April 1995

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

Features

- 5A, 400V and 500V
- $V_{CE(ON)}$ 2V
- T_{FI} 1µs, 0.5µs
- 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

JEDEC TO-204AA
BOTTOM VIEW

EMITTER

COLLECTOR (FLANGE)

GATE
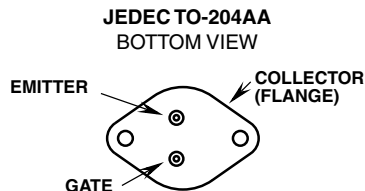
Terminal Diagram

N-CHANNEL ENHANCEMENT MODE

C

G

E
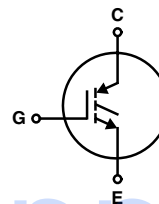
PACKAGING AVAILABILITY

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°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} = 1MΩ)	V_{CGR}	400	500	V
Reverse Collector-Emitter Voltage	$V_{CES(REV.)}$	5	5	V
Gate-Emitter Voltage	V_{GE}	±20	±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°C	P_D	100	100	W
Power Dissipation Derating T_C > +25°C		0.8	0.8	W/°C
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	°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							

Electrical Specifications $T_C = +25^oC$, Unless Otherwise Specified

PARAMETERS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS
			2N6975/2N6977		2N6976/2N6978		
			MIN	MAX	MIN	MAX	
Collector-Emitter Breakdown Voltage	BV_{CES}	$I_C = 1$ mA, $V_{GE} = 0$	400 (Note 1)	-∞	500 (Note 1)	-	V
Gate Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}$, $I_C = 1$mA	2∞ (Note 1)	4.5 (Note 1)	2 (Note 1)	4.5∞ (Note 1)	V
Zero Gate Voltage Collector Current	I_{CES}	$V_{CE} = 400$V	-	250 (Note 1)	-	-	μA
		$V_{CE} = 500$V	-	-	-	250 (Note 1)	μA
		$T_C = +125^oC$	-	-	-	-	μA
		$V_{CE} = 400$V	-	∞1000 (Note 1)	-	-	μA
		$V_{CE} = 500$V	-	-	-	1000 (Note 1)	μA
Gate-Emitter Leakage Current	I_{GES}	$V_{GE} = \pm20$V, $V_{CE} = 0$V	-	100 (Note 1)	-	100 (Note 1)	ns
Reverse Collector-Emitter Leakage Current	I_{ECS}	$R_{GE} = 0\Omega$, $V_{EC} = 5$V	-	5 (Note 1)	-	5 (Note 1)	mA
Collector-Emitter On Voltage	$V_{CE(ON)}$	$I_C = 5$A, $V_{GE} = 10$V	-	2 (Note 1)	-	2 (Note 1)	V
		$I_C = 10$A, $V_{GE} = 20$V	-	2.5	-	2.5	V
Gate-Emitter Plateau Voltage	V_{GEP}	$I_C = 5$A, $V_{CE} = 10$V	3.4 (Note 1)	6.8 (Note 1)	3.4 (Note 1)	6.8 (Note 1)	V
On-State Gate Charge	$Q_{G(ON)}$	$I_C = 5$A, $V_{CE} = 10$V	12 (Note 1)	25 (Note 1)	12 (Note 1)	25 (Note 1)	nC
Turn-On Delay Time	$t_{D(ON)}$	$I_C = 5$A $V_{CE(CLP)} = 300$V $L = 50\mu H$ $T_J = +125^oC$ $V_{GE} = 10$V $R_G = 50\Omega$	50 Max				ns
Rise Time	t_R		50 Max				ns
Turn-Off Delay Time	$t_{D(ON)}$		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} x Frequency)	W_{OFF}	$I_C = 5$A $V_{CE(CLP)} = 300$V $L = 50\mu H$ $T_J = +125^oC$ $V_{GE} = 10$V $R_G = 50\Omega$	2N6975 2N6976	1000 Max (Note 1)			μJ
			2N6977 2N6978	500 Max (Note 1)			μJ
Thermal Resistance Junction-to-Case	$R_{\theta JC}$		1.25 (Note 1)				$^oC/W$

NOTE:

1. JEDEC registered value.

2N6975, 2N6976, 2N6977, 2N6978
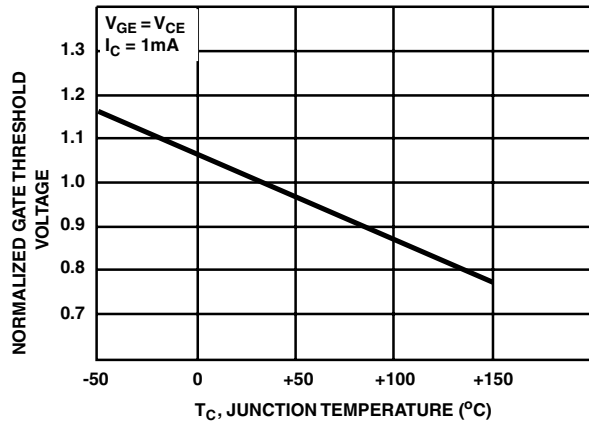
Typical Performance Curves

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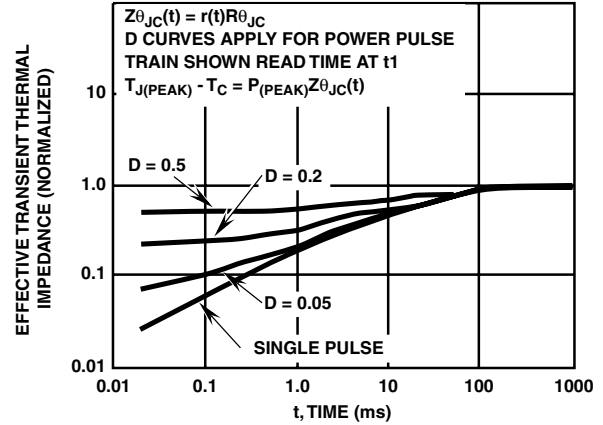

FIGURE 2. NORMALIZED THERMAL RESPONSE CHARACTERISTICS FOR ALL TYPES
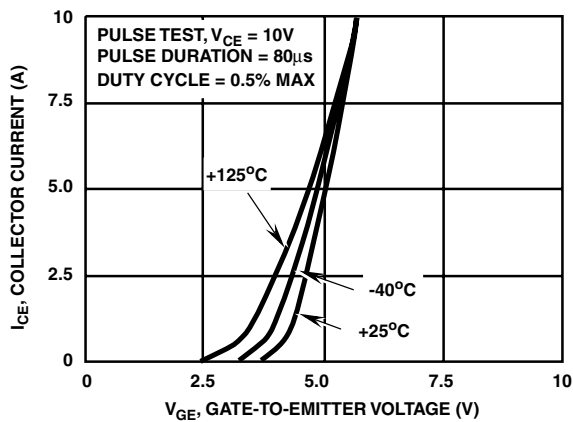

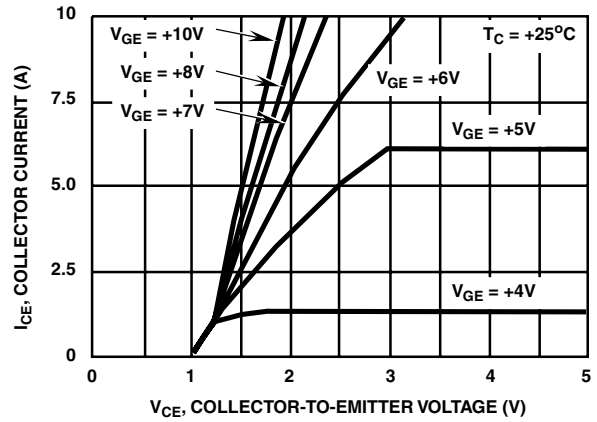FIGURE 3. TYPICAL TRANSFER CHARACTERISTICS FOR ALL TYPES

FIGURE 4. TYPICAL SATURATION CHARACTERISTICS FOR ALL TYPES
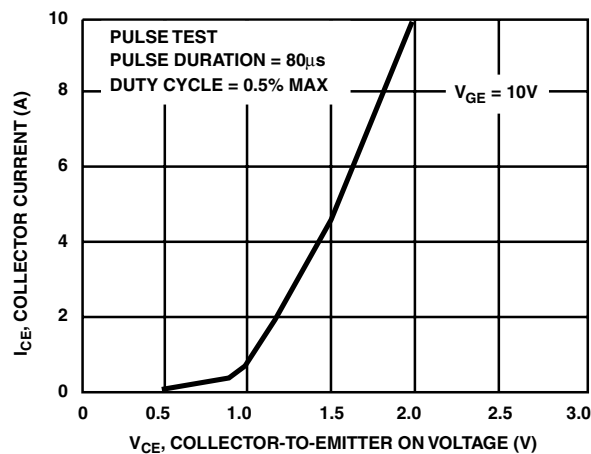
Typical Performance Curves (Continued)

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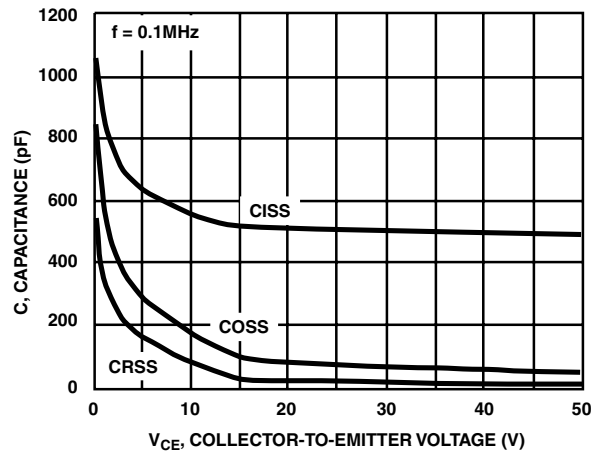

FIGURE 6. CAPACITANCE AS A FUNCTION OF COLLECTOR-TO-EMITTER VOLTAGE FOR ALL TYPES
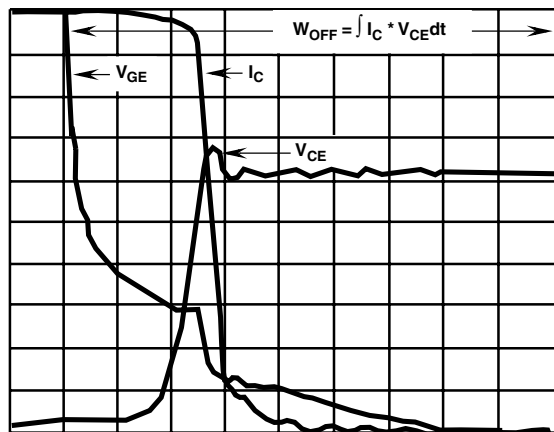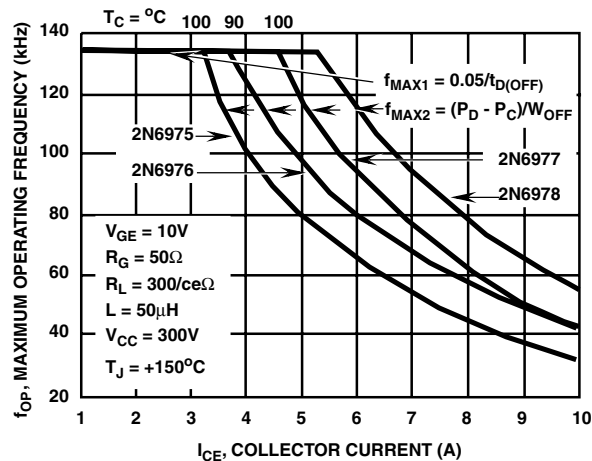

FIGURE 7. TYPICAL INDUCTIVE SWITCHING WAVEFORMS

P_D: ALLOWABLE DISSIPATION
P_C: CONDUCTION DISSIPATION

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

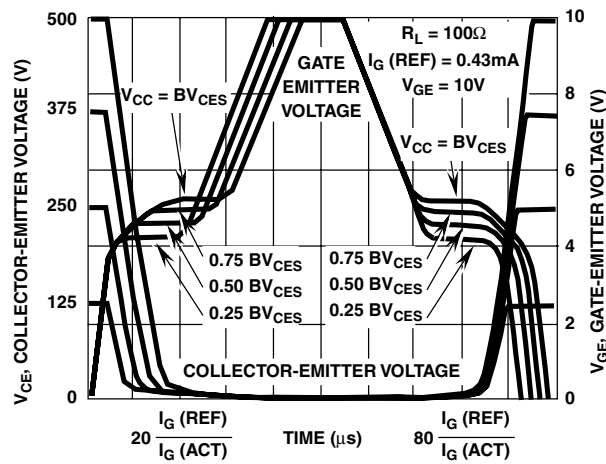## *Typical Performance Curves* (Continued)

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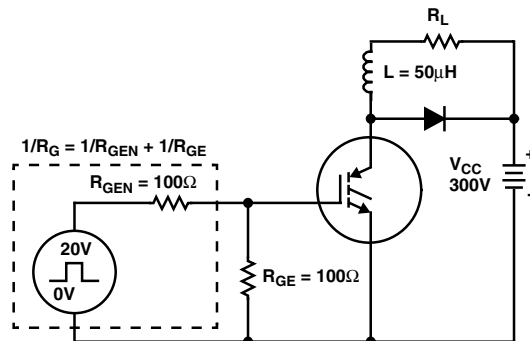(REFER TO APPLICATION NOTES AN7254 AND AN7260)**

FIGURE 10. INDUCTIVE SWITCHING TEST CIRCUIT

TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™	FAST ®	PACMAN™	SuperSOT™-3
Bottomless™	FASTr™	POP™	SuperSOT™-6
CoolFET™	GlobalOptoisolator™	PowerTrench ®	SuperSOT™-8
CROSSVOLT™	GTO™	QFET™	SyncFET™
DenseTrench™	HiSeC™	QS™	TinyLogic™
DOME™	ISOPLANAR™	QT Optoelectronics™	UHC™
EcoSPARK™	LittleFET™	Quiet Series™	UltraFET ®
E²CMOS™	MicroFET™	SILENT SWITCHER ®	VCX™
EnSigna™	MICROWIRE™	SMART START™	
FACT™	OPTOLOGIC™	Star* Power™	
FACT Quiet Series™	OPTOPLANAR™	Stealth™	

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.