

April 1995

5A, 400V and 500V N-Channel IGBTs

### Features

- 5A, 400V and 500V
- $V_{CE(ON)}$  2V
- $T_{FI}$  1 $\mu$ s, 0.5 $\mu$ s
- Low On-State Voltage
- Fast Switching Speeds
- High Input Impedance

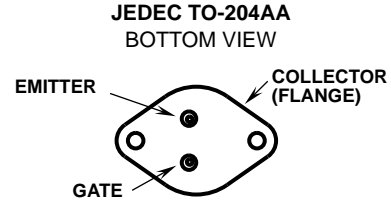
### Applications

- Power Supplies
- Motor Drives
- Protection Circuits

### Description

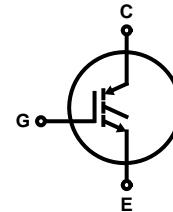
The 2N6975, 2N6976, 2N6977 and the 2N6978 are n-channel enhancement-mode insulated gate bipolar transistors (IGBTs) designed for high-voltage, low on-dissipation applications such as switching regulators and motor drivers. These types can be operated directly from low-power integrated circuits.

### Package



### Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



### PACKAGING AVAILABILITY

PART NUMBER	PACKAGE	BRAND
2N6975	TO-204AA	
2N6976	TO-204AA	
2N6977	TO-204AA	
2N6978	TO-204AA	

NOTE: When ordering, use the entire part number.

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

	2N6975/2N6977 (Note 1)	2N6976/2N6978 (Note 1)	UNITS
Collector-Emitter Voltage . . . . .	$V_{CES}$ 400	500	V
Collector-Gate Voltage ( $R_{GE} = 1M\Omega$ ) . . . . .	$V_{CGR}$ 400	500	V
Reverse Collector-Emitter Voltage . . . . .	$V_{CES(REV.)}$ 5	5	V
Gate-Emitter Voltage . . . . .	$V_{GE}$ $\pm 20$	$\pm 20$	V
Collector Current Continuous . . . . .	$I_C$ 5	5	A
Collector Current Pulsed . . . . .	$I_{CM}$ 10	10	A
Power Dissipation Total at $T_C = +25^\circ\text{C}$ . . . . .	$P_D$ 100	100	W
Power Dissipation Derating $T_C > +25^\circ\text{C}$ . . . . .	0.8	0.8	W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range . . . . .	$T_J, T_{STG}$ -55 to +150	-55 to +150	$^\circ\text{C}$

NOTE:

1. JEDEC registered value.

### 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 2N6975, 2N6976, 2N6977, 2N6978

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

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS
			2N6975/2N6977		2N6976/2N6978		
			MIN	MAX	MIN	MAX	
Collector-Emitter Breakdown Voltage	$BV_{CES}$	$I_C = 1\text{ mA}, V_{GE} = 0$	400 (Note 1)	-°	500 (Note 1)	-	V
Gate Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}, I_C = 1\text{ mA}$	2° (Note 1)	4.5 (Note 1)	2 (Note 1)	4.5° (Note 1)	V
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{CE} = 400\text{ V}$	-	250 (Note 1)	-	-	$\mu\text{A}$
		$V_{CE} = 500\text{ V}$	-	-	-	250 (Note 1)	$\mu\text{A}$
		$T_C = +125^\circ\text{C}$	-	-	-	-	$\mu\text{A}$
		$V_{CE} = 400\text{ V}$	-	°1000 (Note 1)	-	-	$\mu\text{A}$
		$V_{CE} = 500\text{ V}$	-	-	-	1000 (Note 1)	$\mu\text{A}$
Gate-Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}, V_{CE} = 0\text{ V}$	-	100 (Note 1)	-	100 (Note 1)	ns
Reverse Collector-Emitter Leakage Current	$I_{ECS}$	$R_{GE} = 0\Omega, V_{EC} = 5\text{ V}$	-	5 (Note 1)	-	5 (Note 1)	mA
Collector-Emitter On Voltage	$V_{CE(ON)}$	$I_C = 5\text{ A}, V_{GE} = 10\text{ V}$	-	2 (Note 1)	-	2 (Note 1)	V
		$I_C = 10\text{ A}, V_{GE} = 20\text{ V}$	-	2.5	-	2.5	V
Gate-Emitter Plateau Voltage	$V_{GEP}$	$I_C = 5\text{ A}, V_{CE} = 10\text{ V}$	3.4 (Note 1)	6.8 (Note 1)	3.4 (Note 1)	6.8 (Note 1)	V
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 5\text{ A}, V_{CE} = 10\text{ V}$	12 (Note 1)	25 (Note 1)	12 (Note 1)	25 (Note 1)	nC
Turn-On Delay Time	$t_{D(ON)}$	$I_C = 5\text{ A}$ $V_{CE(CLIP)} = 300\text{ V}$ $L = 50\mu\text{H}$ $T_J = +125^\circ\text{C}$ $V_{GE} = 10\text{ V}$ $R_G = 50\Omega$	50 Max				ns
Rise Time	$t_R$		50 Max				ns
Turn-Off Delay Time	$t_{D(OFF)}$		400 Max (Note 1)				ns
Fall Time	$t_{FI}$		2N6975 2N6976	1000 Max (Note 1)			ns
		2N6977 2N6978	500 Max (Note 1)			ns	
Turn-Off Energy Loss per Cycle (Off Switching Dissipation= $W_{OFF} \times \text{Frequency}$ )	$W_{OFF}$	2N6975 2N6976	1000 Max (Note 1)			$\mu\text{J}$	
		2N6977 2N6978	500 Max (Note 1)			$\mu\text{J}$	
Thermal Resistance Junction-to-Case	$R_{\theta JC}$		1.25 (Note 1)				$^\circ\text{C/W}$

NOTE:

1. JEDEC registered value.

Typical Performance Curves

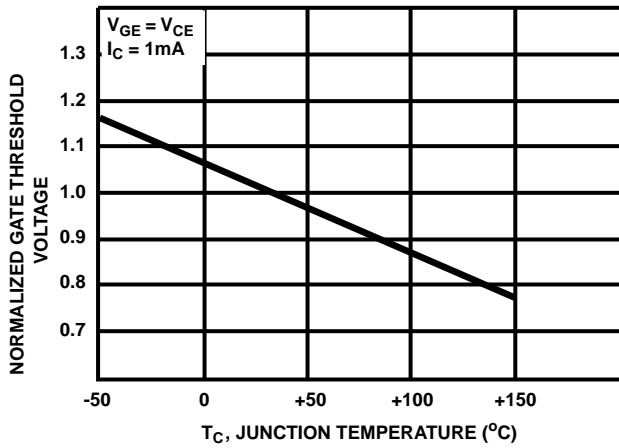


FIGURE 1. TYPICAL NORMALIZED GATE THRESHOLD VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE FOR ALL TYPES

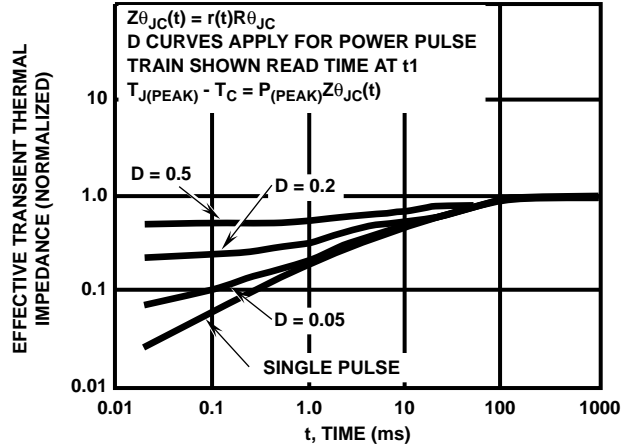


FIGURE 2. NORMALIZED THERMAL RESPONSE CHARACTERISTICS FOR ALL TYPES

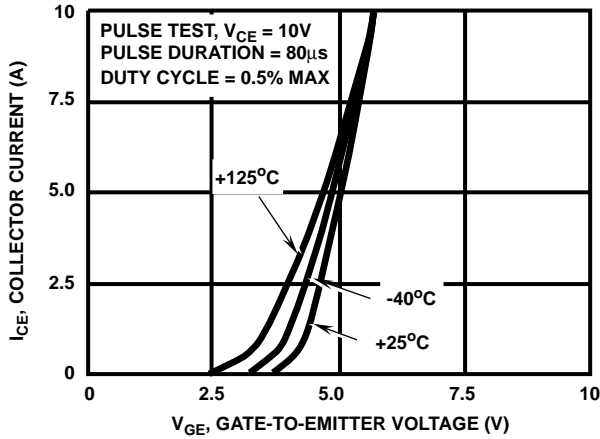


FIGURE 3. TYPICAL TRANSFER CHARACTERISTICS FOR ALL TYPES

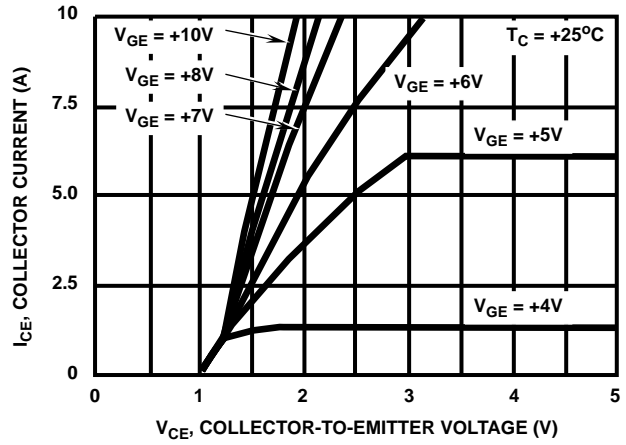


FIGURE 4. TYPICAL SATURATION CHARACTERISTICS FOR ALL TYPES

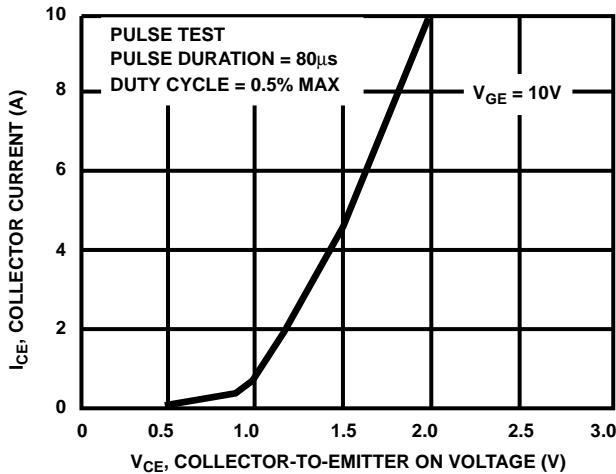


FIGURE 5. TYPICAL COLLECTOR-TO-EMITTER ON-VOLTAGE AS A FUNCTION OF COLLECTOR CURRENT FOR ALL TYPES

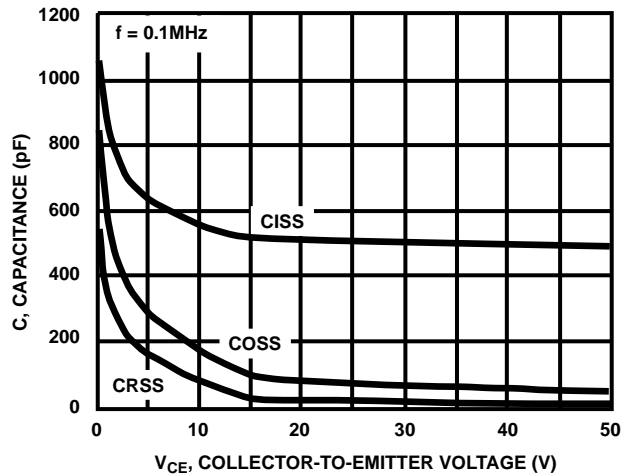


FIGURE 6. CAPACITANCE AS A FUNCTION OF COLLECTOR-TO-EMITTER VOLTAGE FOR ALL TYPES

Typical Performance Curves (Continued)

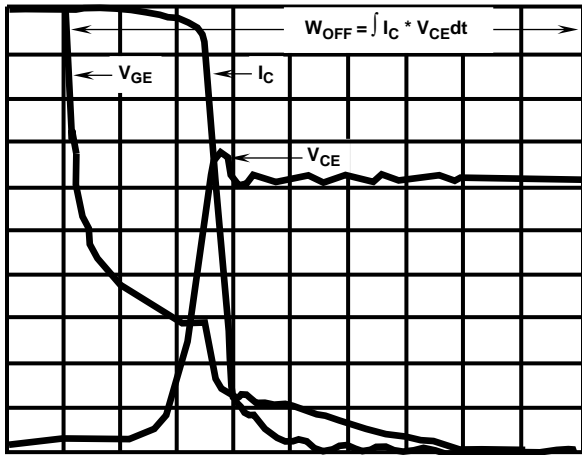
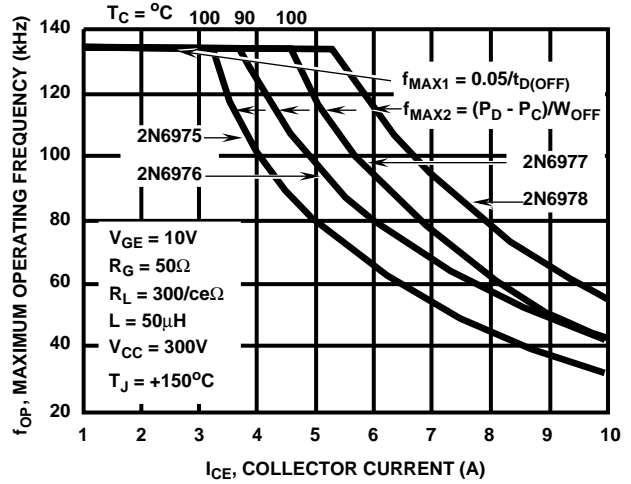


FIGURE 7. TYPICAL INDUCTIVE SWITCHING WAVEFORMS



$P_D$ : ALLOWABLE DISSIPATION  
 $P_C$ : CONDUCTION DISSIPATION

FIGURE 8. MAXIMUM OPERATING FREQUENCY vs COLLECTOR CURRENT (TYPICAL)

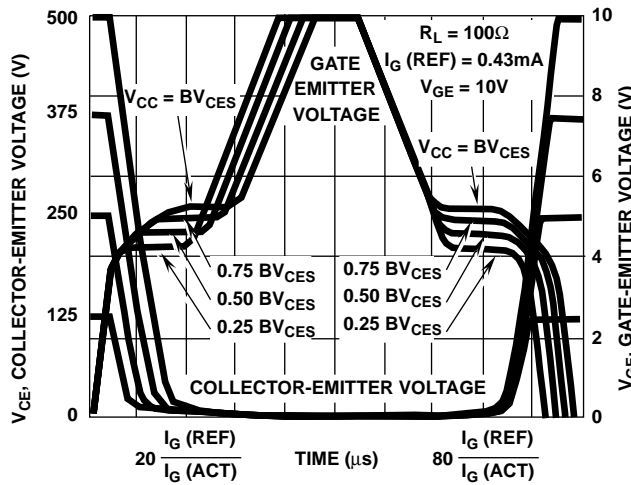


FIGURE 9. NORMALIZED SWITCHING WAVEFORMS AT CONSTANT GATE CURRENT (REFER TO APPLICATION NOTES AN7254 AND AN7260)

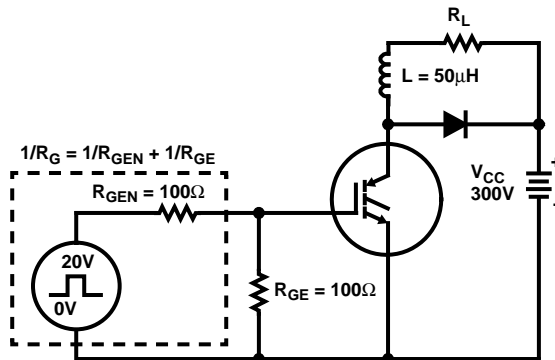


FIGURE 10. INDUCTIVE SWITCHING TEST CIRCUIT