

# HGTP2N120CN, HGT1S2N120CN 13A, 1200V, NPT Series N-Channel IGBT

## Features

- 13A, 1200V,  $T_C = 25^\circ\text{C}$
- 1200V Switching SOA Capability
- Typical Fall Time 360ns at  $T_J = 150^\circ\text{C}$
- Short Circuit Rating
- Low Conduction Loss
- Avalanche Rated
- Temperature Compensating SABER™ Model  
Thermal Impedance SPICE Model  
[www.fairchildsemi.com](http://www.fairchildsemi.com)
- Related Literature
- TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

## Description

The HGTP2N120CN and HGT1S2N120CN are Non-Punch Through (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.

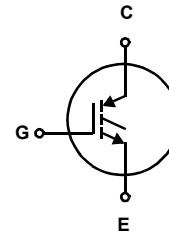
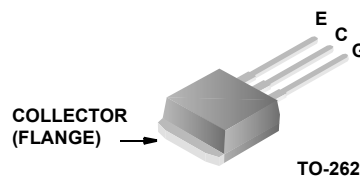
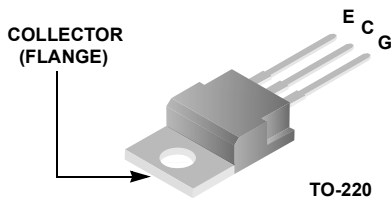
The IGBT is ideal for many high voltage switching applications operating at moderate frequencies where low conduction losses are essential, such as: AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

Formerly Developmental Type TA49313

## Ordering Informations

Part Number	Package	Brand
HGTP2N120CN	TO-220AB	2N120CN
HGT1S2N120CN	TO-262	2N120CN

Note: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-263AB and TO-252AA variant in tape and reel, e.g., HGT1S2N120CNS9A.



### 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**  $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified

Symbol	Parameter	HGTP2N120CN HGT1S2N120CN	Units
$BV_{CES}$	Collector to Emitter Voltage	1200	V
$I_{C25}$ $I_{C110}$	Collector Current Continuous At $T_C = 25^\circ\text{C}$ At $T_C = 110^\circ\text{C}$	13 7	A A
$I_{CM}$	Collector Current Pulsed (Note 1)	20	A
$V_{GES}$	Gate to Emitter Voltage Continuous	$\pm 20$	V
$V_{GEM}$	Gate to Emitter Voltage Pulsed	$\pm 30$	V
SSOA	Switching SOA Operating Area at $T_J = 150^\circ\text{C}$ (Figure 2)	13A at 1200V	
$P_D$	Power Dissipation Total at $T_C = 25^\circ\text{C}$	104	W
	Power Dissipation Derating $T_C > 25^\circ\text{C}$	0.83	W/ $^\circ\text{C}$
$E_{AV}$	Forward Voltage Avalanche Energy (Note 2)	18	mJ
$t_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to 150	$^\circ\text{C}$
$T_L$ $T_{PKG}$	Maximum Lead Temperature for Soldering Leads at 0.063in (1.6mm) from Case for 10s	300	$^\circ\text{C}$
	Package Body for 10s, see Tech Brief 334	260	$^\circ\text{C}$
$t_{SC}$	Short Circuit Withstand Time (Note 3) at $V_{GE} = 15\text{V}$	8	$\mu\text{s}$

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:**

- Pulse width limited by maximum junction temperature.
- $I_{CE} = 3\text{A}$ ,  $L = 4\text{mH}$
- $V_{CE(PK)} = 840\text{V}$ ,  $T_J = 125^\circ\text{C}$ ,  $R_G = 51\Omega$ .

**Electrical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units	
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$I_C = 250\mu\text{A}$ , $V_{GE} = 0\text{V}$	1200	-	-	V	
$BV_{ECS}$	Emitter to Collector Breakdown Voltage	$I_C = 10\text{mA}$ , $V_{GE} = 0\text{V}$	15	-	-	V	
$I_{CES}$	Collector to Emitter Leakage Current	$V_{CE} = 1200\text{V}$	$T_J = 25^\circ\text{C}$	-	-	100	$\mu\text{A}$
			$T_J = 125^\circ\text{C}$	-	100	-	$\mu\text{A}$
			$T_J = 150^\circ\text{C}$	-	-	1.0	mA
$V_{CE(SAT)}$	Collector to Emitter Saturation Voltage	$I_C = 2.6\text{A}$ , $V_{GE} = 15\text{V}$	$T_J = 25^\circ\text{C}$	-	2.05	2.40	V
			$T_J = 150^\circ\text{C}$	-	2.75	3.50	V
$V_{GE(TH)}$	Gate to Emitter Threshold Voltage	$I_C = 45\mu\text{A}$ , $V_{CE} = V_{GE}$	6.4	6.7	-	V	
$I_{GES}$	Gate to Emitter Leakage Current	$V_{GE} = \pm 20\text{V}$	-	-	$\pm 250$	nA	
SSOA	Switching SOA	$T_J = 150^\circ\text{C}$ , $R_G = 51\Omega$ , $V_{GE} = 15\text{V}$ $L = 5\text{mH}$ , $V_{CE(PK)} = 1200\text{V}$	13	-	-	A	
$V_{GEP}$	Gate to Emitter Plateau Voltage	$I_C = 2.6\text{A}$ , $V_{CE} = 600\text{V}$	-	10.2	-	V	
$Q_{g(ON)}$	On-State Gate Charge	$I_C = 2.6\text{A}$ , $V_{CE} = 600\text{V}$	$V_{GE} = 15\text{V}$	-	30	36	nC
			$V_{GE} = 20\text{V}$	-	36	43	nC

**Electrical Characteristics**  $T_C = 25^\circ\text{C}$  unless otherwise noted (Continued)

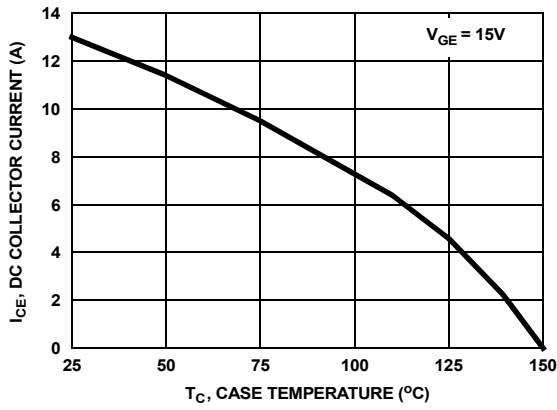
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$t_{d(ON)I}$	Current Trun-On Delay Time	IGBT and Diode at $T_J = 25^\circ\text{C}$ $I_{CE} = 2.6\text{A}$ $V_{CE} = 960\text{V}$ $V_{GE} = 15\text{V}$ $R_G = 51\Omega$ $L = 5\text{mH}$ Test Circuit (Figure 18)	-	25	30	ns
$t_{rI}$	Current Rise Time		-	11	15	ns
$t_{d(OFF)I}$	Curent Turn-Off Delay Time		-	205	220	ns
$t_{fI}$	Current Fall Time		-	260	320	ns
$E_{ON1}$	Turn-On Energy (Note 4)		-	96	-	$\mu\text{J}$
$E_{ON2}$	Turn-On Energy (Note 4)		-	425	590	$\mu\text{J}$
$E_{OFF}$	Turn-Off Energy (Note 5)		-	355	390	$\mu\text{J}$
$t_{d(ON)I}$	Curent Turn-On Delay Time	IGBT and Diode at $T_J = 150^\circ\text{C}$ $I_{CE} = 2.6\text{A}$ $V_{CE} = 960\text{V}$ $V_{GE} = 15\text{V}$ $R_G = 51\Omega$ $L = 5\text{mH}$ Test Circuit (Figure 18)	-	21	25	ns
$t_{rI}$	Current Rise Time		-	11	15	ns
$t_{d(OFF)I}$	Curent Turn-Off Delay Time		-	225	240	ns
$t_{fI}$	Current Fall Time		-	360	420	ns
$E_{ON1}$	Turn-On Energy (Note 4)		-	96	-	$\mu\text{J}$
$E_{ON2}$	Turn-On Energy (Note 4)		-	800	1100	$\mu\text{J}$
$E_{OFF}$	Turn-Off Energy (Note 5)		-	530	580	$\mu\text{J}$
$R_{\theta JC}$	Thermal Resistance Junction to Case		-	-	1.20	$^\circ\text{C/W}$

**Notes:**

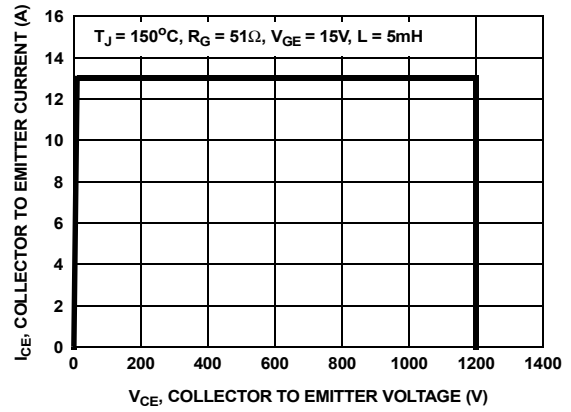
- Values for two Turn-On loss conditions are shown for the convenience of the circuit designer.  $E_{ON1}$  is the turn-on loss of the IGBT only.  $E_{ON2}$  is the turn-on loss when a typical diode is used in the test circuit and the diode is at the same  $T_J$  as the IGBT. The diode type is specified in Figure 18.
- 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 ( $I_{CE} = 0\text{A}$ ). 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

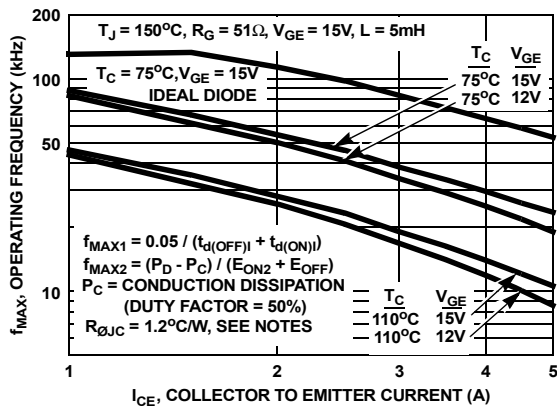
**Figure 1. DC Collector Current vs Case Temperature**



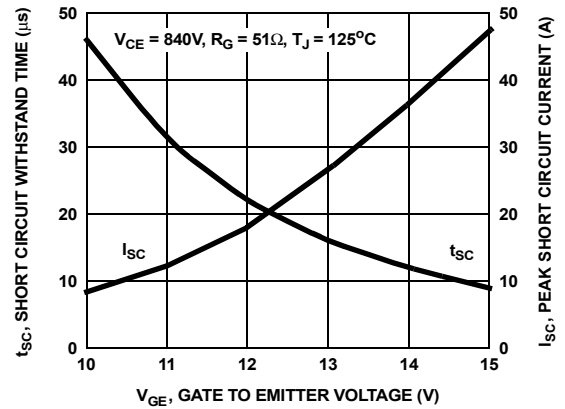
**Figure 2. Minimum Switching Safe Operating Area**



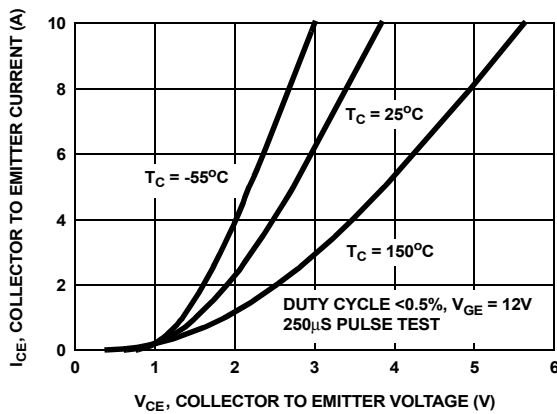
**Figure 3. Operating Frequency vs Collector to Emitter Current**



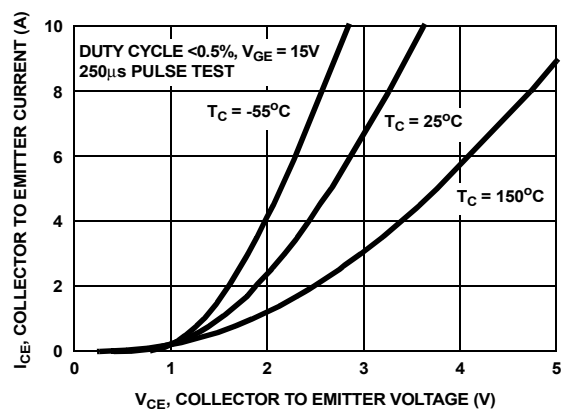
**Figure 4. Short Circuit Withstand Time**



**Figure 5. Collector to Emitter On-State Voltage**

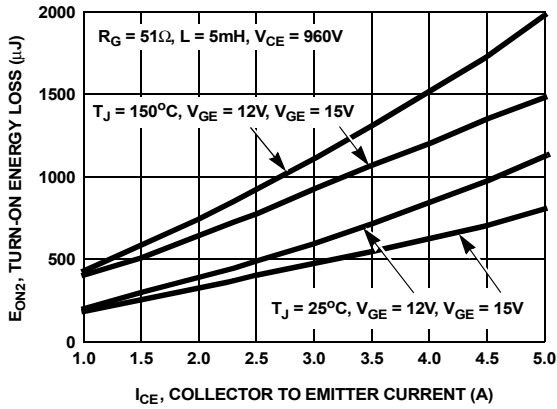


**Figure 6. Collector to Emitter On-State Voltage**

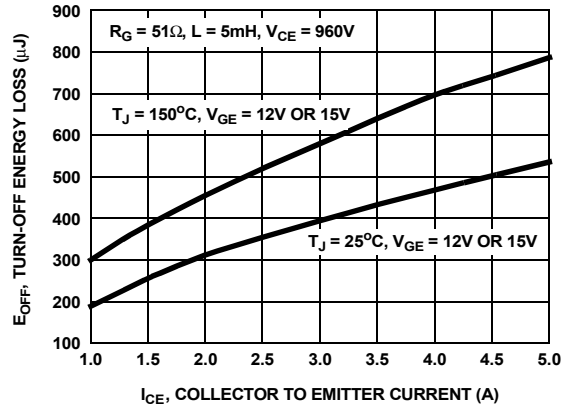


**Typical Performance Characteristics** (Continued)

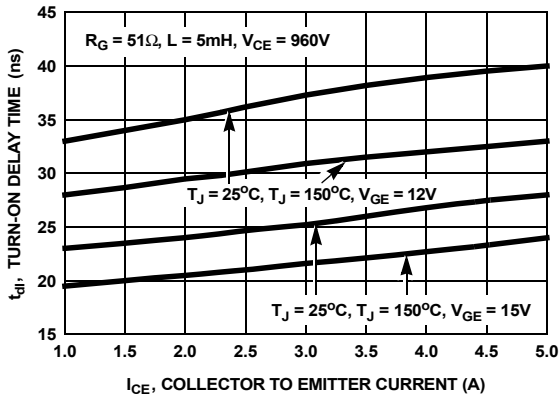
**Figure 7. Turn-On Energy Loss vs Collector to Emitter Current**



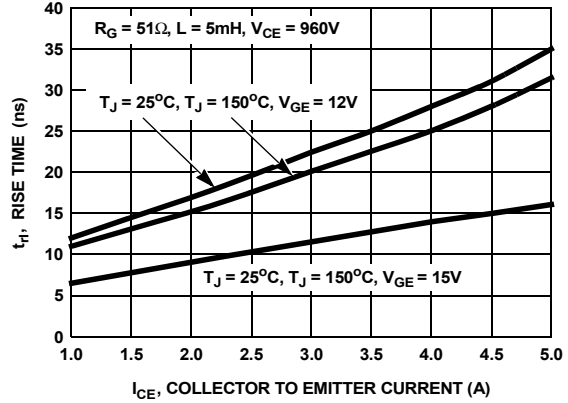
**Figure 8. Turn-Off Energy Loss vs Collector to Emitter Current**



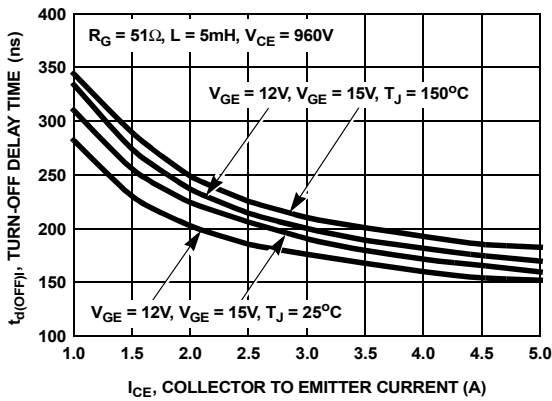
**Figure 9. Turn-On Delay Time vs Collector to Emitter Current**



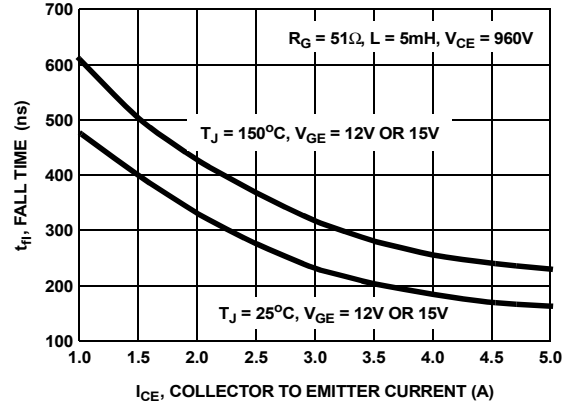
**Figure 10. Turn-On Rise Time vs Collector to Emitter Current**



**Figure 11. Turn-Off Delay Time vs Collector to Emitter Current**

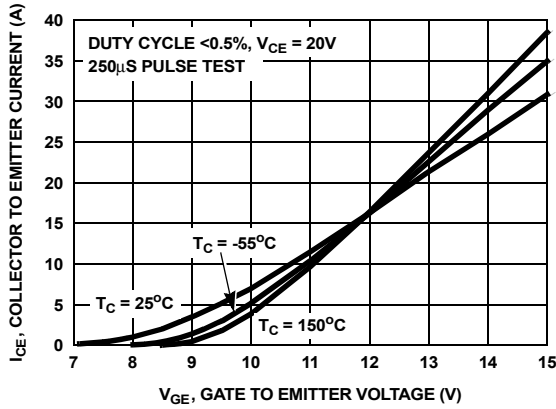


**Figure 12. Fall Time vs Collector to Emitter Current**

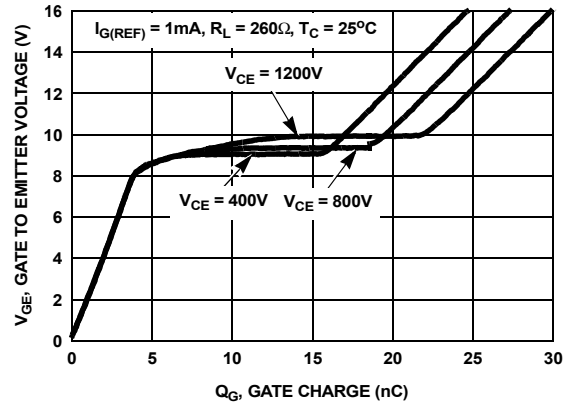


**Typical Performance Characteristics** (Continued)

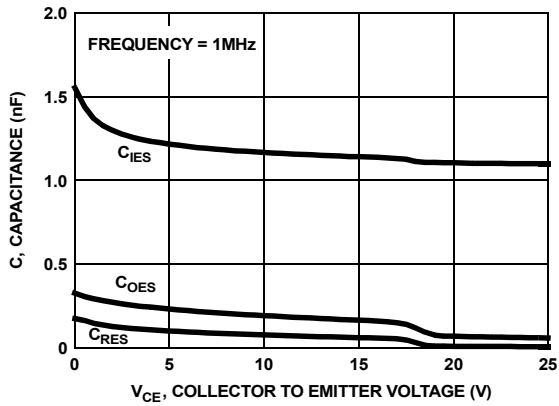
**Figure 13. Transfer Characteristic**



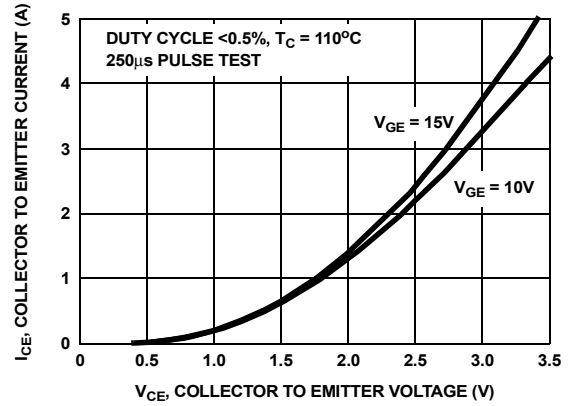
**Figure 14. Gate Charge Waveforms**



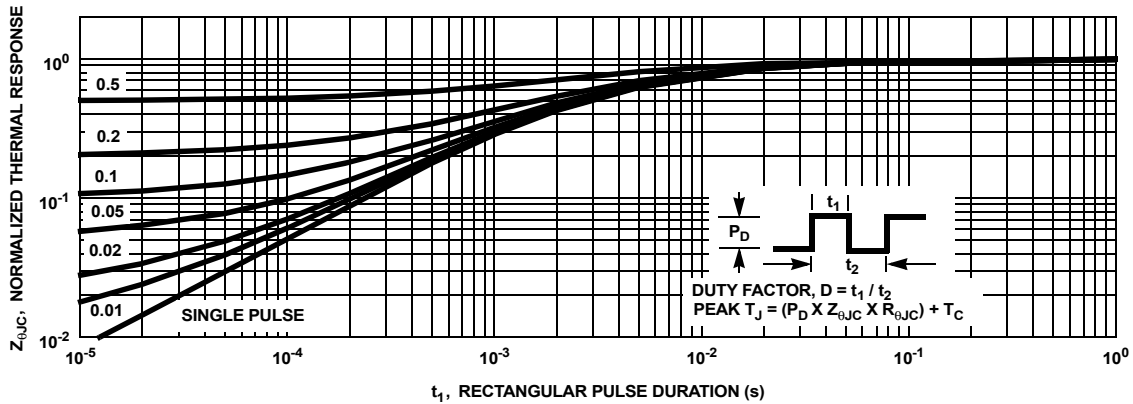
**Figure 15. Capacitance vs Collector to Emitter**



**Figure 16. Collector to Emitter On-Sate Voltage**



**Figure 17. Normalized Transient Thermal Response, Junction to Case**



Test Circuit and Waveforms (Continued)

Figure 18. Inductive Switching Test Circuit

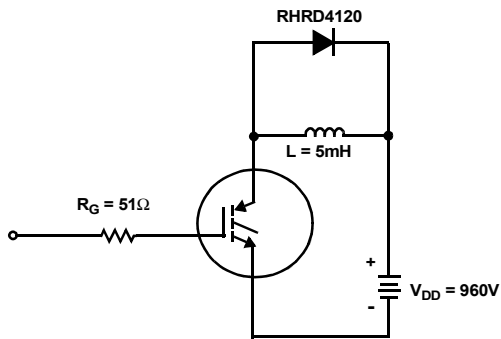
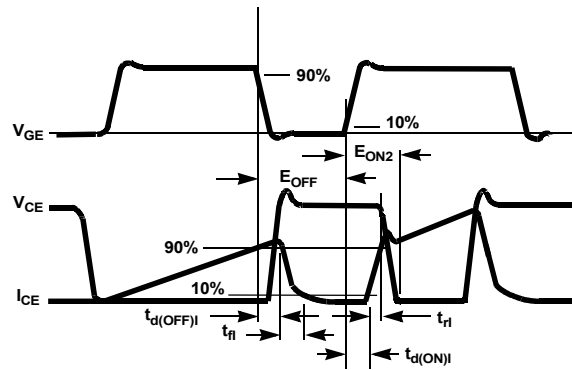


Figure 19. Switching Test Waveforms



## 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 "ECCOSORB<sup>TM</sup> 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 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  $f_{MAX1} = 0.05 / (t_{d(OFF)} + t_{d(ON)})$ . Deadtime (the denominator) has been arbitrarily held to 10% of the on-state time for a 50% duty factor. Other definitions are possible.  $t_{d(OFF)}$  and  $t_{d(ON)}$  are defined in Figure 19. Device turn-off delay can establish an additional frequency limiting condition for an application other than  $T_{JM}$ .  $t_{d(OFF)}$  is important when controlling output ripple under a lightly loaded condition.

$f_{MAX2}$  is defined by  $f_{MAX2} = (P_D - P_C) / (E_{OFF} + E_{ON2})$ . 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  $P_C = (V_{CE} \times I_{CE}) / 2$ .

$E_{ON2}$  and  $E_{OFF}$  are defined in the switching waveforms shown in Figure 19.  $E_{ON2}$  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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CoolFET™	FRFET™	MICROCOUPLER™	PowerSaver™	SuperSOT™-3
CROSSVOLT™	GlobalOptoisolator™	MicroFET™	PowerTrench®	SuperSOT™-6
DOME™	GTO™	MicroPak™	QFET®	SuperSOT™-8
EcoSPARK™	HiSeC™	MICROWIRE™	QS™	SyncFET™
E <sup>2</sup> CMOS™	I <sup>2</sup> C™	MSX™	QT Optoelectronics™	TinyLogic®
EnSigna™	i-Lo™	MSXPro™	Quiet Series™	TINYOPTO™
FACT™	ImpliedDisconnect™	OCX™	RapidConfigure™	TruTranslation™
FACT Quiet Series™		OCXPro™	RapidConnect™	UHC™
Across the board. Around the world.™		OPTOLOGIC®	µSerDes™	UltraFET®
The Power Franchise®		OPTOPLANAR™	SILENT SWITCHER®	UniFET™
Programmable Active Droop™		PACMAN™	SMART START™	VCX™

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## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
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. I15