



# HGTP10N40F1D, HGTP10N50F1D

10A, 400V and 500V N-Channel IGBTs  
with Anti-Parallel Ultrafast Diodes

April 1995

## Features

- 10A, 400V and 500V
- Latch Free Operation
- Typical Fall Time < 1.4μs
- High Input Impedance
- Low Conduction Loss
- Anti-Parallel Diode
- $t_{RR} < 60\text{ns}$

## Description

The IGBT is a MOS gated high voltage switching device combining the best features of MOSFETs and bipolar transistors. The device has the high input impedance of a MOSFET and the low on-state conduction loss of a bipolar transistor. The much lower on-state voltage drop varies only moderately between +25°C and +150°C. The diode used in parallel with the IGBT is an ultrafast ( $t_{RR} < 60\text{ns}$ ) with soft recovery characteristic.

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

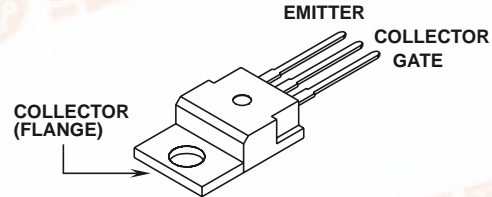
### PACKAGING AVAILABILITY

PART NUMBER	PACKAGE	BRAND
HGTP10N40F1D	TO-220AB	10N40F1D
HGTP10N50F1D	TO-220AB	10N50F1D

NOTE: When ordering, use the entire part number

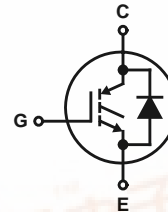
## Package

JEDEC TO-220AB



## Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



## Absolute Maximum Ratings $T_C = +25^\circ\text{C}$ , Unless Otherwise Specified

	HGTP10N40F1D	HGTP10N50F1D	UNITS
Collector-Emitter Voltage	400	500	V
Collector-Gate Voltage $R_{GE} = 1\text{M}\Omega$	400	500	V
Collector Current Continuous at $T_C = +25^\circ\text{C}$	12	12	A
at $T_C = +90^\circ\text{C}$	10	10	A
Collector Current Pulsed (Note 1)	12	12	A
Gate-Emitter Voltage Continuous	$\pm 20$	$\pm 20$	V
Diode Forward Current at $T_C = +25^\circ\text{C}$	16	16	A
at $T_C = +90^\circ\text{C}$	10	10	A
Power Dissipation Total at $T_C = +25^\circ\text{C}$	75	75	W
Power Dissipation Derating $T_C > +25^\circ\text{C}$	0.6	0.6	W/°C
Operating and Storage Junction Temperature Range	-55 to +150	-55 to +150	°C
Maximum Lead Temperature for Soldering	260	260	°C

NOTE:

1.  $T_J = +150^\circ\text{C}$ , Min.  $R_{GE} = 25\Omega$  without latch.

### INTERASIL CORPORATION 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	4,567,641
4,587,713	4,598,461	4,605,948	4,618,872	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
4,860,090	4,883,767	4,888,627	4,890,143	4,901,127	4,904,609	4,933,740	4,963,951

## Specifications HGTP10N40F1D, HGTP10N50F1D

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

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS	
			HGTP10N40F1D		HGTP10N50F1D			
			MIN	MAX	MIN	MAX		
Collector-Emitter Breakdown Voltage	$V_{CE(S)}$	$I_C = 1.25\text{mA}, V_{GE} = 0\text{V}$	400	-	500	-	V	
Gate Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}, I_C = 1\text{mA}$	2.0	4.5	2.0	4.5	V	
Zero Gate Voltage Collector Current	$I_{CES}$	$T_J = +150^\circ\text{C}, V_{CE} = 400\text{V}$	-	1.25	-	-	mA	
		$T_J = +150^\circ\text{C}, V_{CE} = 500\text{V}$	-	-	-	1.25	mA	
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{V}, V_{CE} = 0\text{V}$	-	100	-	100	nA	
Collector-Emitter On-Voltage	$V_{CE(ON)}$	$T_J = +150^\circ\text{C}, I_C = 5\text{A}, V_{GE} = 10\text{V}$	-	2.5	-	2.5	V	
		$T_J = +150^\circ\text{C}, I_C = 5\text{A}, V_{GE} = 15\text{V}$	-	2.2	-	2.2	V	
		$T_J = +25^\circ\text{C}, I_C = 5\text{A}, V_{GE} = 10\text{V}$	-	2.5	-	2.5	V	
		$T_J = +25^\circ\text{C}, I_C = 5\text{A}, V_{GE} = 15\text{V}$	-	2.2	-	2.2	V	
Gate-Emitter Plateau Voltage	$V_{GEP}$	$I_C = 5\text{A}, V_{CE} = 10\text{V}$	5.3 (Typ)				V	
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 5\text{A}, V_{CE} = 10\text{V}$	13.4 (Typ)				nC	
Turn-On Delay Time	$t_{D(ON)}$	Resistive Load, $I_C = 5\text{A}$ , $V_{CE} = 400\text{V}, R_L = 80\Omega$ , $T_J = +150^\circ\text{C}, V_{GE} = 10\text{V}$ , $R_G = 25\Omega$	45 (Typ)				ns	
Rise Time	$t_{RI}$		35 (Typ)				ns	
Turn-Off Delay Time	$t_{D(OFF)}$		130 (Typ)				ns	
Fall Time	$t_{FI}$		1400 (Typ)				ns	
Turn-Off Energy Loss Per Cycle (Off Switching Dissipation = $W_{OFF} \times$ Frequency)	$W_{OFF}$		0.64 (Typ)				mJ	
Turn-Off Delay Time	$t_{D(OFF)I}$		Inductive Load (See Figure 13), $I_C = 5\text{A}, V_{CE(CLIP)} = 400\text{V}, R_L =$ $80\Omega, L = 50\mu\text{H}, T_J = +150^\circ\text{C}, V_{GE} =$ $10\text{V}, R_G = 25\Omega$	-	375	-	375	ns
Fall Time	$t_{FI}$			-	1200	-	1200	ns
Turn-Off Energy Loss Per Cycle (Off Switching Dissipation = $W_{OFF} \times$ Frequency)	$W_{OFF}$	-		1.2	-	1.2	mJ	
Thermal Resistance Junction-to-Case (IGBT)	$R_{\theta JC}$		-	1.67	-	1.67	$^\circ\text{C/W}$	
Thermal Resistance of Diode	$R_{\theta JC}$		-	2.0	-	2.0	$^\circ\text{C/W}$	
Diode Forward Voltage	$V_{EC}$	$I_{EC} = 10\text{A}$	-	1.7	-	1.7	V	
Diode Reverse Recovery Time	$t_{RR}$	$I_{EC} = 10\text{A}, dI_{EC}/dt = 100\text{A}/\mu\text{s}$	-	60	-	60	ns	

### Typical Performance Curves

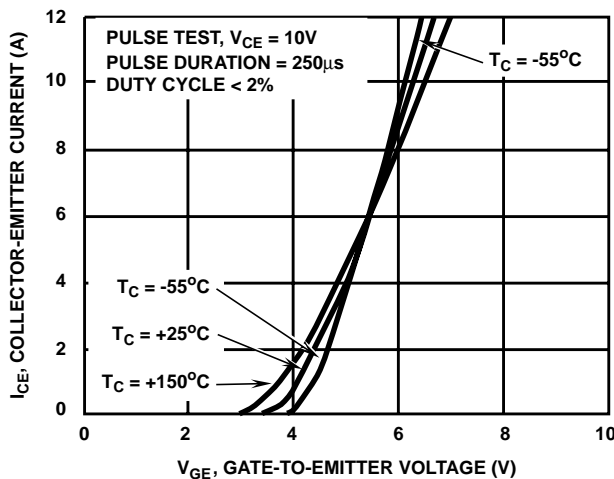


FIGURE 1. TYPICAL TRANSFER CHARACTERISTICS

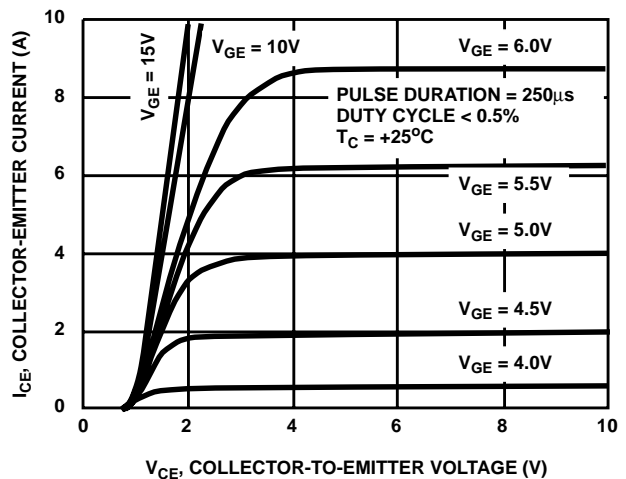


FIGURE 2. TYPICAL SATURATION CHARACTERISTICS

# HGTP10N40F1D, HGTP10N50F1D

## Typical Performance Curves (Continued)

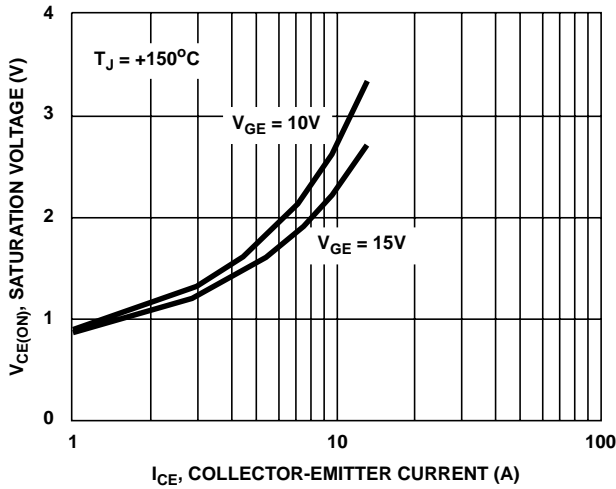


FIGURE 3. SATURATION VOLTAGE vs COLLECTOR-EMITTER CURRENT (TYPICAL)

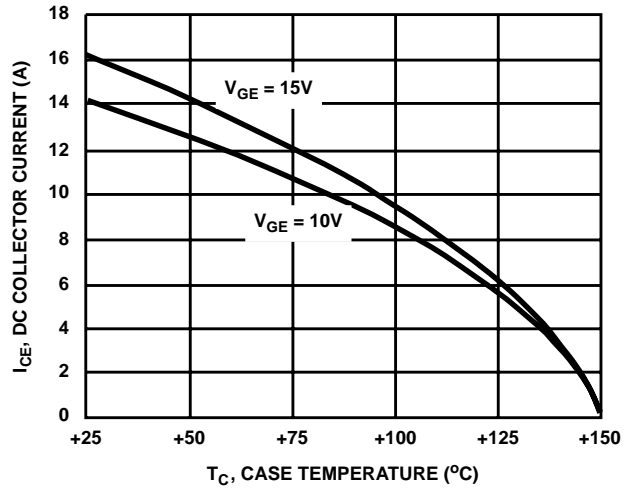


FIGURE 4. DC COLLECTOR CURRENT vs CASE TEMPERATURE

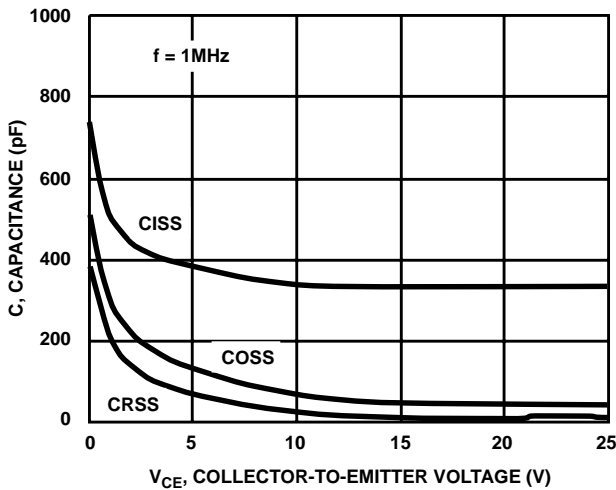


FIGURE 5. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE (TYPICAL)

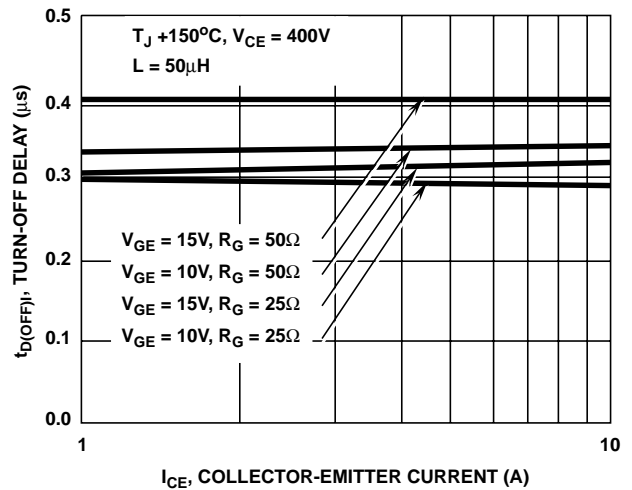


FIGURE 6. TURN-OFF DELAY vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

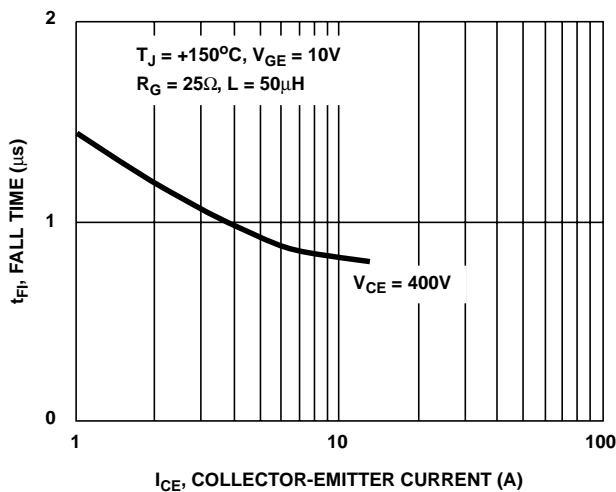


FIGURE 7. FALL TIME vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

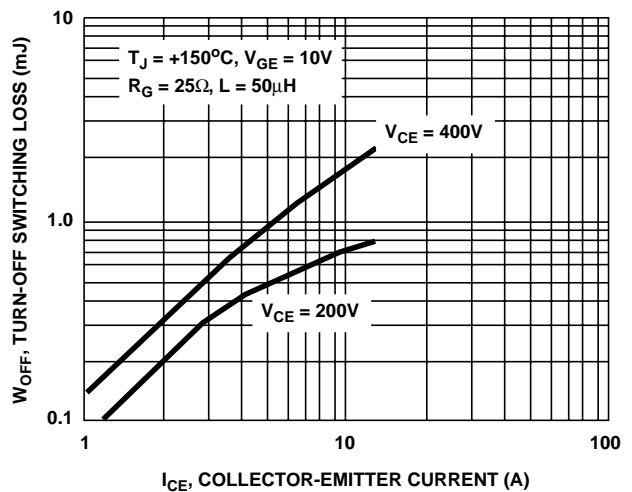
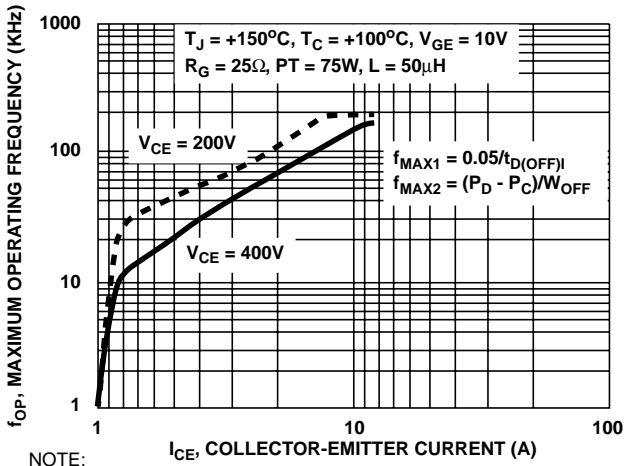


FIGURE 8. TURN-OFF SWITCHING LOSS vs COLLECTOR-EMITTER CURRENT (TYPICAL)

# HGTP10N40F1D, HGTP10N50F1D

## Typical Performance Curves (Continued)



NOTE:  
 $P_D$  = ALLOWABLE DISSIPATION     $P_C$  = CONDUCTION DISSIPATION

FIGURE 9. MAXIMUM OPERATING FREQUENCY vs COLLECTOR CURRENT AND VOLTAGE (TYPICAL)

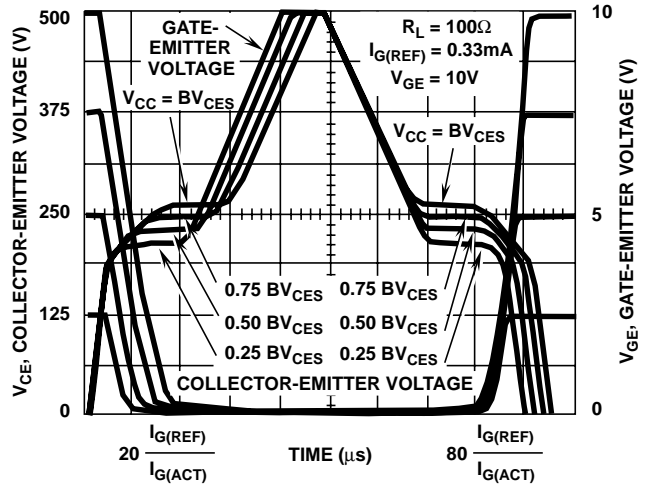


FIGURE 10. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT

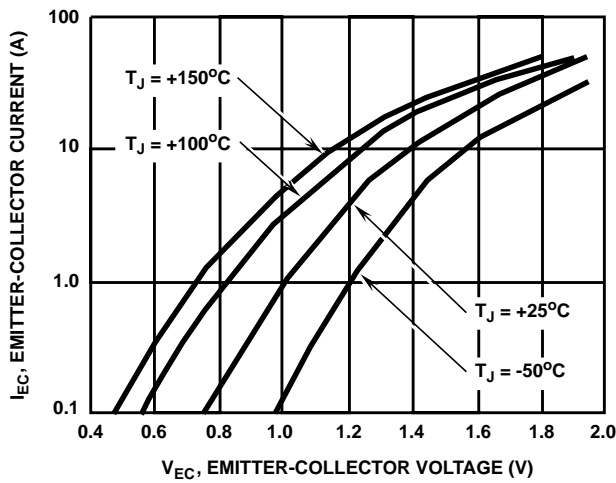


FIGURE 11. TYPICAL FORWARD VOLTAGE

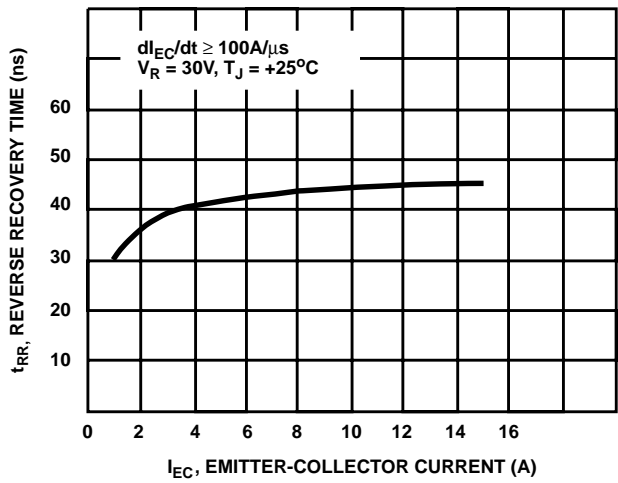


FIGURE 12. TYPICAL REVERSE RECOVERY TIME

## Test Circuit

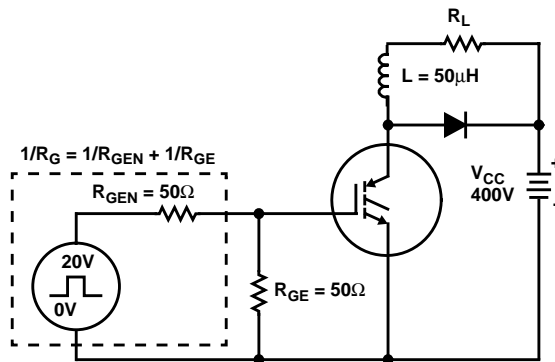


FIGURE 13. INDUCTIVE SWITCHING TEST CIRCUIT

## **HGTP10N40F1D, HGTP10N50F1D**

All Intersil semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

*Intersil products are sold by description only. Intersil Corporation reserves the right to make changes in circuit design and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that data sheets are current before placing orders. Information furnished by Intersil is believed to be accurate and reliable. However, no responsibility is assumed by Intersil or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Intersil or its subsidiaries.*

For information regarding Intersil Corporation and its products, see web site <http://www.intersil.com>

### **Sales Office Headquarters**

#### **NORTH AMERICA**

Intersil Corporation  
P. O. Box 883, Mail Stop 53-204  
Melbourne, FL 32902  
TEL: (407) 724-7000  
FAX: (407) 724-7240

#### **EUROPE**

Intersil SA  
Mercure Center  
100, Rue de la Fusee  
1130 Brussels, Belgium  
TEL: (32) 2.724.2111  
FAX: (32) 2.724.22.05

#### **ASIA**

Intersil (Taiwan) Ltd.  
Taiwan Limited  
7F-6, No. 101 Fu Hsing North Road  
Taipei, Taiwan  
Republic of China  
TEL: (886) 2 2716 9310  
FAX: (886) 2 2715 3029