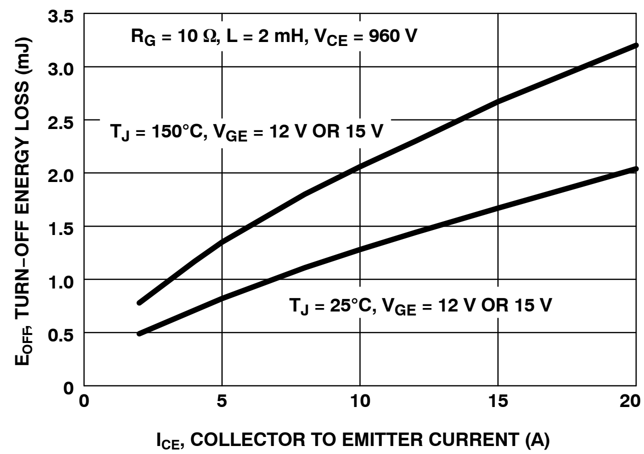


Figure 8. TURN-OFF ENERGY LOSS vs COLLECTOR TO EMITTER CURRENT

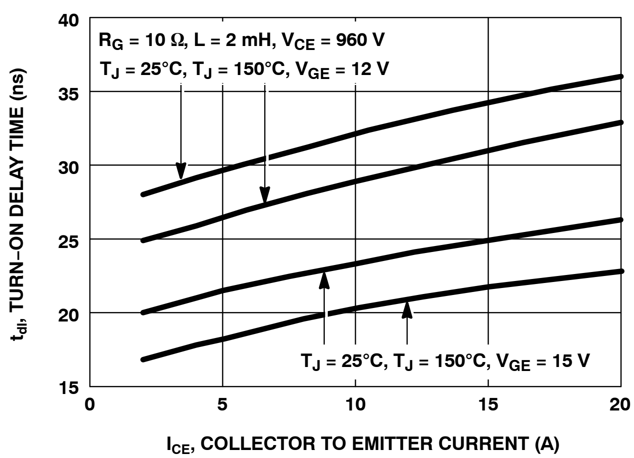


Figure 9. TURN-ON DELAY TIME vs COLLECTOR TO EMITTER CURRENT

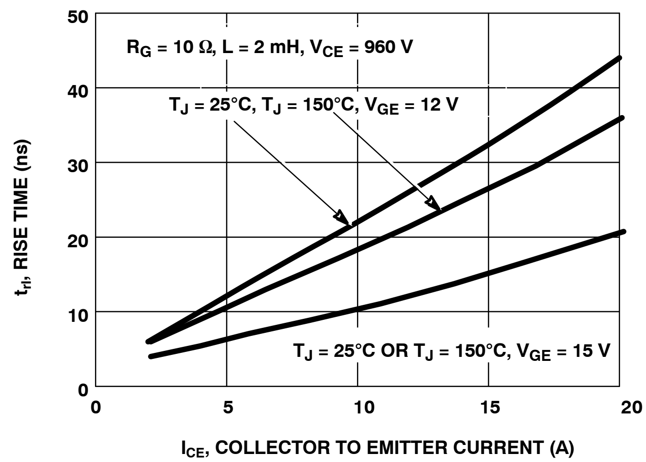


Figure 10. TURN-ON RISE TIME vs COLLECTOR TO EMITTER CURRENT

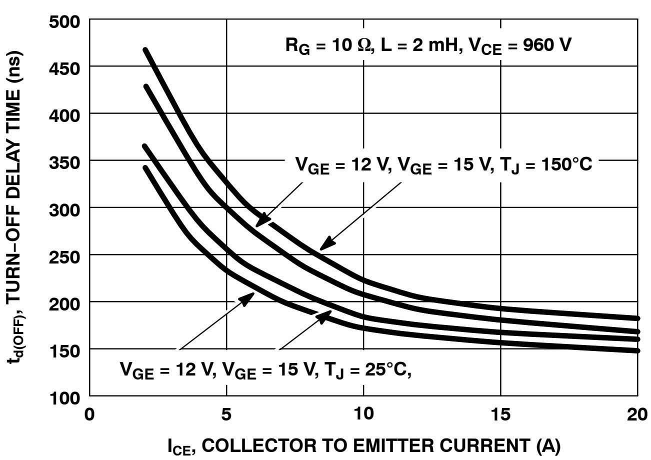


Figure 11. TURN-OFF DELAY TIME vs COLLECTOR TO EMITTER CURRENT

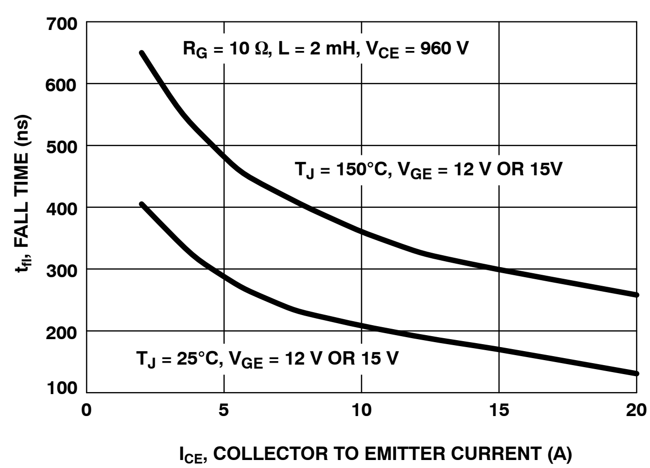


Figure 12. FALL TIME vs COLLECTOR TO EMITTER CURRENT

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TYPICAL PERFORMANCE CHARACTERISTICS (continued)

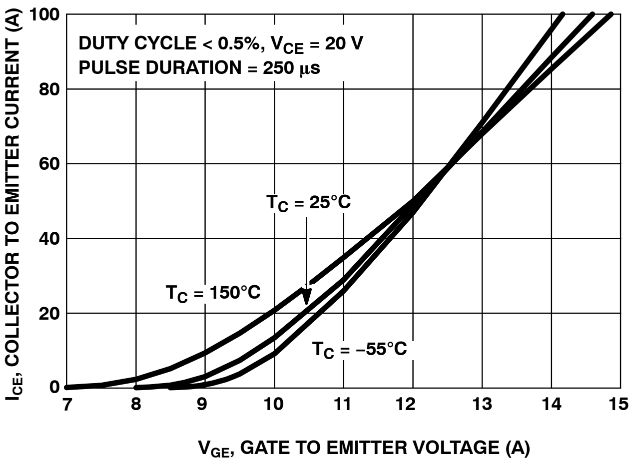


Figure 13. TRANSFER CHARACTERISTIC

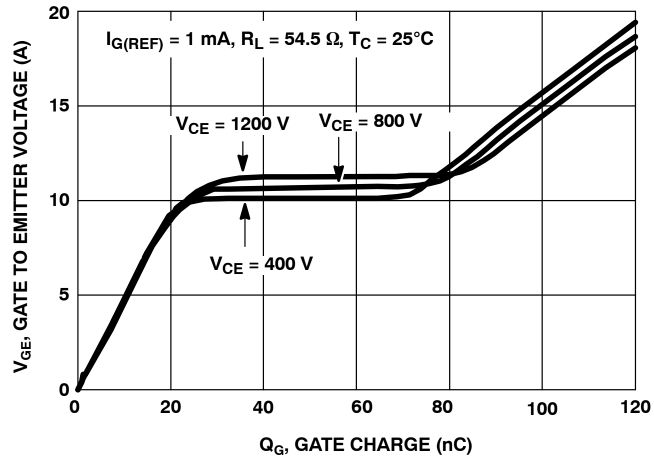


Figure 14. GATE CHARGE WAVEFORMS

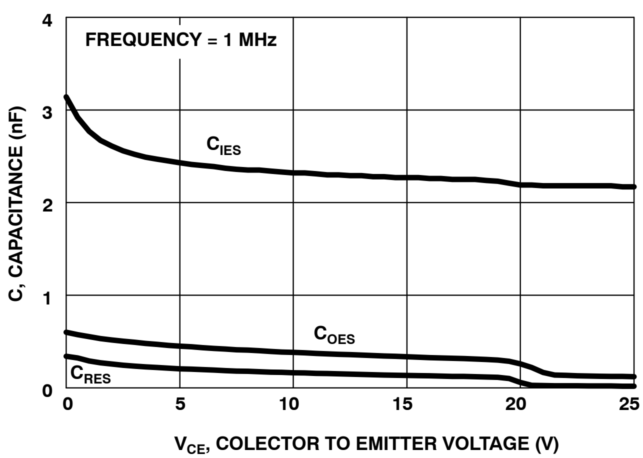


Figure 15. CAPACITANCE vs COLLECTOR TO EMITTER VOLTAGE

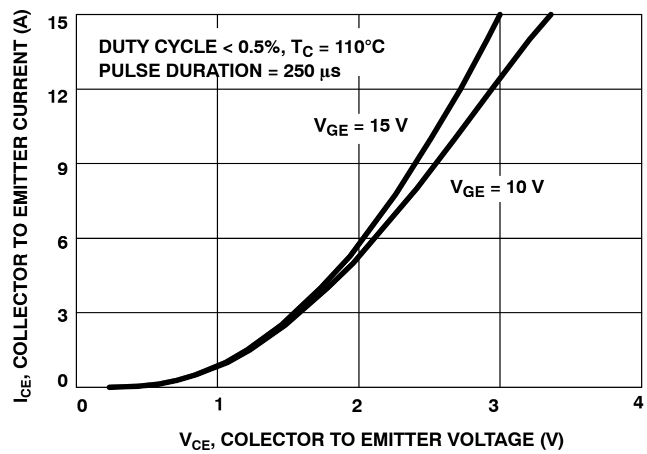


Figure 16. COLLECTOR TO EMITTER ON−STATE VOLTAGE

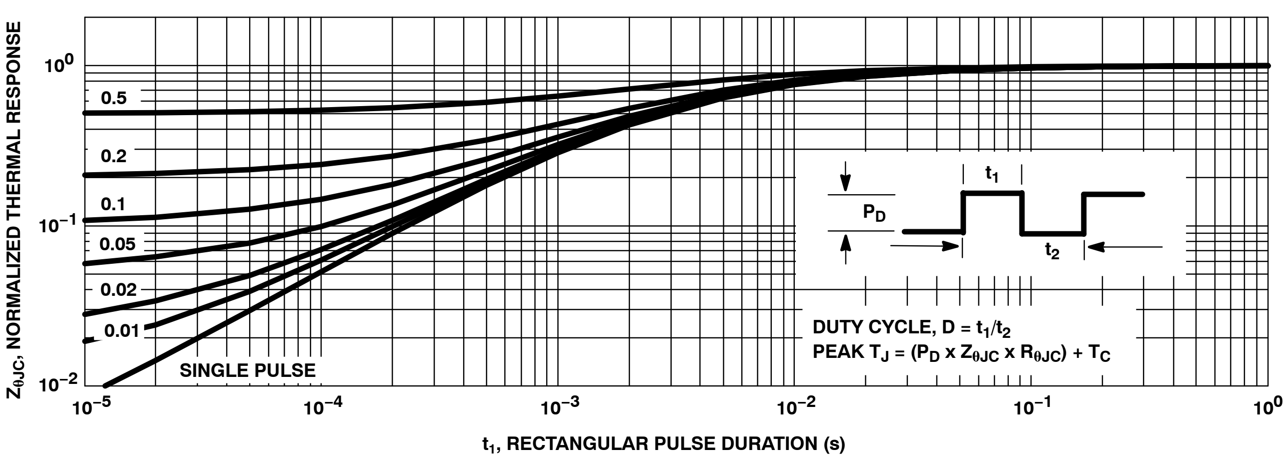


Figure 17. NORMALIZED TRANSIENT THERMAL RESPONSE, JUNCTION TO CASE

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

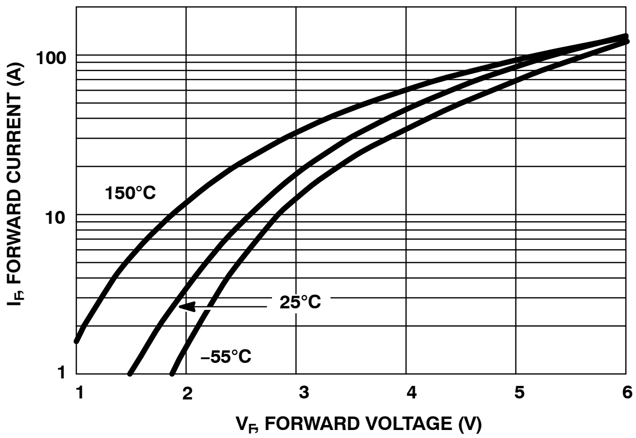


Figure 18. DIODE FORWARD CURRENT vs FORWARD VOLTAGE DROP

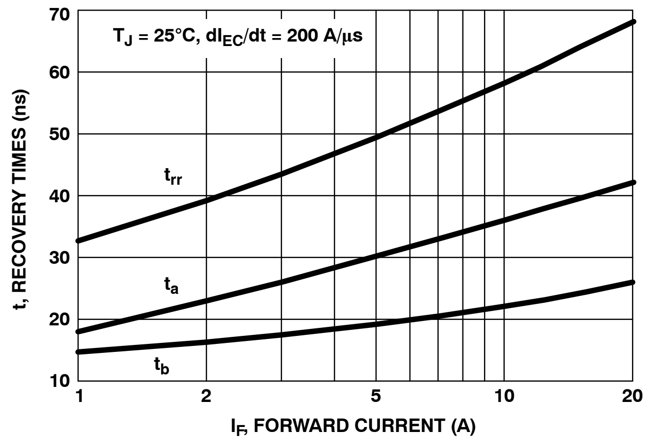


Figure 19. RECOVERY TIMES vs FORWARD CURRENT

TEST CIRCUITS AND WAVEFORMS

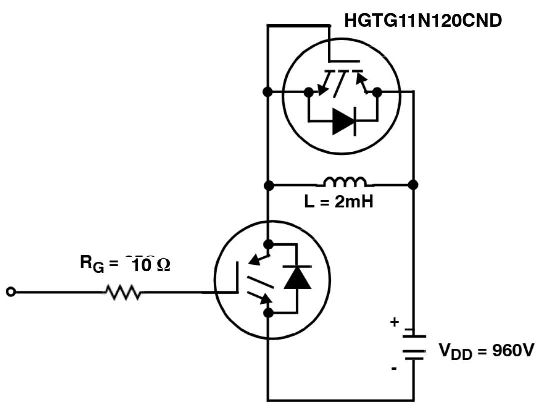


Figure 20. Inductive Switching Test Circuit

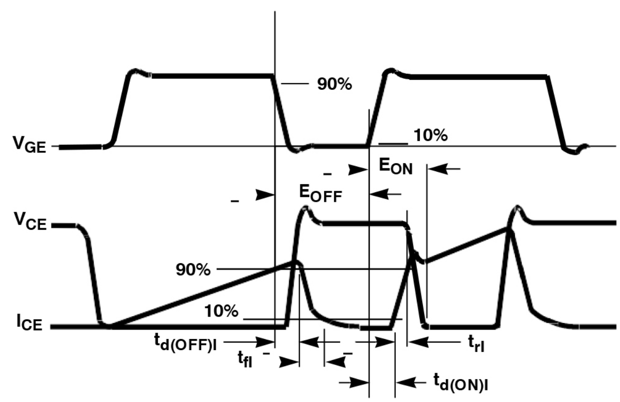


Figure 21. SWITCHING TEST WAVEFORMS

HANDLING PRECAUTIONS FOR IGBTS

Insulated Gate Bipolar Transistors are susceptible to gate−insulation damage by the electrostatic discharge of energy through the devices. When handling these devices, care should be exercised to assure that the static charge built in the handler's body capacitance is not discharged through the device. With proper handling and application procedures, however, IGBTs are currently being extensively used in production by numerous equipment manufacturers in military, industrial and consumer applications, with virtually no damage problems due to electrostatic discharge. IGBTs can be handled safely if the following basic precautions are taken:

1. Prior to assembly into a circuit, all leads should be kept shorted together either by the use of metal shorting springs or by the insertion into conductive material such as "ECCOSORBD™ LD26" or equivalent
2. When devices are removed by hand from their carriers, the hand being used should be grounded by any suitable means − for example, with a metallic wristband
3. Tips of soldering irons should be grounded
4. Devices should never be inserted into or removed from circuits with power on
5. Gate Voltage Rating − Never exceed the gate−voltage rating of V_{GEM}. Exceeding the rated V_{GE} can result in permanent damage to the oxide layer in the gate region
6. Gate Termination − The gates of these devices are essentially capacitors. Circuits that leave the gate open− circuited or floating should be avoided. These conditions can result in turn−on of the device due to voltage buildup on the input capacitor due to leakage currents or pickup
7. Gate Protection − These devices do not have an internal monolithic Zener diode from gate to emitter. If gate protection is required an external Zener is recommended

OPERATING FREQUENCY INFORMATION

Operating frequency information for a typical device (Figure 3) is presented as a guide for estimating device performance for a specific application. Other typical frequency vs collector current (I_{CE}) plots are possible using the information s11hown for a typical unit in Figures 5, 6, 7, 8, 9 and 11. The operating frequency plot (Figure 3) of a typical device shows f_{MAX1} or f_{MAX2}; whichever is smaller at each point. The information is based on measurements of a typical device and is bounded by the maximum rated junction temperature.

f_{MAX1} is defined by $f_{MAX1} = 0.05/(t_{d(OFF)I} + t_{d(ON)I})$. Deadtime (the denominator) has been arbitrarily held to 10% of the on−state time for a 50% duty factor. Other definitions are possible. $t_{d(OFF)I}$ and $t_{d(ON)I}$ are defined in Figure 21. Device turn−off delay can establish an additional frequency limiting condition for an application other than T_{JM}. $t_{d(OFF)I}$ is important when controlling output ripple under a lightly loaded condition.

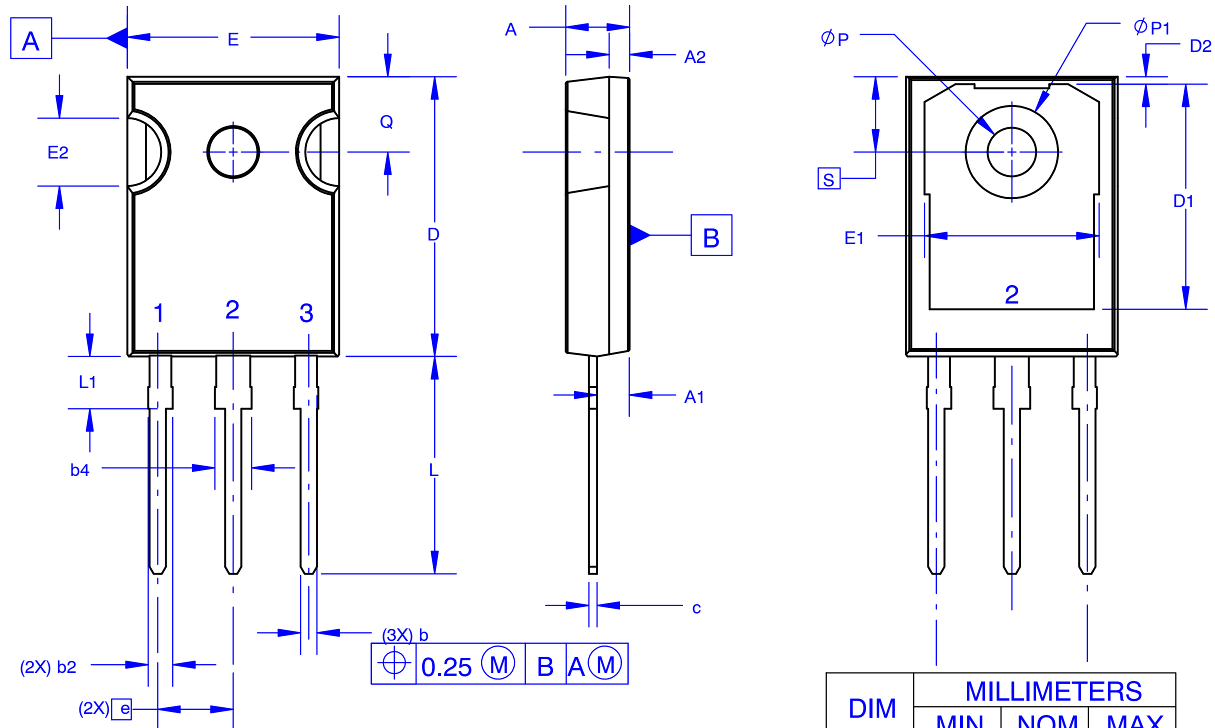
f_{MAX2} is defined by $f_{MAX2} = (P_D - P_C)/(E_{OFF} + E_{ON})$. The allowable dissipation (P_D) is defined by $P_D = (T_{JM} - T_C)/R_{\theta JC}$. The sum of device switching and conduction losses must not exceed P_D. A 50% duty factor was used (Figure 3) and the conduction losses (P_C) are approximated by

$$P_C = (V_{CE} \times I_{CE})/2 \qquad \text{(eq. 1)}$$

E_{ON} and E_{OFF} are defined in the switching waveforms shown in Figure 21. E_{ON} is the integral of the instantaneous power loss ($I_{CE} \times V_{CE}$) during turn−on and E_{OFF} is the integral of the instantaneous power loss ($I_{CE} \times V_{CE}$) during turn−off. All tail losses are included in the calculation for E_{OFF}; i.e., the collector current equals zero ($I_{CE} = 0$).

TO−247−3LD SHORT LEAD
CASE 340CK
ISSUE A

DATE 31 JAN 2019



NOTES: UNLESS OTHERWISE SPECIFIED.

A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.58	4.70	4.82
A1	2.20	2.40	2.60
A2	1.40	1.50	1.60
b	1.17	1.26	1.35
b2	1.53	1.65	1.77
b4	2.42	2.54	2.66
c	0.51	0.61	0.71
D	20.32	20.57	20.82
D1	13.08	~	~
D2	0.51	0.93	1.35
E	15.37	15.62	15.87
E1	12.81	~	~
E2	4.96	5.08	5.20
e	~	5.56	~
L	15.75	16.00	16.25
L1	3.69	3.81	3.93
ØP	3.51	3.58	3.65
ØP1	6.60	6.80	7.00
Q	5.34	5.46	5.58
S	5.34	5.46	5.58

GENERIC
MARKING DIAGRAM*

AYWWZZ
XXXXXXX
XXXXXXX
∘

XXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
ZZ = Assembly Lot Code

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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