HARRIS
S E M I C O N D U C T O R

HGTP12N60D1

12A, 600V N-Channel IGBT

Features

- **12A, 600V**
- **Latch Free Operation**
- **Typical Fall Time <500ns**
- **High Input Impedance**
- **Low Conduction Loss**

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 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.
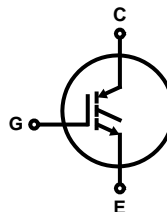
PACKAGING AVAILABILITY

PART NUMBER	PACKAGE	BRAND
HGTP12N60D1	TO-220AB	G12N60D1

Package

JEDEC TO-220AB
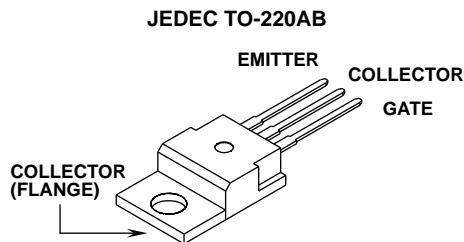
Terminal Diagram

N-CHANNEL ENHANCEMENT MODE

Absolute Maximum Ratings T_C = +25°C, Unless Otherwise Specified

	HGTP12N60D1	UNITS
Collector-Emitter Voltage . . . . BV$_{CES}$	600	V
Collector-Gate Voltage R$_{GE}$ = 1MΩ . . . . BV$_{CGR}$	600	V
Collector Current Continuous at T$_C$ = +25°C . . . . I$_{C25}$	21	A
at V$_{GE}$ = 15V at T$_C$ = +90°C . . . . I$_{C90}$	12	A
Collector Current Pulsed (Note 1) . . . . I$_{CM}$	48	A
Gate-Emitter Voltage Continuous. . . . . V$_{GES}$	±25	V
Switching Safe Operating Area at T$_J$ = +150°C . . . . SSOA	30A at 0.8 BV$_{CES}$	-
Power Dissipation Total at T$_C$ = +25°C . . . . P$_D$	75	W
Power Dissipation Derating T$_C$ > +25°C	0.6	W/^{o}C
Operating and Storage Junction Temperature Range . . . . T$_J$, T$_{STG}$	-55 to +150	^{o}C
Maximum Lead Temperature for Soldering . . . . T$_L$	260	^{o}C

NOTE:

1. Repetitive Rating: Pulse width limited by maximum junction temperature.

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							

File Number   **2830.3**

Electrical Specifications T_C = +25°C, Unless Otherwise Specified

PARAMETERS	SYMBOL	TEST CONDITIONS		LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
Collector-Emitter Breakdown Voltage	BV_{CES}	I_C = 250µA, V_{GE} = 0V		600	-	-	V
Collector-Emitter Leakage Voltage	I_{CES}	V_{CE} = BV_{CES}	T_C = +25°C	-	-	1.0	µA
		V_{CE} = 0.8 BV_{CES}	T_C = +125°C	-	-	4.0	mA
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C = I_{C90}, V_{GE} = 15V	T_C = +25°C	-	1.9	2.5	V
			T_C = +125°C	-	2.1	2.7	V
Gate-Emitter Threshold Voltage	$V_{GE(TH)}$	I_C = 250µA, V_{CE} = V_{GE}, T_C = +25°C		3.0	4.5	6.0	V
Gate-Emitter Leakage Current	I_{GES}	V_{GE} = ±20V		-	-	±500	nA
Gate-Emitter Plateau Voltage	V_{GEP}	I_C = I_{C90}, V_{CE} = 0.5 BV_{CES}		-	7.2	-	V
On-State Gate Charge	$Q_{G(ON)}$	I_C = I_{C90}, V_{CE} = 0.5 BV_{CES}	V_{GE} = 15V	-	45	60	nC
			V_{GE} = 20V	-	70	90	nC
Current Turn-On Delay Time	$t_{D(ON)I}$	L = 500µH, I_C = I_{C90}, R_G = 25Ω, V_{GE} = 15V, T_J = +150°C, V_{CE} = 0.8 BV_{CES}		-	100	-	ns
Current Rise Time	t_{RI}			-	150	-	ns
Current Turn-Off	$t_{D(OFF)I}$			-	430	600	ns
Current Fall Time	t_{FI}			-	430	600	ns
Turn-Off Energy (Note 1)	W_{OFF}			-	1.8	-	mJ
Thermal Resistance IGBT	$R_{\theta JC}$			-	-	1.67	°C/W

NOTE:

1. Turn-off Energy Loss (W_{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} = 0A). The HGTP12N60D1 was 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.
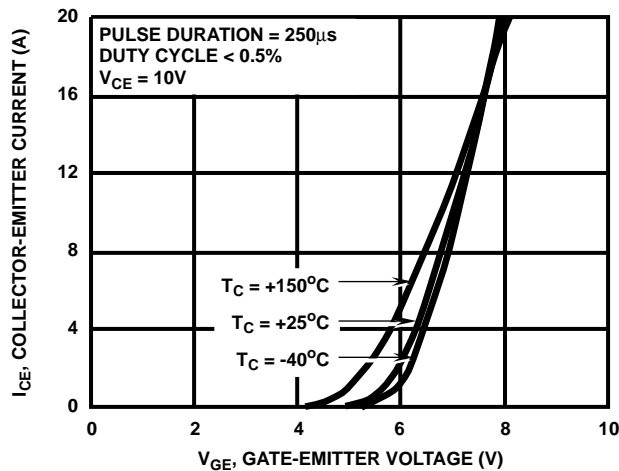
Typical Performance Curves

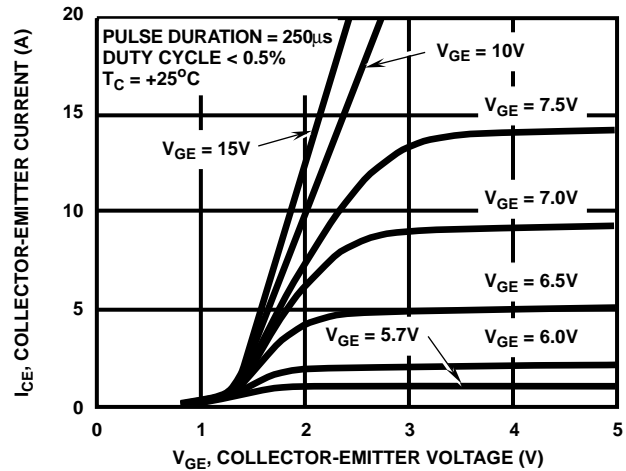**FIGURE 1. TRANSFER CHARACTERISTICS (TYPICAL)**

FIGURE 2. SATURATION CHARACTERISTICS (TYPICAL)

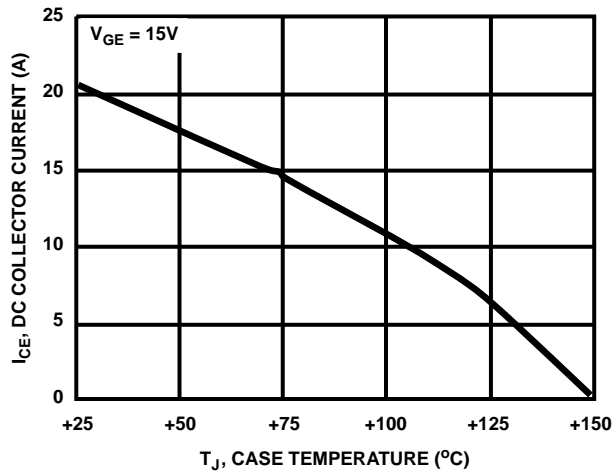## *Typical Performance Curves* (Continued)

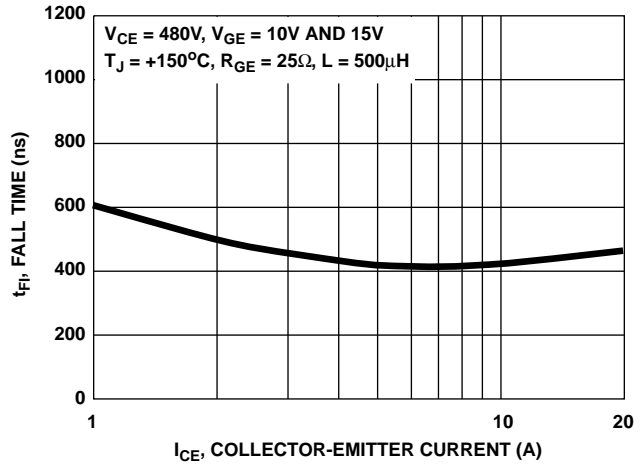FIGURE 3. DC COLLECTOR CURRENT vs CASE TEMPERATURE

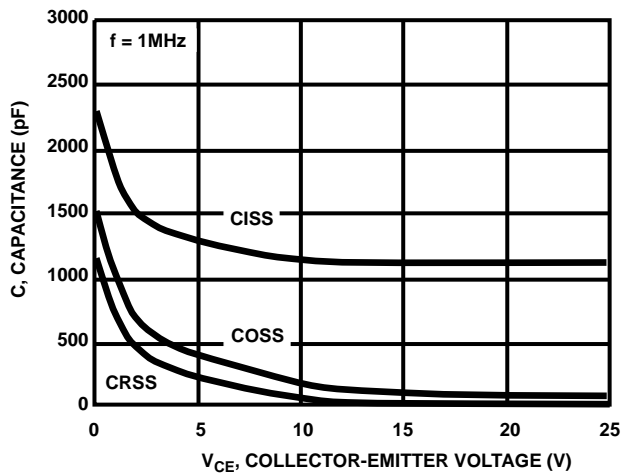FIGURE 4. FALL TIME vs COLLECTOR-EMITTER CURRENT

FIGURE 5. CAPACITANCE vs COLLECTOR-EMITTER VOLTAGE
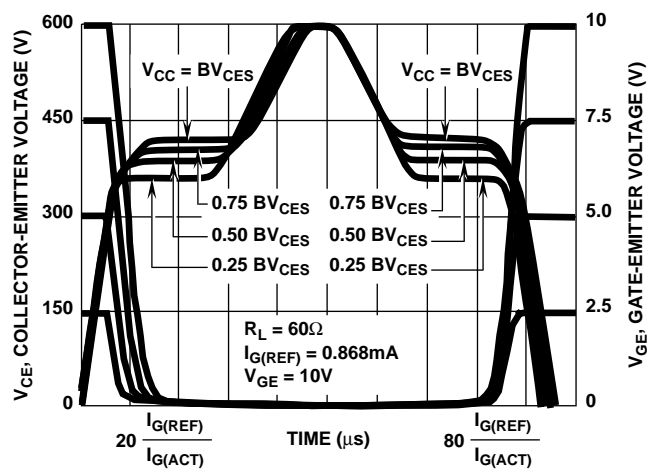

FIGURE 6. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT. (REFER TO APPLICATION NOTES AN7254 AND AN7260)
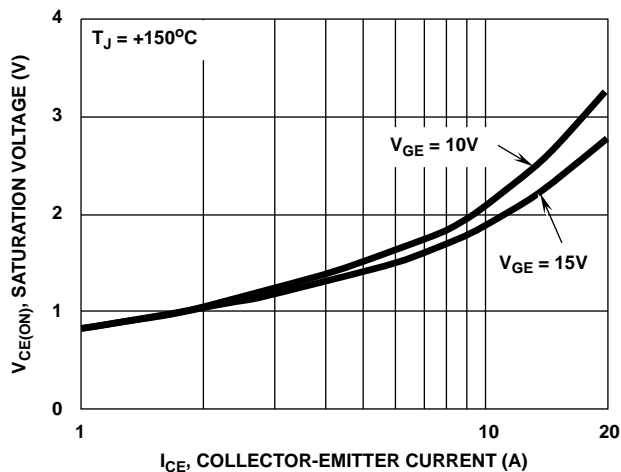

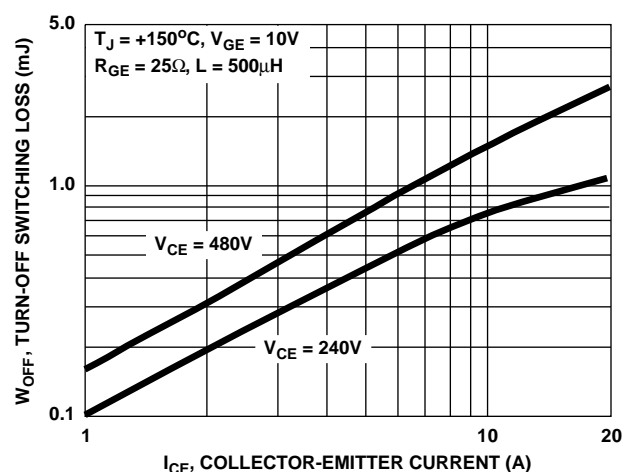FIGURE 7. SATURATION VOLTAGE vs COLLECTOR-EMITTER CURRENT

FIGURE 8. TURN-OFF SWITCHING LOSS vs COLLECTOR-EMITTER CURRENT
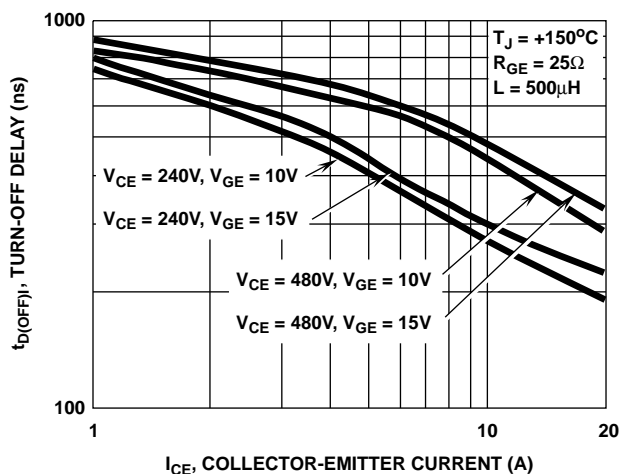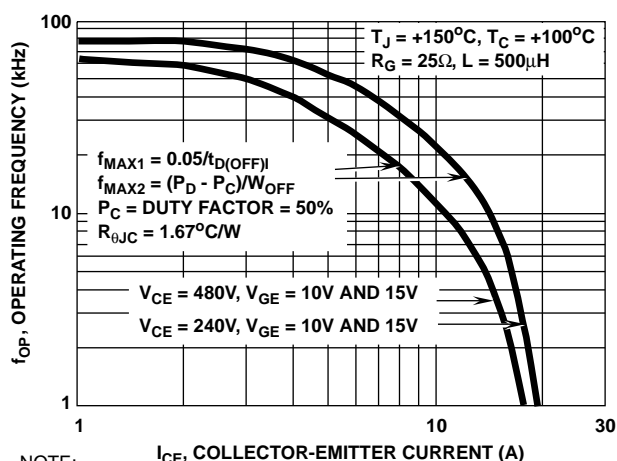
Typical Performance Curves (Continued)

FIGURE 9. TURN-OFF DELAY vs COLLECTOR-EMITTER CURRENT

NOTE:
P_D = ALLOWABLE DISSIPATION P_C = CONDUCTION DISSIPATION

FIGURE 10. OPERATING FREQUENCY vs COLLECTOR-EMITTER CURRENT AND VOLTAGE

Operating Frequency Information

Operating frequency information for a typical device (Figure 10) 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 7, 8 and 9. The operating frequency plot (Figure 10) 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} = $0.05/t_{D(OFF)I}$. $t_{D(OFF)I}$ deadtime (the denominator) has been arbitrarily held to 10% of the on-state time for a 50% duty factor. Other definitions are possible. $t_{D(OFF)I}$ is defined as the time between the 90% point of the trailing edge of the input pulse and the point where the collector current falls to 90% of its maximum value. Device

turn-off delay can establish an additional frequency limiting condition for an application other than T_{JMAX}. $t_{D(OFF)I}$ is important when controlling output ripple under a lightly loaded condition.

f_{MAX2} is defined by f_{MAX2} = $(P_D - P_C)/W_{OFF}$. The allowable dissipation (P_D) is defined by P_D = $(T_{JMAX} - T_C)/R_{\theta JC}$. The sum of device switching and conduction losses must not exceed P_D. A 50% duty factor was used (Figure 10) and the conduction losses (P_C) are approximated by P_C = $(V_{CE} \bullet I_{CE})/2$. W_{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} = 0A).

The switching power loss (Figure 10) is defined as $f_{MAX2} \bullet W_{OFF}$. Turn-on switching losses are not included because they can be greatly influenced by external circuit conditions and components.