

April 1995

### Features

- 10A, 400V and 500V
- $V_{CE(ON)}$ : 2.5V Max.
- $T_{FALL}$ : 1 $\mu$ s, 0.5 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance
- Anti-Parallel Diode

### Applications

- Power Supplies
- Motor Drives
- Protective Circuits

### Description

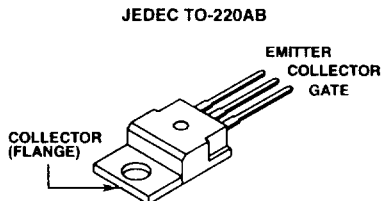
The HGTP10N40C1D, HGTP10N40E1D, HGTP10N50C1D, and HGTP10N50E1D are n-channel enhancement-mode insulated gate bipolar transistors (IGBTs) designed for high voltage, low on-dissipation applications such as switching regulators and motor drivers. They feature a discrete anti-parallel diode that shunts current around the IGBT in the reverse direction without introducing carriers into the depletion region. These types can be operated directly from low power integrated circuits.

#### PACKAGING AVAILABILITY

PART NUMBER	PACKAGE	BRAND
HGTP10N40C1D	TO-220AB	10N40C1D
HGTP10N40E1D	TO-220AB	10N40E1D
HGTP10N50C1D	TO-220AB	10N50C1D
HGTP10N50E1D	TO-220AB	10N50E1D

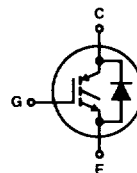
NOTE: When ordering, use the entire part number.

### Package



### Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



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

	HGTP10N40C1D HGTP10N40E1D	HGTP10N50C1D HGTP10N50E1D	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 $T_C = +25^\circ\text{C}$	17.5	17.5	A
at $T_C = +90^\circ\text{C}$	10	10	
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/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	-55 to +150	-55 to +150	$^\circ\text{C}$

# Specifications HGTP10N40C1D, HGTP10N40E1D, HGTP10N50C1D, HGTP10N50E1D

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

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS	
			HGTP10N40C1D, HGTP10N40E1D		HGTP10N50C1D, HGTP10N50E1D			
			MIN	MAX	MIN	MAX		
Collector-Emitter Breakdown Voltage	$BV_{CES}$	$I_C = 1\text{mA}, V_{GE} = 0$	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	$I_{CES}$	$V_{CE} = 400\text{V}, T_C = +25^\circ\text{C}$	-	250	-	-	$\mu\text{A}$	
		$V_{CE} = 500\text{V}, T_C = +25^\circ\text{C}$	-	-	-	250	$\mu\text{A}$	
		$V_{CE} = 400\text{V}, T_C = +125^\circ\text{C}$	-	1000	-	-	$\mu\text{A}$	
		$V_{CE} = 500\text{V}, T_C = +125^\circ\text{C}$	-	-	-	1000	$\mu\text{A}$	
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{V}, V_{CE} = 0$	-	100	-	100	nA	
Collector-Emitter On Voltage	$V_{CE(ON)}$	$I_C = 10\text{A}, V_{GE} = 10\text{V}$	-	2.5	-	2.5	V	
		$I_C = 17.5\text{A}, V_{GE} = 20\text{V}$	-	3.2	-	3.2	V	
Gate-Emitter Plateau Voltage	$V_{GEP}$	$I_C = 5\text{A}, V_{CE} = 10\text{V}$	-	6 (Typ)	-	6 (Typ)	V	
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 5\text{A}, V_{CE} = 10\text{V}$	-	19 (Typ)	-	19 (Typ)	nC	
Turn-On Delay Time	$t_{D(ON)}$	$I_C = 10\text{A}, V_{CE(CLIP)} = 300\text{V},$ $L = 50\mu\text{H}, T_J = +100^\circ\text{C},$ $V_{GE} = 10\text{V}, R_G = 50\Omega$	-	50	-	50	ns	
Rise Time	$t_{RI}$		-	50	-	50	ns	
Turn-Off Delay Time	$t_{D(OFF)}$		-	400	-	400	ns	
Fall Time	$t_{FI}$		40E1D, 50E1D	680 (Typ)	1000	680 (Typ)	1000	ns
			40C1D, 50C1D	400 (Typ)	500	400 (Typ)	500	ns
Turn-Off Energy Loss per Cycle (Off Switching Dissipation = $W_{OFF} \times \text{Frequency}$ )	$W_{OFF}$	$I_C = 10\text{A}, V_{CE(CLIP)} = 300\text{V},$ $L = 50\mu\text{H}, T_J = +100^\circ\text{C},$ $V_{GE} = 10\text{V}, R_G = 50\Omega$	1810 (Typ)				$\mu\text{J}$	
			1070 (Typ)				$\mu\text{J}$	
Thermal Resistance Junction-to-Case	$R_{\theta JC}$		-	1.67	-	1.67	$^\circ\text{C/W}$	
Diode Forward Voltage	$V_{EC}$	$I_{EC} = 10\text{A}$	-	2	-	2	V	
Diode Reverse Recovery Time	$t_{RR}$	$I_{EC} = 10\text{A}, di/dt = 100\text{A}/\mu\text{s}$	-	100	-	100	ns	

**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							

**3**  
IGBTs

Typical Performance Curves

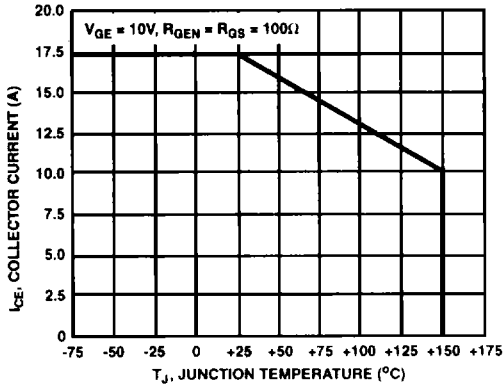


FIGURE 1. MAX. SWITCHING CURRENT LEVEL.  $R_G = 50\Omega$ ,  $V_{GE} = 0V$  ARE THE MIN. ALLOWABLE VALUES

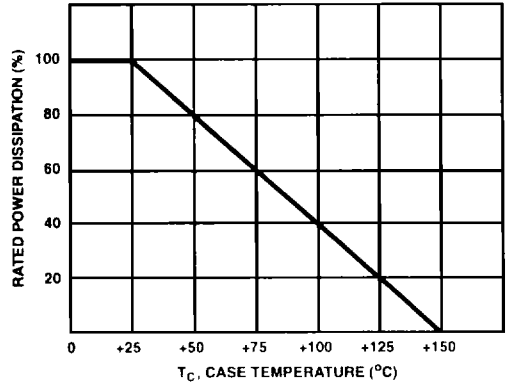


FIGURE 2. POWER DISSIPATION vs TEMPERATURE DERATING CURVE

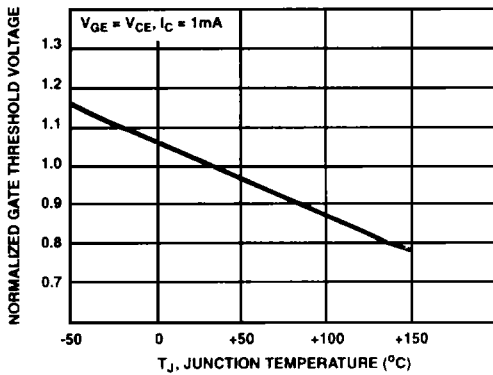


FIGURE 3. TYPICAL NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

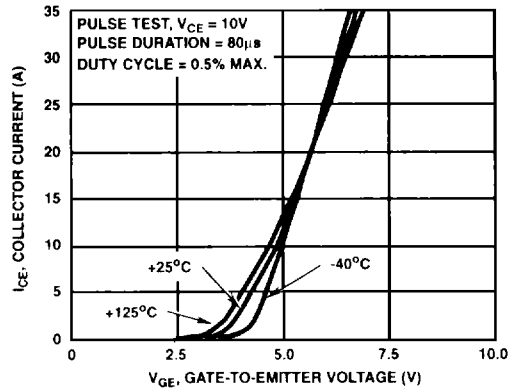


FIGURE 4. TYPICAL TRANSFER CHARACTERISTICS

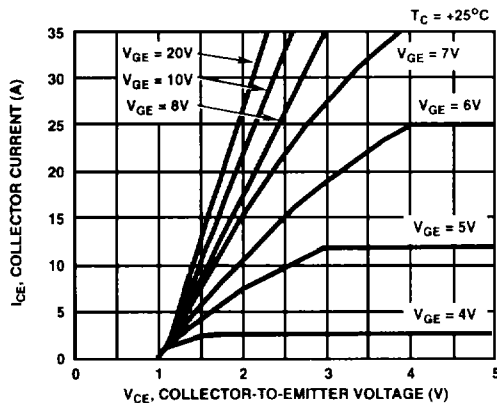


FIGURE 5. TYPICAL SATURATION CHARACTERISTICS

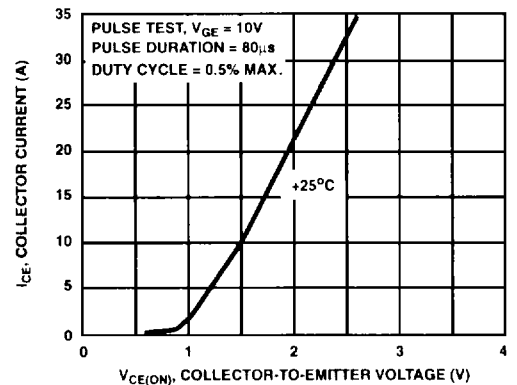


FIGURE 6. TYPICAL COLLECTOR-TO-EMITTER ON-VOLTAGE vs COLLECTOR CURRENT

Typical Performance Curves (Continued)

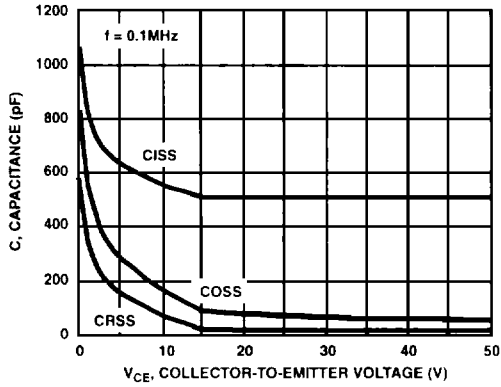


FIGURE 7. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE

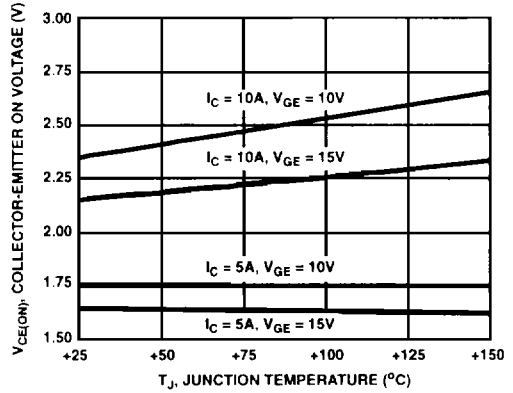


FIGURE 8. TYPICAL  $V_{CE(ON)}$  vs TEMPERATURE

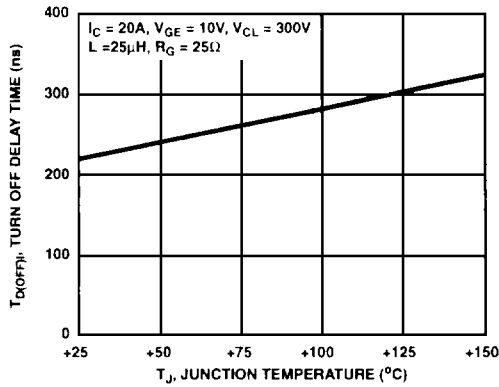


FIGURE 9. TYPICAL TURN-OFF DELAY TIME

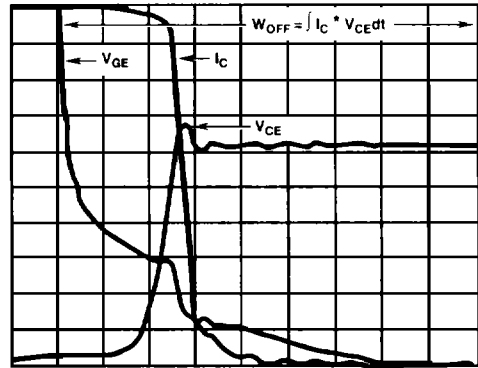


FIGURE 10. TYPICAL INDUCTIVE SWITCHING WAVEFORMS

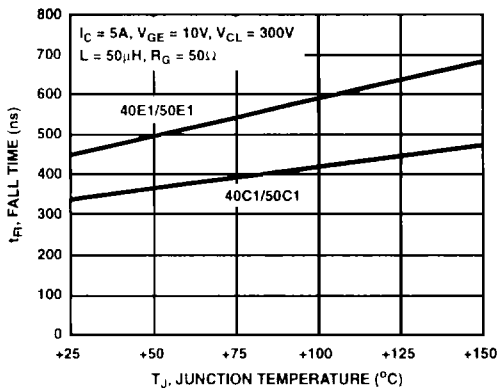


FIGURE 11. TYPICAL FALL TIME ( $I_C = 5A$ )

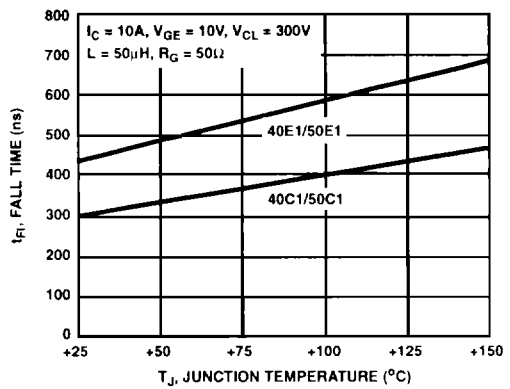


FIGURE 12. TYPICAL FALL TIME ( $I_C = 10A$ )

Typical Performance Curves (Continued)

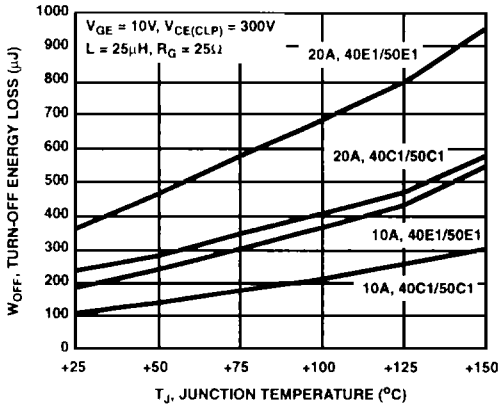


FIGURE 13. TYPICAL CLAMPED INDUCTIVE TURN-OFF SWITCHING LOSS/CYCLE

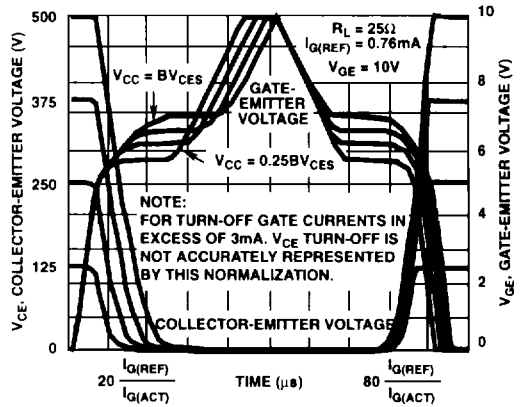


FIGURE 14. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT. (REFER TO APPLICATION NOTES AN7254 AND AN7260)

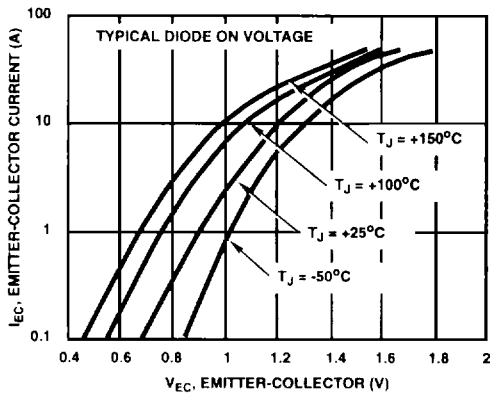


FIGURE 15. TYPICAL DIODE EMITTER-TO-COLLECTOR VOLTAGE vs CURRENT FOR ALL TYPES

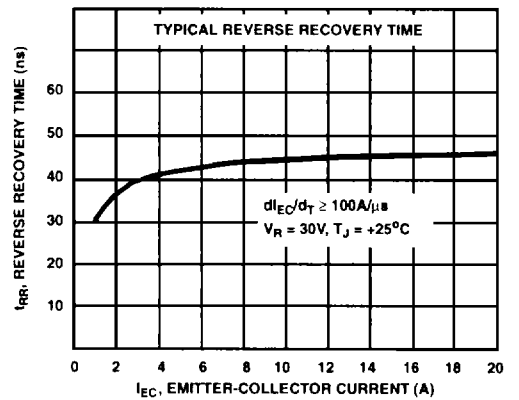


FIGURE 16. TYPICAL DIODE REVERSE-RECOVERY TIME FOR ALL TYPES

Test Circuit

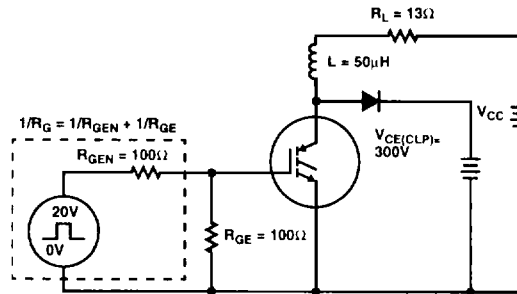


FIGURE 17. INDUCTIVE SWITCHING TEST CIRCUIT