

## 20A, 500V N-Channel IGBT with Anti-Parallel Ultrafast Diode

April 1995

### Features

- 20A, 500V
- Latch Free Operation
- Typical Fall Time < 500ns
- High Input Impedance
- Low Conduction Loss
- With Anti-Parallel Diode
- $t_{RR} < 60ns$

### 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 ( $t_{RR} < 60ns$ ) with soft recovery characteristic.

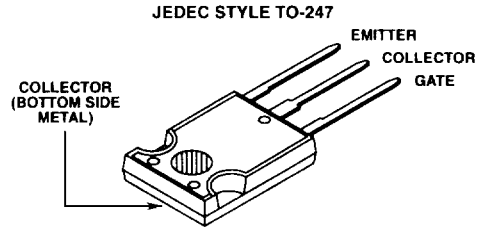
IGBTs are ideal for many high voltage switching applications operating at frequencies where low conduction losses are essential, such as: AC and DC motor controls, power supplies and drivers for solenoids, relays and contractors.

#### PACKAGING AVAILABILITY

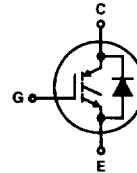
PART NUMBER	PACKAGE	BRAND
HGTG20N50C1D	TO-247	G20N50C1D

NOTE: When ordering, use the entire part number.

### Package



### Terminal Diagram



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

	HGTG20N50C1D	UNITS
Collector-Emitter Voltage	500	V
Collector-Gate Voltage $R_{GE} = 1M\Omega$	500	V
Collector Current Continuous at $T_C = +25^\circ C$	26	A
at $T_C = +90^\circ C$	20	A
Collector Current Pulsed (Note 1)	35	A
Gate-Emitter Voltage Continuous	$\pm 20$	V
Diode Forward Current at $T_C = +25^\circ C$	26	A
at $T_C = +90^\circ C$	20	A
Power Dissipation Total at $T_C = +25^\circ C$	75	W
Power Dissipation Derating $T_C > +25^\circ C$	0.8	W/ $^\circ C$
Operating and Storage Junction Temperature Range	-55 to +150	$^\circ C$
Maximum Lead Temperature for Soldering	260	$^\circ C$

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

#### 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 HGTG20N50C1D

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

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS		UNITS
			MIN	MAX	
Collector-Emitter Breakdown Voltage	$BV_{CES}$	$I_C = 1\text{mA}$ , $V_{GE} = 0\text{V}$	500	-	V
Gate Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}$ , $I_C = 1\text{mA}$	2	4.5	V
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{CE} = 500\text{V}$	-	250	$\mu\text{A}$
		$T_C = +125^\circ\text{C}$ , $V_{CE} = 500\text{V}$	-	1000	$\mu\text{A}$
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0\text{V}$	-	100	nA
Collector-Emitter On-Voltage	$V_{CE(SAT)}$	$I_C = 20\text{A}$ , $V_{GE} = 10\text{V}$	-	2.5	V
		$I_C = 35\text{A}$ , $V_{GE} = 20\text{V}$	-	3.2	V
Gate-Emitter Plateau Voltage	$V_{GEP}$	$I_C = 10\text{A}$ , $V_{CE} = 10\text{V}$	-	6 (Typ)	V
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 10\text{A}$ , $V_{CE} = 10\text{V}$	-	33 (Typ)	nC
Turn-On Delay Time	$t_{D(ON)}$	$I_C = 20\text{A}$ , $V_{CE(CL P)} = 300\text{V}$ , $L = 25\mu\text{H}$ , $T_J = +100^\circ\text{C}$ , $V_{GE} = 10\text{V}$ , $R_G = 25\Omega$	-	50	ns
Rise Time	$t_{RI}$		-	50	ns
Turn-Off Delay Time	$t_{D(OFF)}$		-	400	ns
Fall Time	$t_{FI}$		400 (Typ)	500	ns
Turn-Off Energy Loss Per Cycle (Off Switching Dissipation = $W_{OFF} \times \text{Frequency}$ )	$W_{OFF}$	$I_C = 20\text{A}$ , $V_{CE(CL P)} = 300\text{V}$ , $L = 25\mu\text{H}$ , $T_J = +100^\circ\text{C}$ , $V_{GE} = 10\text{V}$ , $R_G = 25\Omega$	1070 (Typ)		$\mu\text{J}$
Thermal Resistance Junction-to-Case (IGBT)	$R_{\theta JC}$		-	1.25	$^\circ\text{C/W}$
Thermal Resistance of Diode	$R_{\theta JC}$		-	1.5	ns
Diode Forward Voltage	$V_{EC}$	$I_{EC} = 20\text{A}$	-	1.8	V
Diode Reverse Recovery Time	$t_{RR}$	$I_{EC} = 20\text{A}$ , $di_{EC}/dt = 100\text{A}/\mu\text{s}$	-	60	ns

### Typical Performance Curves

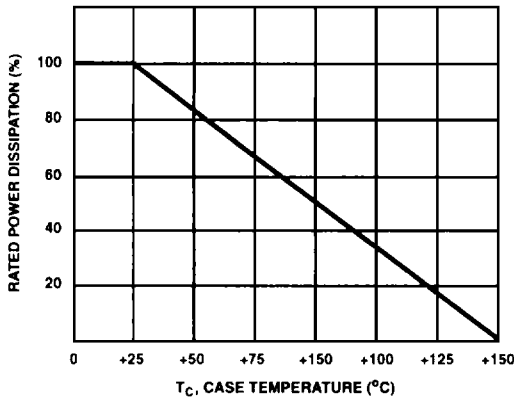


FIGURE 1. POWER DISSIPATION vs TEMPERATURE DERATING CURVE

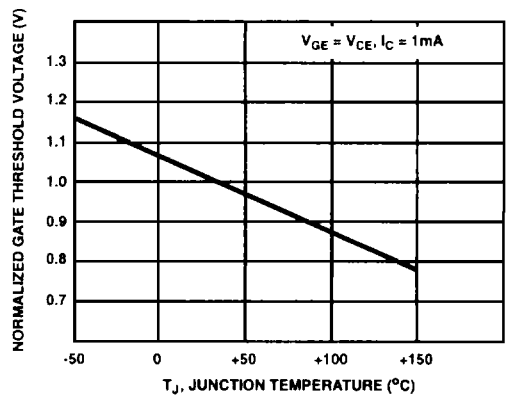


FIGURE 2. TYPICAL NORMALIZED GATE-THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

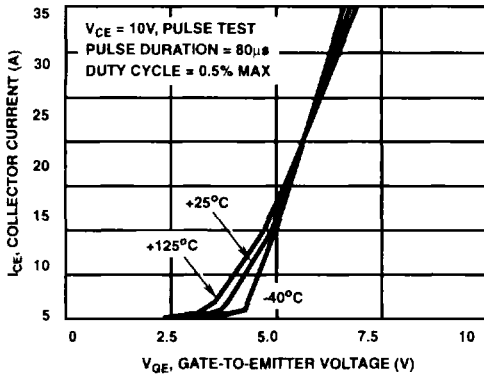


FIGURE 3. TYPICAL TRANSFER CHARACTERISTICS

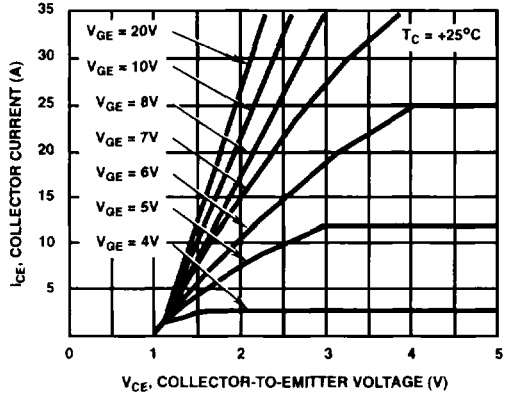


FIGURE 4. TYPICAL SATURATION CHARACTERISTICS

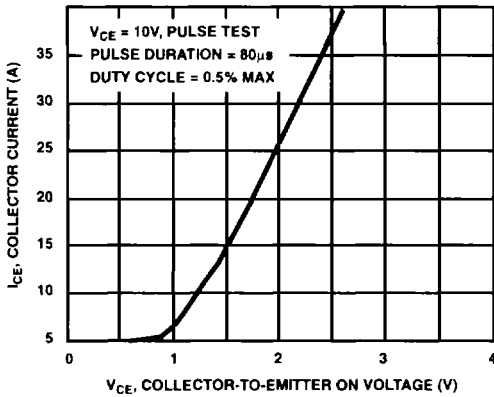


FIGURE 5. TYPICAL COLLECTOR-TO-EMITTER ON-VOLTAGE vs COLLECTOR CURRENT

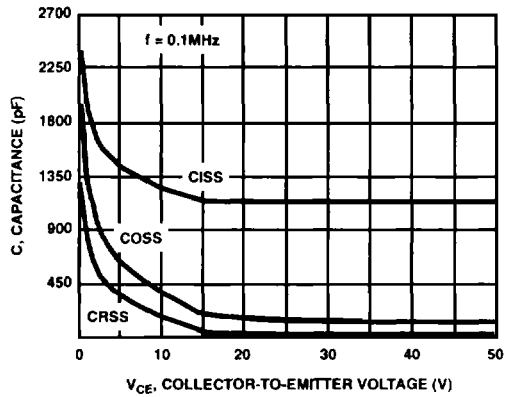


FIGURE 6. CAPACITANCE vs COLLECTOR-TO-EMITTER VOLTAGE

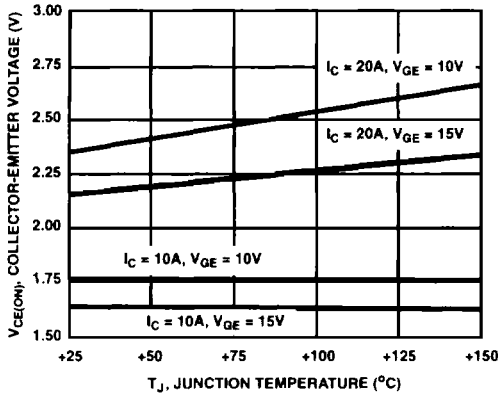


FIGURE 7. TYPICAL  $V_{CE(ON)}$  vs TEMPERATURE

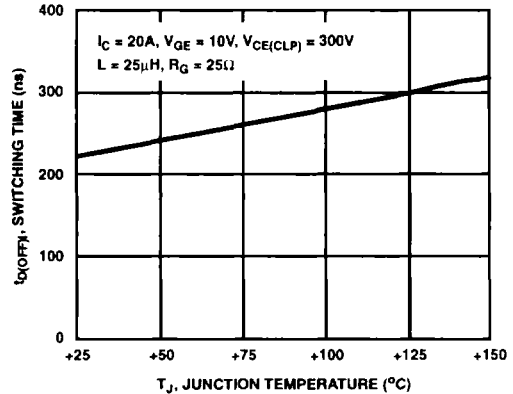


FIGURE 8. TYPICAL TURN-OFF DELAY TIME

Typical Performance Curves (Continued)

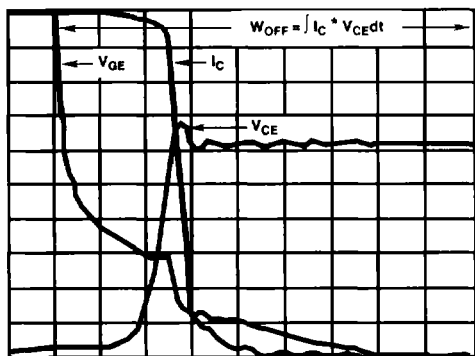


FIGURE 9. TYPICAL INDUCTIVE SWITCHING WAVEFORMS

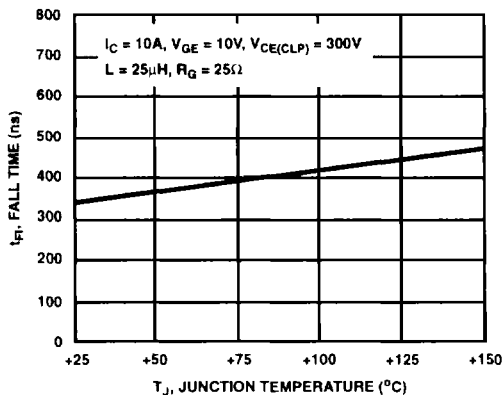


FIGURE 10. TYPICAL FALL TIME ( $I_C = 10A$ )

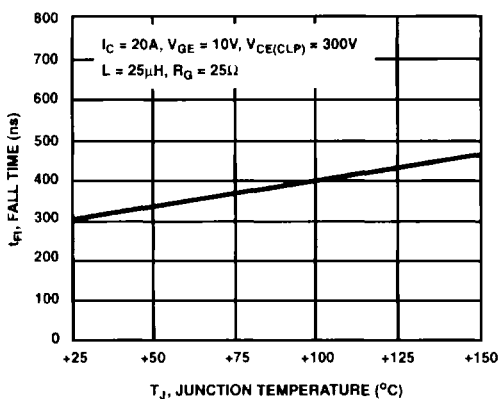


FIGURE 11. TYPICAL FALL TIME ( $I_C = 20A$ )

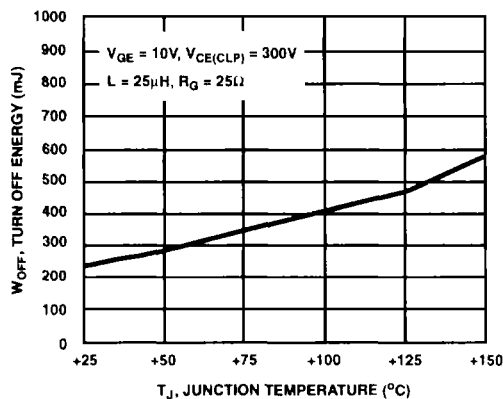
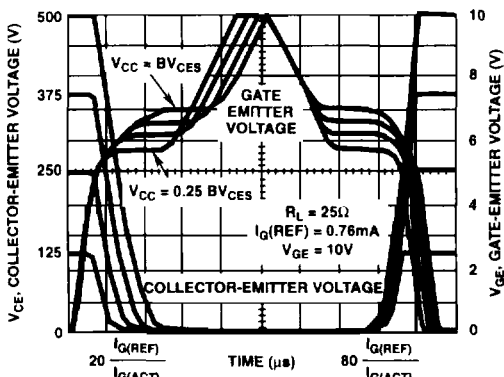


FIGURE 12. TYPICAL CLAMPED INDUCTIVE TURN-OFF SWITCHING LOSS/CYCLE



NOTE: For Turn-Off gate currents in excess of 3mA,  $V_{CE}$  Turn-Off is not accurately represented by this normalization.

FIGURE 13. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT (REFER TO APPLICATION NOTES AN7254 AND AN7260)

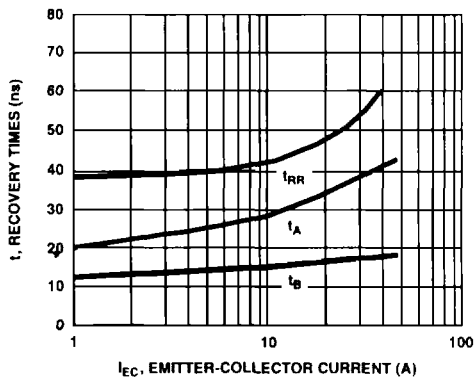


FIGURE 14. TYPICAL  $t_{RR}$ ,  $t_A$ ,  $t_B$  vs FORWARD CURRENT

Typical Performance Curves (Continued)

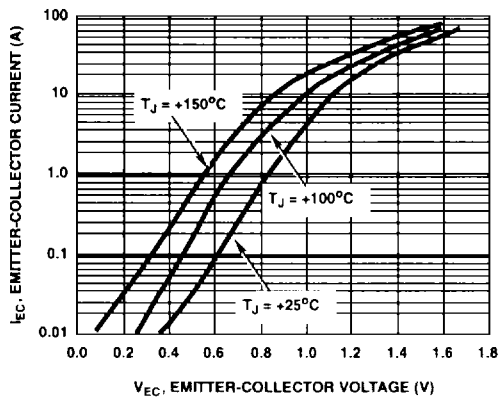


FIGURE 15. FORWARD VOLTAGE vs FORWARD CURRENT CHARACTERISTIC

Test Circuit

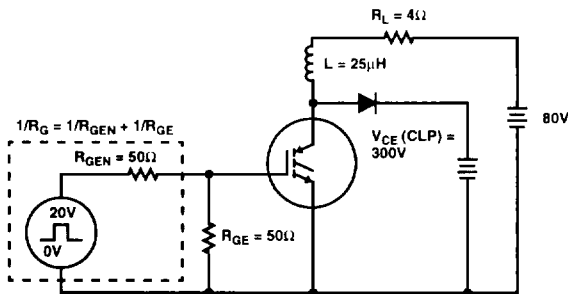


FIGURE 16. INDUCTIVE SWITCHING TEST CIRCUIT