

March 1997

6A, 400V and 500V N-Channel IGBTs

### Features

- 6A, 400V and 500V
- $V_{CE(ON)}$ : 2.5V Max.
- $T_{FALL}$ : 1.0 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance

### Applications

- Power Supplies
- Motor Drives
- Protective Circuits

### Description

The HGTD6N40E1, HGTD6N40E1S, HGTD6N50E1, and HGTD6N50E1S are n-channel enhancement-mode insulated gate bipolar transistors (IGBTs) designed for high voltage, low on-dissipation applications such as switching regulators and motor drivers. These types can be operated directly from low power integrated circuits.

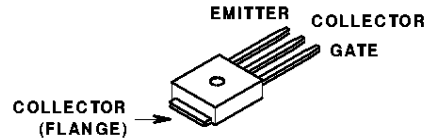
#### PACKAGING AVAILABILITY

PART NUMBER	PACKAGE	BRAND
HGTD6N40E1	TO-251AA	G6N40E
HGTD6N50E1	TO-251AA	G6N50E
HGTD6N40E1S	TO-252AA	G6N40E
HGTD6N50E1S	TO-252AA	G6N50E

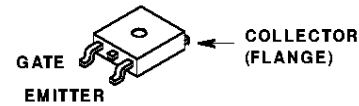
NOTE: When ordering, use the entire part number.

### Packages

HGTD6N40E1, HGTD6N50E1  
JEDEC TO-251AA

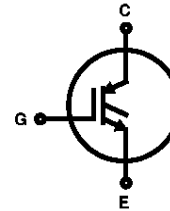


HGTD6N40E1S, HGTD6N50E1S  
JEDEC TO-252AA



### Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



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

	HGTD6N40E1 HGTD6N40E1S	HGTD6N50E1 HGTD6N50E1S	UNITS
Collector-Emitter Voltage	400	500	V
Collector-Gate Voltage $R_{GE} = 1M\Omega$	400	500	V
Gate-Emitter Voltage	$\pm 20$	$\pm 20$	V
Collector Current Continuous at $T_C = +25^\circ\text{C}$	7.5	7.5	A
at $T_C = +90^\circ\text{C}$	6.0	6.0	A
Power Dissipation Total at $T_C = +25^\circ\text{C}$	60	60	W
Power Dissipation Derating $T_C > +25^\circ\text{C}$	0.48	0.48	W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	-55 to +150	-55 to +150	$^\circ\text{C}$

#### HARRIS 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	4,567,641
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
4,860,080	4,883,767	4,888,627	4,890,143	4,901,127	4,904,609	4,933,740	4,963,951
4,969,027							

# Specifications HGTD6N40E1, HGTD6N40E1S, HGTD6N50E1, HGTD6N50E1S

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

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS	
			HGTD6N40E1 HGTD6N40E1S		HGTD6N50E1 HGTD6N50E1S			
			MIN	MAX	MIN	MAX		
Collector-Emitter Breakdown Voltage	$BV_{CES}$	$I_C = 250\mu\text{A}, V_{GE} = 0\text{V}$	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	$I_{CES}$	$T_J = +150^\circ\text{C}, V_{CE} = 400\text{V}$	-	250	-	-	$\mu\text{A}$	
		$T_J = +150^\circ\text{C}, V_{CE} = 500\text{V}$	-	-	-	250	$\mu\text{A}$	
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{V}, V_{CE} = 0\text{V}$	-	100	-	100	nA	
Collector-Emitter On-Voltage	$V_{CE(ON)}$	$T_J = +150^\circ\text{C}, I_C = 3\text{A}, V_{GE} = 10\text{V}$	-	2.9	-	2.9	V	
		$T_J = +150^\circ\text{C}, I_C = 3\text{A}, V_{GE} = 15\text{V}$	-	2.5	-	2.5	V	
		$T_J = +25^\circ\text{C}, I_C = 3\text{A}, V_{GE} = 10\text{V}$	-	2.5	-	2.5	V	
		$T_J = +25^\circ\text{C}, I_C = 3\text{A}, V_{GE} = 15\text{V}$	-	2.4	-	2.4	V	
Gate-Emitter Plateau Voltage	$V_{GEP}$	$I_C = 3\text{A}, V_{CE} = 10\text{V}$	6.5 (Typ)				V	
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 3\text{A}, V_{CE} = 10\text{V}$	6.9 (Typ)				nC	
Turn-On Delay Time	$t_{D(ON)}$	Resistive Load, $I_C = 3\text{A}, V_{CE} = 400\text{V}, R_L = 133\Omega, T_J = +150^\circ\text{C}, V_{GE} = 10\text{V}, R_G = 25\Omega$	90 (Typ)				ns	
Rise Time	$t_R$		32 (Typ)				ns	
Turn-Off Delay Time	$t_{D(OFF)}$		24 (Typ)				ns	
Fall Time	$t_F$		1100 (Typ)				ns	
Turn-Off Energy Loss Per Cycle (Off Switching Dissipation = $W_{OFF} \times$ Frequency)	$W_{OFF}$		0.29 (Typ)				mJ	
Turn-Off Delay Time	$t_{D(OFF)I}$		Inductive Load (See Figure 11), $I_C = 3\text{A}, V_{CE(CLIP)} = 400\text{V}, R_L = 133\Omega, L = 50\mu\text{H}, T_J = +150^\circ\text{C}, V_{GE} = 10\text{V}, R_G = 25\Omega$	-	190	-	190	ns
Fall Time	$t_{FI}$			-	1	-	1	$\mu\text{s}$
Turn-Off Energy Loss Per Cycle (Off Switching Dissipation = $W_{OFF} \times$ Frequency)	$W_{OFF}$	-		0.43	-	0.43	mJ	
Thermal Resistance Junction-to-Case (IGBT)	$R_{\theta JC}$		-	2.08	-	2.08	$^\circ\text{C/W}$	

## Typical Performance Curves

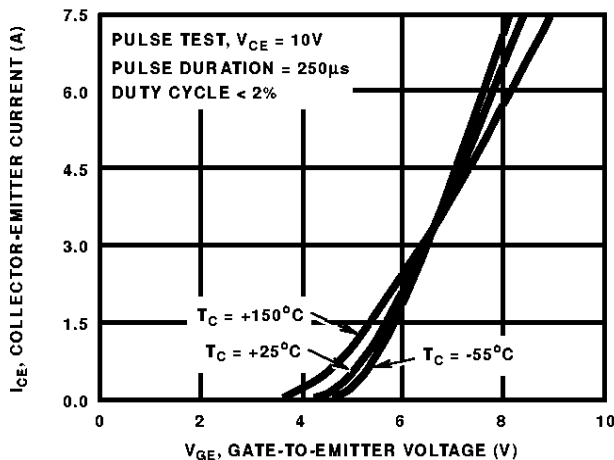


FIGURE 1. TYPICAL TRANSFER CHARACTERISTICS

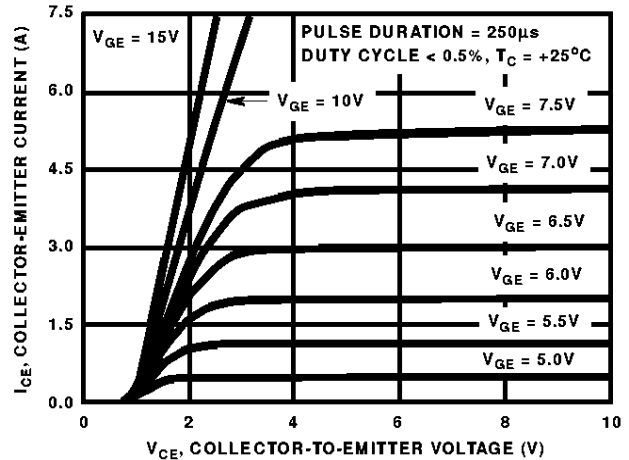


FIGURE 2. TYPICAL SATURATION CHARACTERISTICS

Typical Performance Curves (Continued)

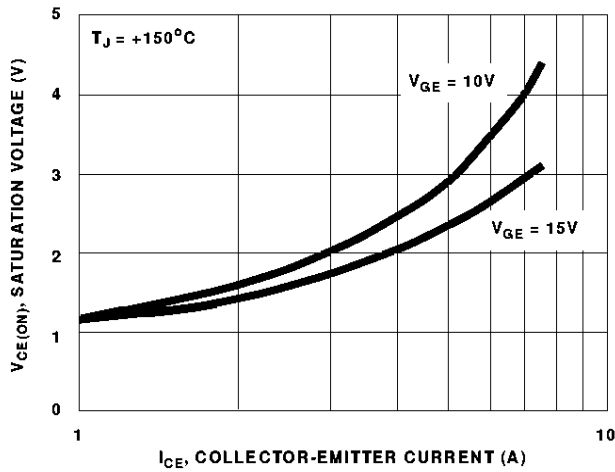


FIGURE 3. SATURATION VOLTAGE vs COLLECTOR-EMITTER CURRENT (TYPICAL)

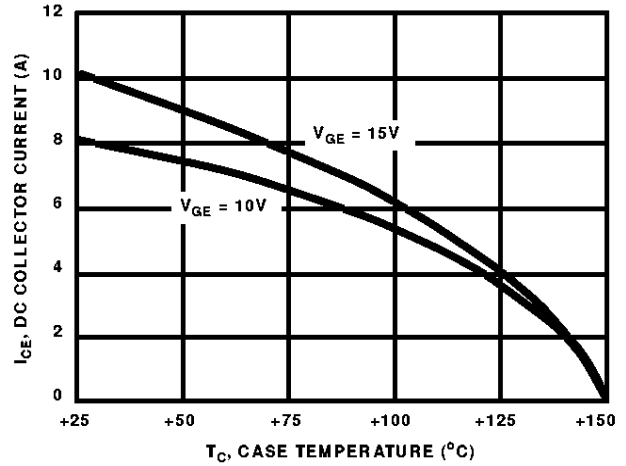


FIGURE 4. DC COLLECTOR CURRENT vs CASE TEMPERATURE

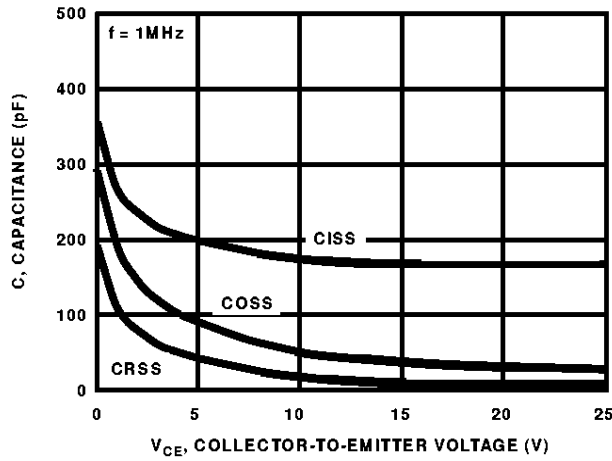


FIGURE 5. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE (TYPICAL)

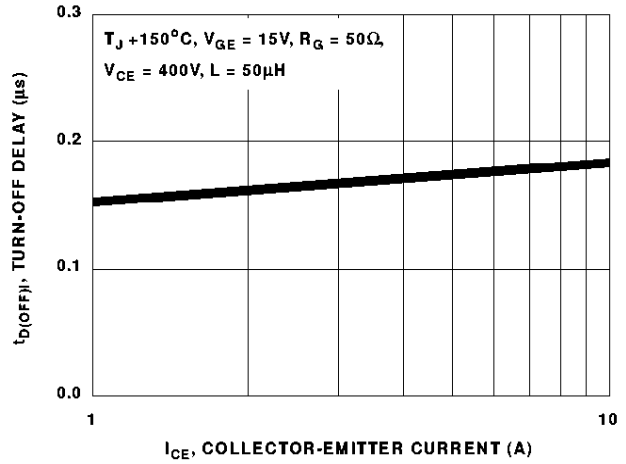


FIGURE 6. TURN-OFF DELAY vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

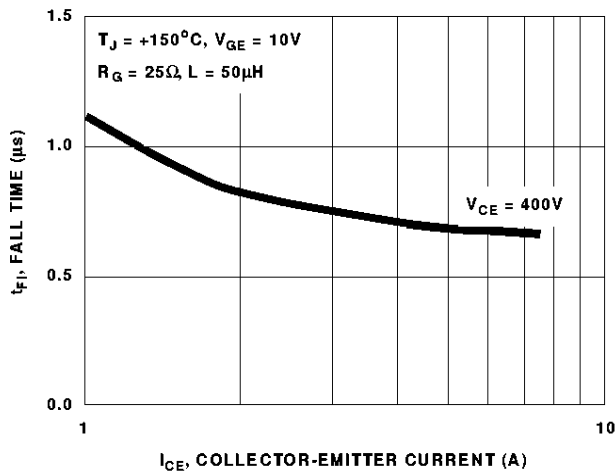


FIGURE 7. FALL TIME vs COLLECTOR-TO-EMITTER CURRENT (TYPICAL)

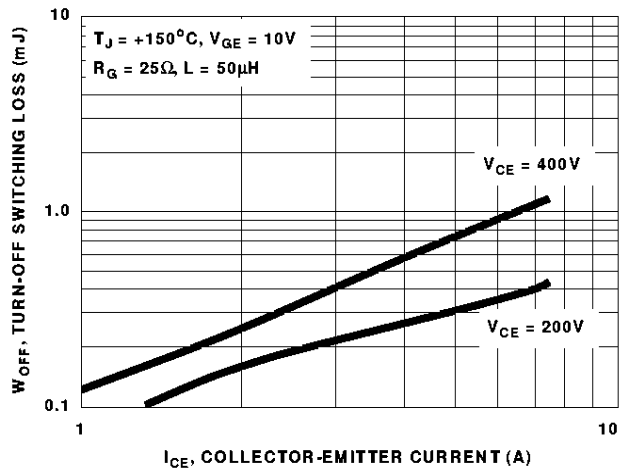


FIGURE 8. TURN-OFF SWITCHING LOSS vs COLLECTOR-EMITTER CURRENT (TYPICAL)

Typical Performance Curves (Continued)

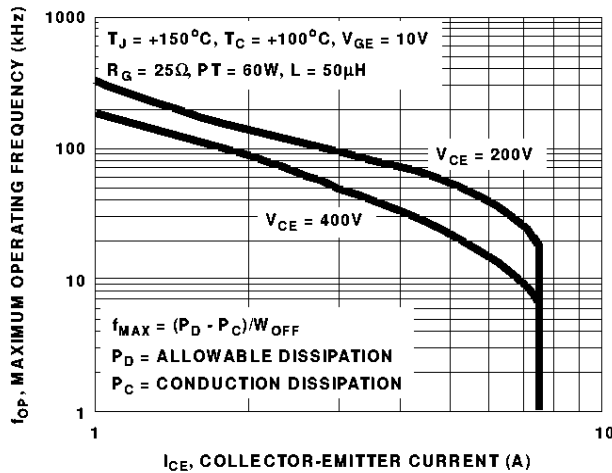


FIGURE 9. MAXIMUM OPERATING FREQUENCY vs COLLECTOR CURRENT AND VOLTAGE (TYPICAL)

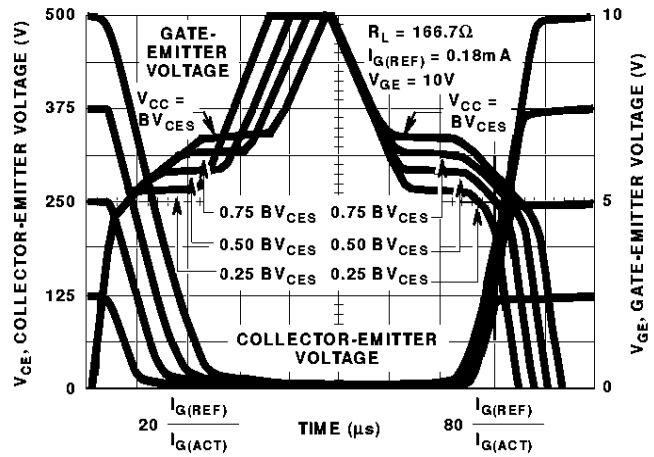


FIGURE 10. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT

Test Circuit

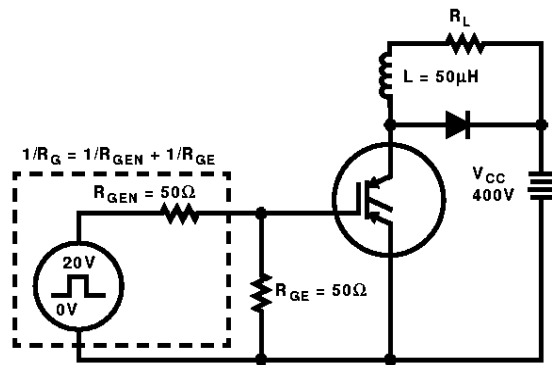


FIGURE 11. INDUCTIVE SWITCHING TEST CIRCUIT

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