Data Sheet December 2001

6.2A, 1200V, NPT Series N-Channel IGBT with Anti-Parallel Hyperfast Diode

The HGTP1N120CND and the HGT1S1N120CNDS are **N**on-**P**unch **T**hrough (NPT) IGBT designs. They are new members 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 is development type number TA49317. The diode used in anti-parallel with the IGBT is the RHRD4120 (TA49056).

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.

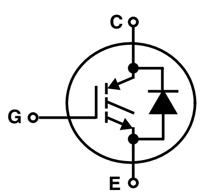
Formerly developmental type TA49315.

Ordering Information

PART NUMBER	PACKAGE	BRAND
HGTP1N120CND	TO-220AB	1N120CND
HGT1S1N120CNDS	TO-263AB	1N120CND

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-263AB in tape and reel, e.g. HGT1S1N120CNDS9A.

Symbol

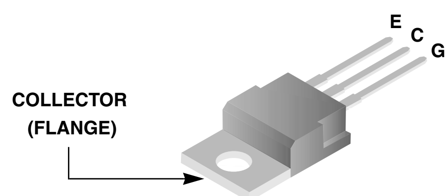


Features

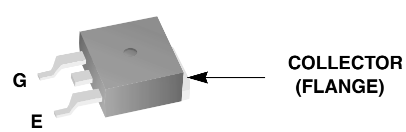
- 6.2A, 1200V, $T_C = 25^oC$
- 1200V Switching SOA Capability
- Typical E_{OFF} . . . . 200µJ at $T_J = 150^oC$
- Short Circuit Rating
- Low Conduction Loss
- *Temperature Compensating* SABER™ Model
  Thermal Impedance SPICE Model
  www.fairchildsemi.com/
- Related Literature
  - TB334, “Guidelines for Soldering Surface Mount Components to PC Boards”

Packaging

JEDEC TO-220AB



JEDEC TO-263AB



FAIRCHILD SEMICONDUCTOR IGBT PRODUCT IS COVERED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS

4,364,073	4,417,385	4,430,792	4,443,931	4,466,176	4,516,143	4,532,534	4,587,713
4,598,461	4,605,948	4,620,211	4,631,564	4,639,754	4,639,762	4,641,162	4,644,637
4,682,195	4,684,413	4,694,313	4,717,679	4,743,952	4,783,690	4,794,432	4,801,986
4,803,533	4,809,045	4,809,047	4,810,665	4,823,176	4,837,606	4,860,080	4,883,767
4,888,627	4,890,143	4,901,127	4,904,609	4,933,740	4,963,951	4,969,027	

Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

		HGTP1N120CND, HGT1S1N120CNDS	UNITS
Collector to Emitter Voltage	BV_{CES}	1200	V
Collector Current Continuous			
At $T_C = 25^oC$	I_{C25}	6.2	A
At $T_C = 110^oC$	I_{C110}	3.2	A
Average Rectified Forward Current at $T_C = 148^oC$	$I_{F(AV)}$	4	A
Collector Current Pulsed (Note 1)	I_{CM}	6	A
Gate to Emitter Voltage Continuous	V_{GES}	±20	V
Gate to Emitter Voltage Pulsed	V_{GEM}	±30	V
Switching Safe Operating Area at $T_J = 150^oC$ (Figure 2)	SSOA	6A at 1200V	
Power Dissipation Total at $T_C = 25^oC$	P_D	60	W
Power Dissipation Derating $T_C > 25^oC$		0.476	W/^{o}C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to 150	^{o}C
Maximum Lead Temperature for Soldering			
Leads at 0.063in (1.6cm) from Case for 10s	T_L	300	^{o}C
Package Body for 10s, see Tech Brief 334	T_{pkg}	260	^{o}C
Short Circuit Withstand Time (Note 2) at $V_{GE} = 15V$	t_{SC}	8	µs
Short Circuit Withstand Time (Note 2) at $V_{GE} = 13V$	t_{SC}	11	µs

CAUTION: Stresses above those listed in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Single Pulse; $V_{GE} = 15V$; Pulse width limited by maximum junction temperature.
2. $V_{CE(PK)} = 840V$, $T_J = 125^oC$, $R_G = 82\Omega$.

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNITS
Collector to Emitter Breakdown Voltage	BV_{CES}	$I_C = 250\mu A$, $V_{GE} = 0V$		1200	-	-	V
Collector to Emitter Leakage Current	I_{CES}	$V_{CE} = 1200V$	$T_C = 25^oC$	-	-	250	µA
			$T_C = 125^oC$	-	20	-	µA
			$T_C = 150^oC$	-	-	1.0	mA
Collector to Emitter Saturation Voltage	$V_{CE(SAT)}$	$I_C = 1.0A$, $V_{GE} = 15V$	$T_C = 25^oC$	-	2.05	2.4	V
			$T_C = 150^oC$	-	2.75	3.2	V
Gate to Emitter Threshold Voltage	$V_{GE(TH)}$	$I_C = 50\mu A$, $V_{CE} = V_{GE}$		6.0	7.1	-	V
Gate to Emitter Leakage Current	I_{GES}	$V_{GE} = \pm 20V$		-	-	±250	nA
Switching SOA	SSOA	$T_J = 150^oC$, $R_G = 82\Omega$, $V_{GE} = 15V$, L = 2mH, $V_{CE(PK)} = 1200V$		6	-	-	A
Gate to Emitter Plateau Voltage	V_{GEP}	$I_C = 1.0A$, $V_{CE} = 600V$		-	9.7	-	V
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 1.0A$, $V_{CE} = 600V$	$V_{GE} = 15V$	-	13	19	nC
			$V_{GE} = 20V$	-	16	28	nC
Current Turn-On Delay Time	$t_{d(ON)I}$	IGBT and Diode at $T_J = 25^oC$ $I_{CE} = 1.0A$, $V_{CE} = 960V$, $V_{GE} = 15V$, $R_G = 82\Omega$, L = 4mH, Test Circuit (Figure 20)		-	15	21	ns
Current Rise Time	t_{rI}			-	11	15	ns
Current Turn-Off Delay Time	$t_{d(OFF)I}$			-	65	95	ns
Current Fall Time	t_{fI}			-	365	450	ns
Turn-On Energy (Note 3)	E_{ON}			-	175	195	µJ
Turn-Off Energy (Note 3)	E_{OFF}			-	140	155	µJ

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified **(Continued)**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Current Turn-On Delay Time	$t_{d(ON)I}$	IGBT and Diode at $T_J = 150^oC$, $I_{CE} = 1.0$ A, $V_{CE} = 960V$, $V_{GE} = 15V$, $R_G = 82\Omega$, L = 4mH, Test Circuit (Figure 20)	-	13	20	ns
Current Rise Time	t_{rI}		-	11	18	ns
Current Turn-Off Delay Time	$t_{d(OFF)I}$		-	75	100	ns
Current Fall Time	t_{fI}		-	465	625	ns
Turn-On Energy (Note 3)	E_{ON}		-	385	460	µJ
Turn-Off Energy (Note 3)	E_{OFF}		-	200	225	µJ
Diode Forward Voltage	V_{EC}	$I_{EC} = 1A$	-	1.3	1.8	V
Diode Reverse Recovery Time	t_{rr}	$I_{EC} = 1A$, $dI_{EC}/dt = 200A/\mu s$	-	-	50	ns
Thermal Resistance Junction To Case	$R_{\theta JC}$	IGBT	-	-	2.1	$^oC/W$
		Diode	-	-	3	$^oC/W$

NOTE:

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 ($I_{CE} = 0A$). 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. Turn-on losses include losses due to diode recovery.

Typical Performance Curves Unless Otherwise Specified

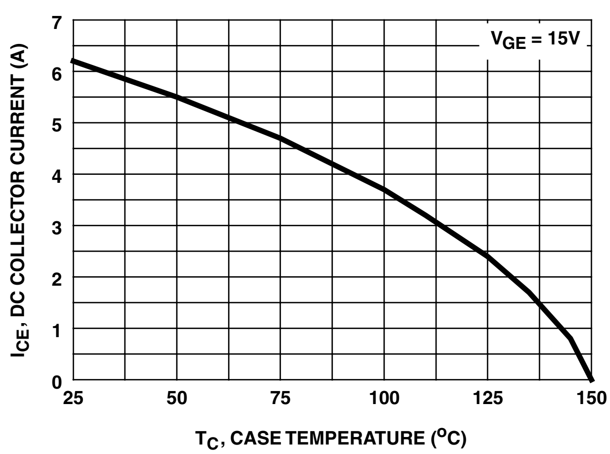


FIGURE 1. DC COLLECTOR CURRENT vs CASE TEMPERATURE

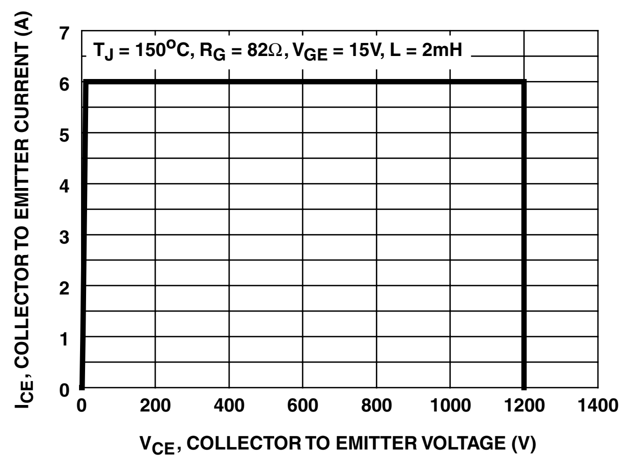


FIGURE 2. MINIMUM SWITCHING SAFE OPERATING AREA

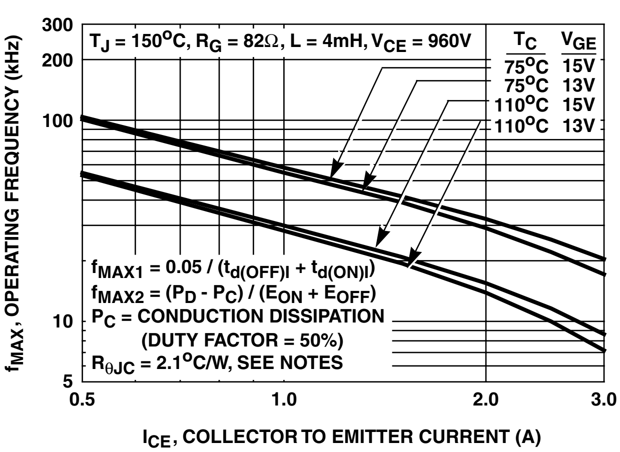


FIGURE 3. OPERATING FREQUENCY vs COLLECTOR TO EMITTER CURRENT

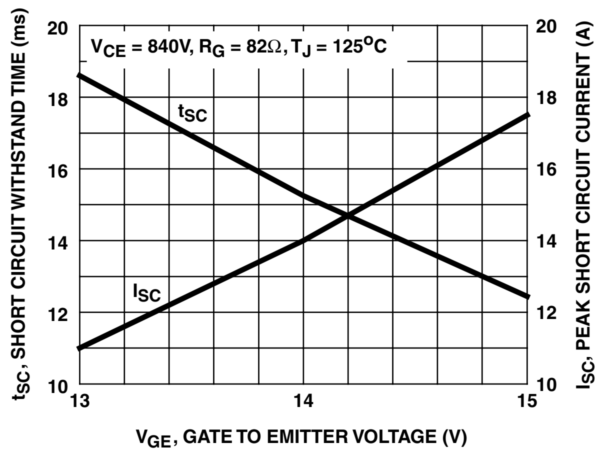


FIGURE 4. SHORT CIRCUIT WITHSTAND TIME

Typical Performance Curves Unless Otherwise Specified **(Continued)**

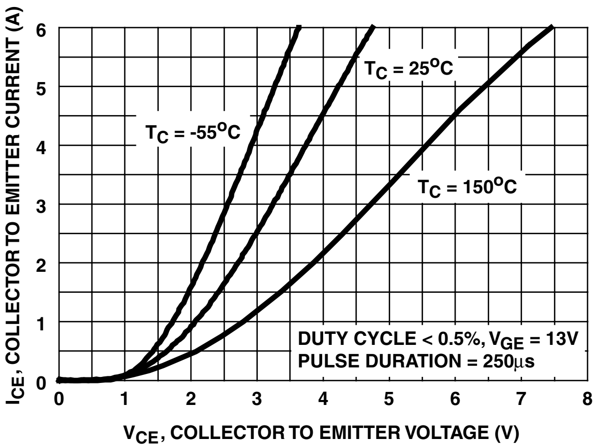


FIGURE 5. COLLECTOR TO EMITTER ON-STATE VOLTAGE

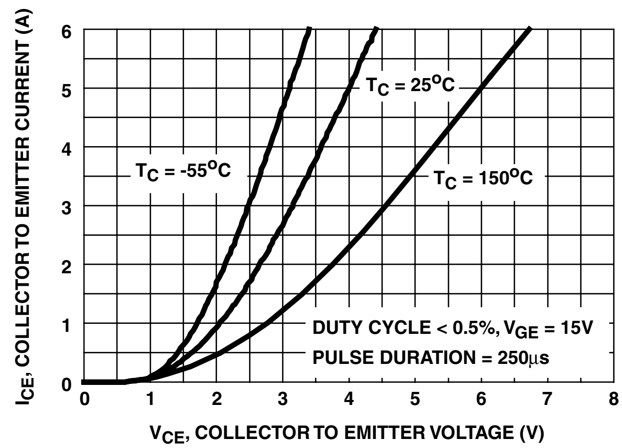


FIGURE 6. COLLECTOR TO EMITTER ON-STATE VOLTAGE

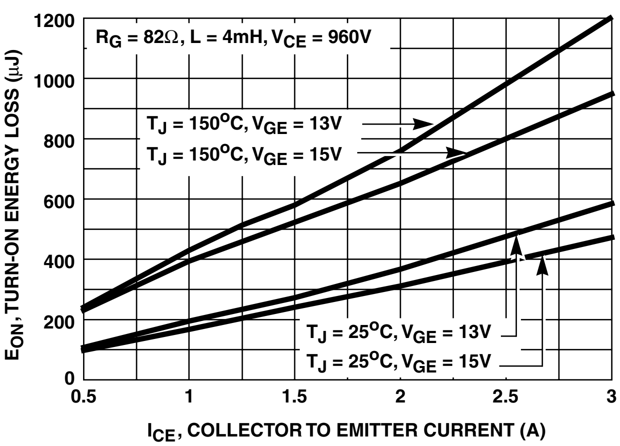


FIGURE 7. TURN-ON ENERGY LOSS vs COLLECTOR TO EMITTER CURRENT

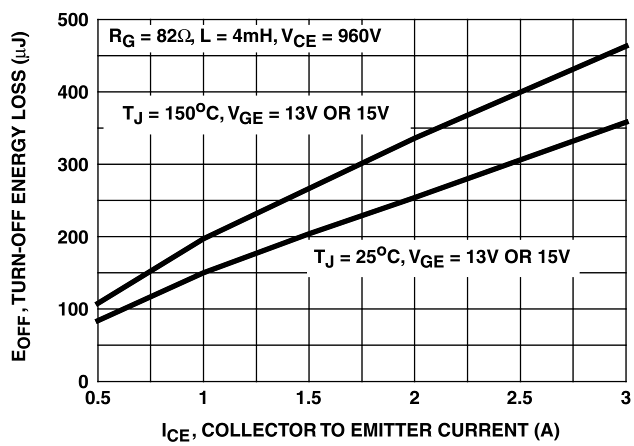


FIGURE 8. TURN-OFF ENERGY LOSS vs COLLECTOR TO EMITTER CURRENT

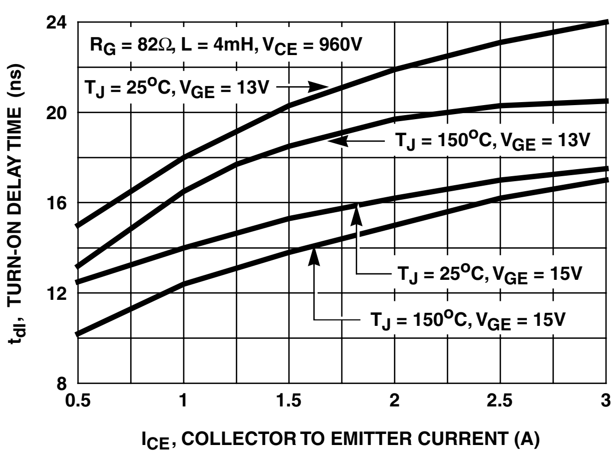


FIGURE 9. TURN-ON DELAY TIME vs COLLECTOR TO EMITTER CURRENT

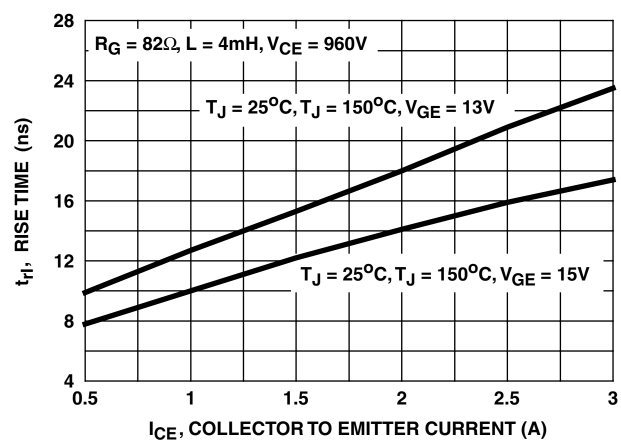


FIGURE 10. TURN-ON RISE TIME vs COLLECTOR TO EMITTER CURRENT

Typical Performance Curves Unless Otherwise Specified **(Continued)**

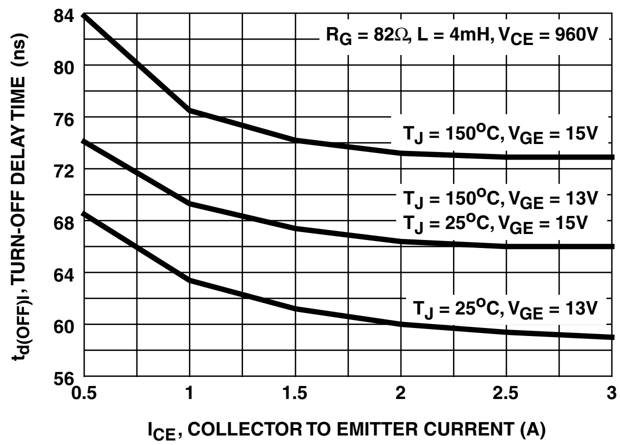


FIGURE 11. TURN-OFF DELAY TIME vs COLLECTOR TO EMITTER CURRENT

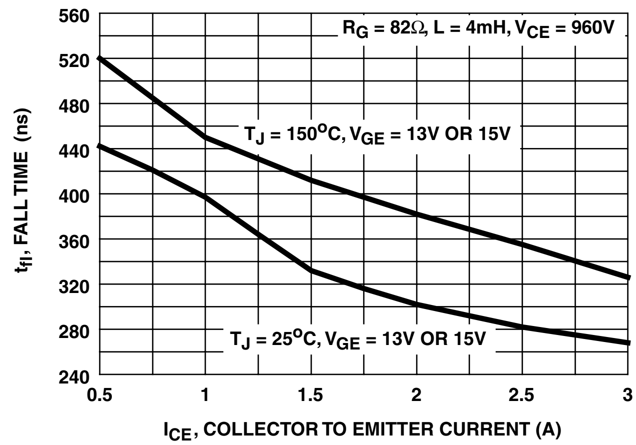


FIGURE 12. TURN-OFF FALL TIME vs COLLECTOR TO EMITTER CURRENT

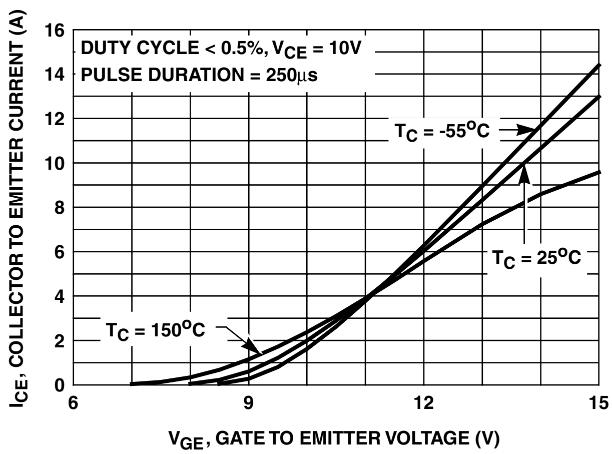


FIGURE 13. TRANSFER CHARACTERISTIC

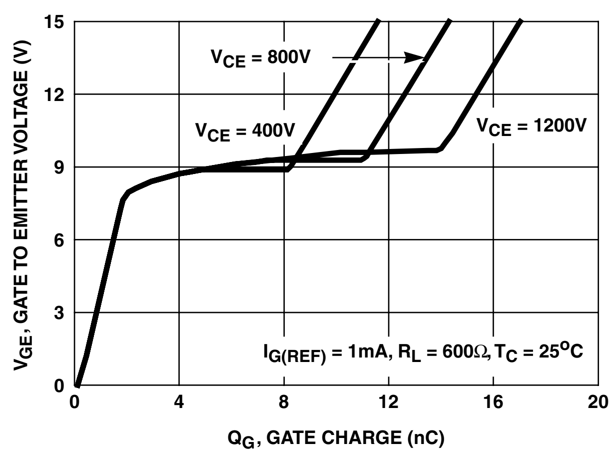


FIGURE 14. GATE CHARGE WAVEFORMS

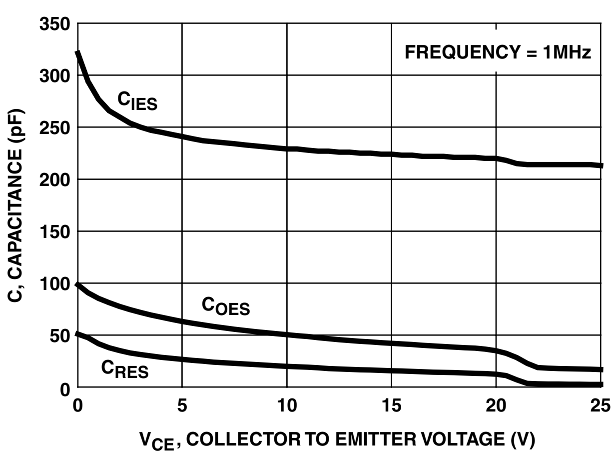


FIGURE 15. CAPACITANCE vs COLLECTOR TO EMITTER VOLTAGE

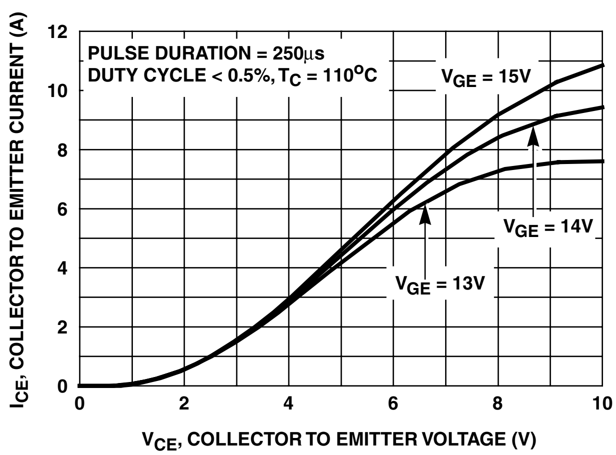


FIGURE 16. COLLECTOR TO EMITTER ON-STATE VOLTAGE

Typical Performance Curves Unless Otherwise Specified **(Continued)**

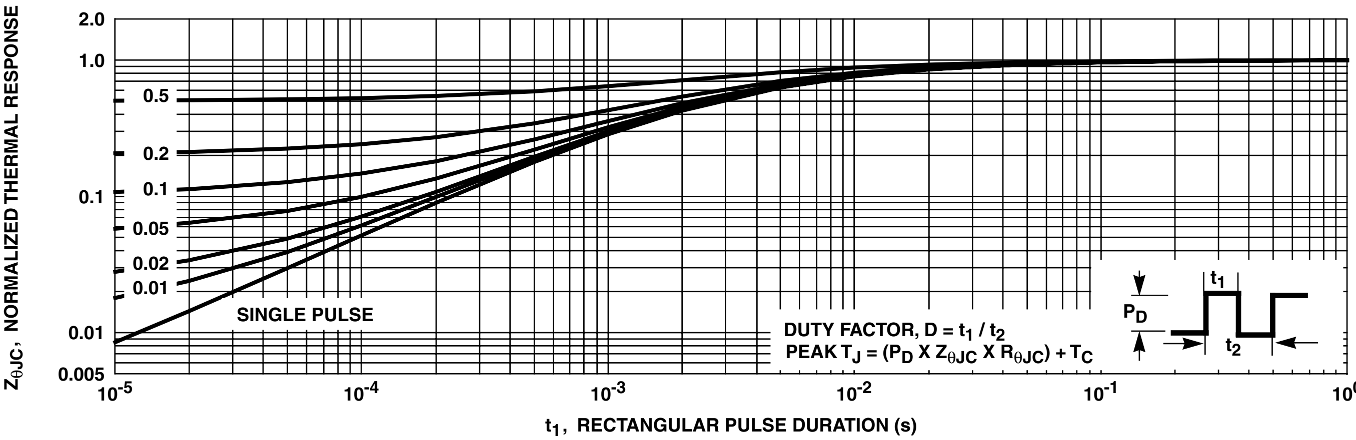


FIGURE 17. NORMALIZED TRANSIENT THERMAL RESPONSE, JUNCTION TO CASE

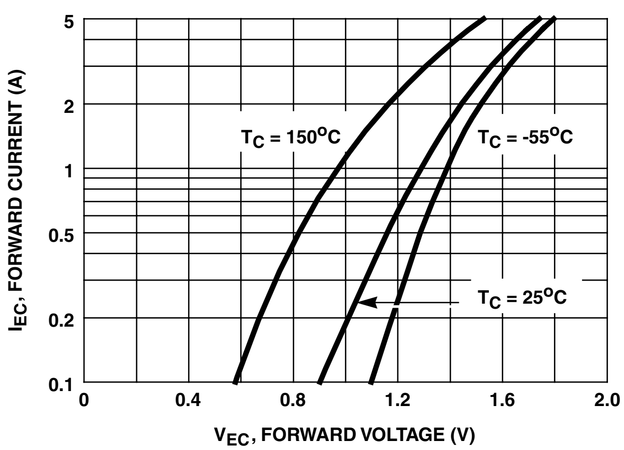


FIGURE 18. DIODE FORWARD CURRENT vs FORWARD VOLTAGE DROP

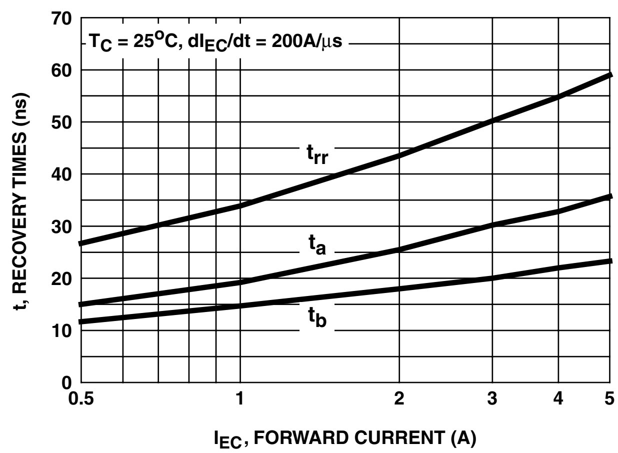


FIGURE 19. RECOVERY TIMES vs FORWARD CURRENT

Test Circuit and Waveforms

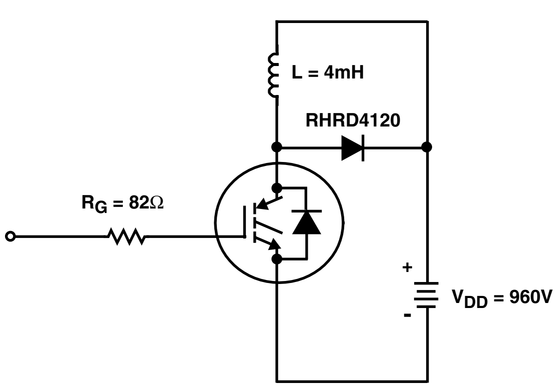


FIGURE 20. INDUCTIVE SWITCHING TEST CIRCUIT

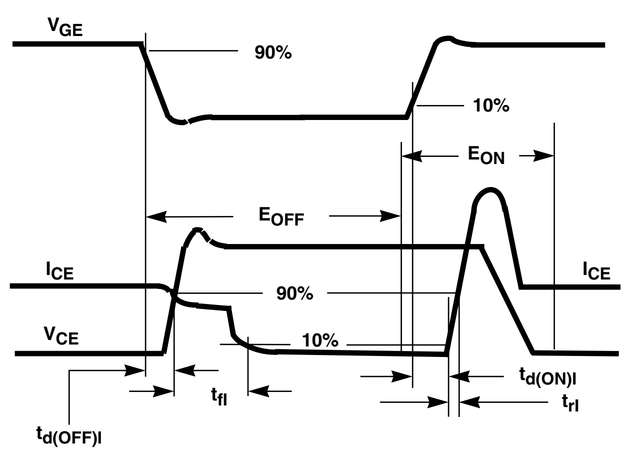


FIGURE 21. SWITCHING TEST WAVEFORMS

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 shown for a typical unit in Figures 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 $P_C = (V_{CE} \times I_{CE})/2$.

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 ($I_{CE} = 0$).

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CROSSVOLT™	GlobalOptoisolator™	POP™	SuperSOT™-3	
DenseTrench™	GTO™	Power247™	SuperSOT™-6	
DOME™	HiSeC™	PowerTrench®	SuperSOT™-8	
EcoSPARK™	ISOPLANAR™	QFET™	SyncFET™	
E^2CMOS™	LittleFET™	QS™	TinyLogic™	
EnSigna™	MicroFET™	QT Optoelectronics™	TruTranslation™	
FACT™	MicroPak™	Quiet Series™	UHC™	
FACT Quiet Series™	MICROWIRE™	SILENT SWITCHER®	UltraFET®	

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
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Rev. H4