2008-3

TOSHIBA
Leading Innovation >>>

PRODUCT GUIDE

Discrete IGBTs

s e m i c o n d u c t o r

http://www.semicon.toshiba.co.jp/eng

IGBT: Insulated Gate Bipolar Transistor

IGBTs combine the MOSFET advantage of high input impedance with the bipolar transistor advantage of high-voltage drive.
The conductivity modulation characteristics of a bipolar transistor make it ideal for load control applications that require high breakdown voltage and high current.
Toshiba offers a family of fast switching IGBTs, which are low in carrier injection and recombination in carrier.

Features of the Toshiba Discrete IGBTs

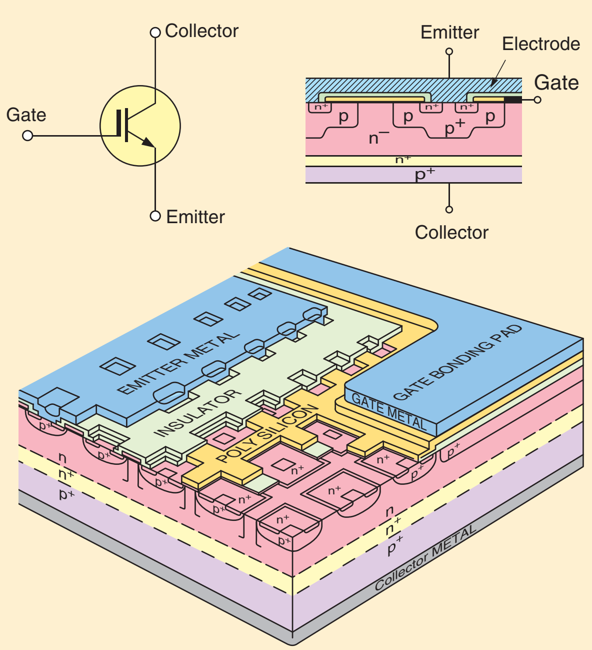
The Toshiba discrete IGBTs are available in high-voltage and high-current ratings. They are used in inverter and power conversion circuits for such diverse applications as motor drivers, uninterruptible power supply (UPS) systems, IH cookers, plasma display panels (PDPs), strobe flashes and so on.

(1) IGBTs also featuring fast switching
(2) Low collector-emitter saturation voltage even in the large current area
(3) IGBTs featuring a built-in diode with optimal characteristics tailored to specific applications
(4) High input impedance allows voltage drives
(5) Available in a variety of packages

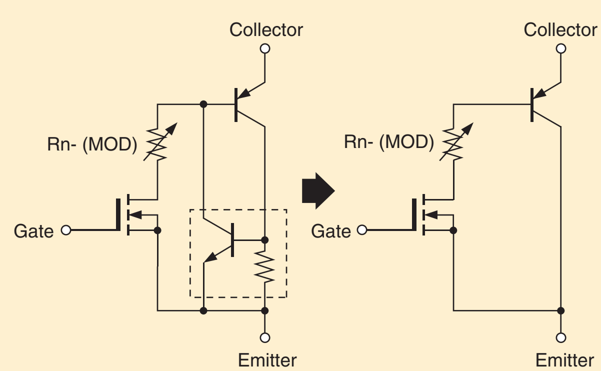
Construction

The basic structure of the planar IGBT consists of four layers (pnpn), as shown in the following figure. Low saturation voltage is achieved by using a pnp transistor to allow conductivity modulation during conduction. Unlike MOSFETs, the IGBT does not have an integral reverse diode, since the collector contact is made on the p^+ layer.

Planar Structure



Equivalent Circuit



2 IGBT Technical Overview

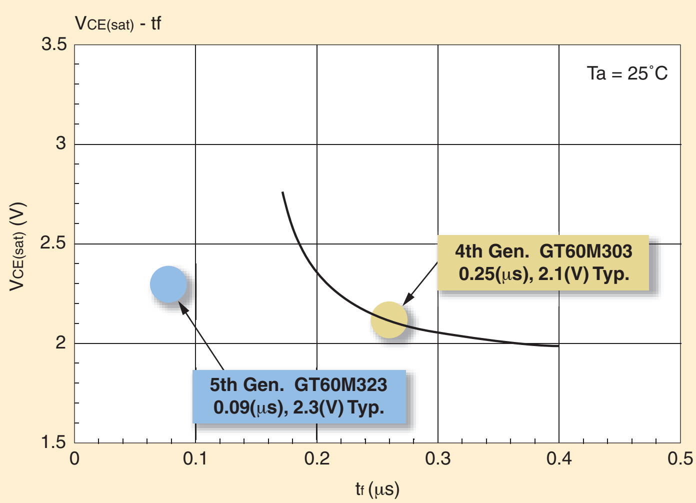
Prior to the development of IGBTs, power MOSFETs were used for power amplifier applications which require high input impedance and fast switching. However, at high voltages, the on-state resistance rapidly increases as the breakdown voltage increases. It is thus difficult to improve the conduction loss of power MOSFETs.

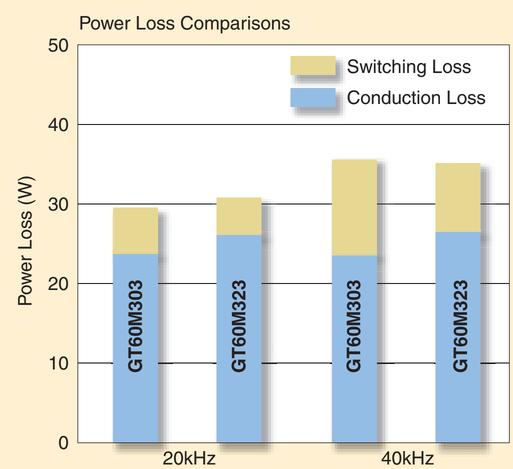
On the other hand, the IGBT structure consists of a PNP bipolar transistor and a collector contact made on the p^+ layer. The IGBT has a low on-state voltage drop due to conductivity modulation.

The following figure shows the $V_{CE(sat)}$ curve of a soft-switching 900-V IGBT. Toshiba has offered IGBTs featuring fast switching by using carrier lifetime control techniques. Now, Toshiba offers even faster IGBTs with optimized carrier injection into the collector Player.

In the future, Toshiba will launch IGBTs with varied characteristics optimized for high-current-conduction and high-frequency-switching applications. The improvements in IGBTs will be spurred by optimized wafers, smaller pattern geometries and improved carrier lifetime control techniques.

Soft-Switching 900-V IGBT (Example: GT60M303 vs. GT60M323)





■ Simulation conditions
I_{CP} = 60 A, V_{CEP} = 750 V, R_G = 10 Ω(during turn-off)
V_{GE} = 18 V, Tj = 125°C, typical components used

Discrete IGBT Development Trends

1200
- (1) High V_{CES} (3rd gen): Low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and thinner wafers
- (3) High ruggedness (next gen): Thinner wafers and finer process geometries
- (2) Soft switching (5th gen): Low $V_{CE(sat)}$ due to trench gate structure
- (4) Soft switching (next gen): Thinner wafers and finer process geometries

900 to 100 V
- (1) Soft switching (4th gen): Low $V_{CE(sat)}$ due to trench gate structure
- (2) Soft switching (5th gen): Low $V_{CE(sat)}$ due to optimized carrier injection and trench gate structure
- (3) Soft switching (next gen): Thinner wafers and finer process geometries

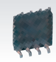
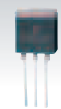
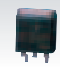
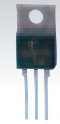
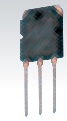
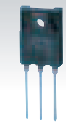
600V
- (1) High V_{CES} (3rd gen): Low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and thinner wafers
- (4) High ruggedness (next gen): Thinner wafers and finer process geometries
- (2) Fast switching (4th gen): High speedy tf due to optimized carrier injection
- (5) Fast switching (next gen): Thinner wafers and finer process geometries
- (3) Soft switching (4th gen): Low $V_{CE(sat)}$ due to trench gate structure
- (6) Soft switching (next gen): Thinner wafers and finer process geometries

400V
- (1) Strobe flashes (5th gen): Low $V_{CE(sat)}$ due to trench gate structure
- (2) Strobe flashes (6th gen): High current due to trench gate structure and optimized wafers
- (3) Strobe flashes (next gen): High current due to optimized wafers and finer process geometries

300 to 400 V
- (1) Plasma displays (4th gen): Low $V_{CE(sat)}$ due to trench gate structure and high I_C due to life time control
- (2) Plasma displays (4th gen): Improved transient performance due to Cu connector
- (3) Plasma displays (next gen): Dynamic $V_{CE(sat)}$ due to thinner wafers and finer process geometries

Year: 2006 → 2008 → 2010

3 Discrete IGBT Product List

Applications and Features	Breakdown Voltage V_{CES} (V) @Ta = 25˚C	IGBT Current Rating I_C (A) @Ta = 25˚C		TSSOP-8	SOP-8	TO-220NIS	TO-220SIS	TO-220FL	TO-220SM	TO-220AB	TO-3P(N)	TO-3P(N)IS	TO-3P(LH)
		DC	Pulsed										
General-purpose motors General-purpose inverters Hard switching fc: up to 20 kHz High V_{CES} Series	600	5	10			GT5J301			GT5J311				
		10	20			GT10J303			GT10J312		GT10J301		
		15	30			GT15J301			GT15J311				
		20	40								GT20J301 GT20J101		
		30	60								GT30J301 GT30J101		
		50	100										GT50J301 GT50J102
	1200	10	20								GT10Q301 GT10Q101		
		15	30								GT15Q301 GT15Q102		
		25	50										GT25Q301 GT25Q102
General-purpose inverters Fast switching Hard switching fc: up to 50 kHz FS series	600	10	20			GT10J321							
		15	30			GT15J321							
		20	40			GT20J321							
		30	60								GT30J324 GT30J121		
		50	100										GT50J325 GT50J121
General-purpose inverters Low-$V_{CE(sat)}$ IGBT	600	15	30						GT15J331				
Resonant switching Soft switching Soft-Switching Series	400	40	100										
		50	100							GT40G121			GT50G321
	600	30	100									GT30J322	
		37	100									GT35J321	
		40	100								GT40J321 GT40J322		
		50	100								GT50J327 GT50J328		GT50J322 GT50J322H
			120								GT50J122		
		60	120										GT60J321 GT60J323 GT60J323H
		80	160										GT80J101B
	900	15	30									GT15M321	
		50	120								GT50M322		
		60	120										GT60M303 GT60M323
	1000	50	120								GT50N322A		
		57	120										GT60N322
		60	120										GT60N321
	1050	60	120										GT60N323
	1200	42	80								GT40Q321		
PFC	600	30	100									GT30J122	
Strobe flashes	400		130		GT5G131								
			150	GT8G133 GT8G134 GT8G136	GT8G132								
			200										
Plasma display panels	300		120	GT10G131			GF30F122						
			200				GT45F122 GT45F123 GT45F124						
	400		120				GT30G122						
			200				GT45G122 GT45G123 GT45G124						

4 Part Numbering Scheme

Example **GT 60 M 3 03 A**

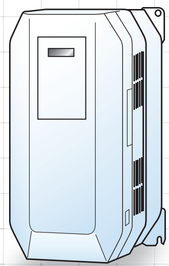
- A: Version
- 03: Serial number
- 3: 1: N-channel 2: P-channel 3: N-channel with built-in freewheeling diode
- M: Voltage rating (see Table 1.)
- 60: Collector current rating (DC)
- GT: Discrete IGBT

Table 1

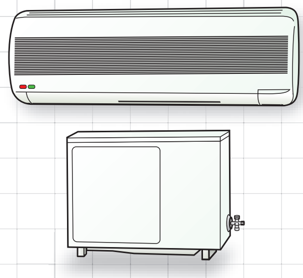
Letter	Voltage (V)	Letter	Voltage (V)	Letter	Voltage (V)
C	150	J	600	Q	1200
D	200	K	700	R	1300
E	250	L	800	S	1400
F	300	M	900	T	1500
G	400	N	1000	U	1600
H	500	P	1100	V	1700

The fast-switching (FS) series, a new addition to our third-generation IGBTs, features high ruggedness which helps to improve the energy efficiency of electronic equipment.

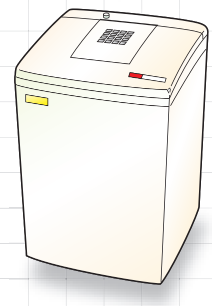
General-Purpose Inverters



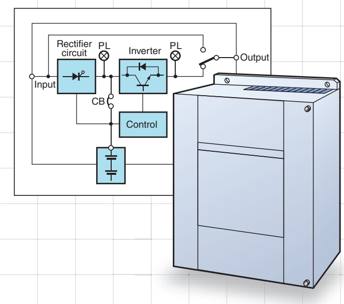
Inverter Air Conditioners



Inverter Washing Machines



UPS

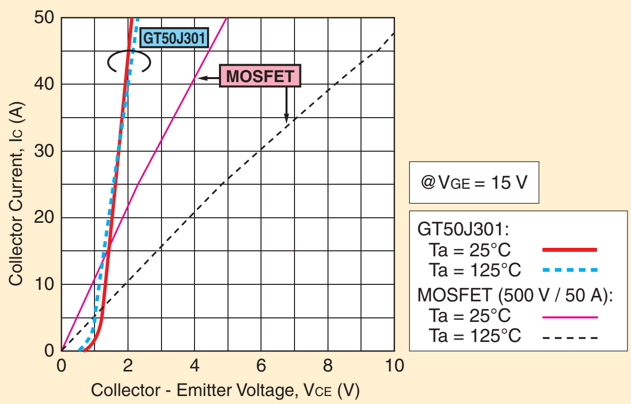


For general-purpose inverters — Discrete IGBT Trend

Our 3rd generation low-loss and low-noise IGBTs are ideal for inverter applications to reduce switching loss and thus improve energy efficiency. The following graphs compare the thermal and turn-on characteristics of our 3rd generation IGBTs and 500-V MOSFETs

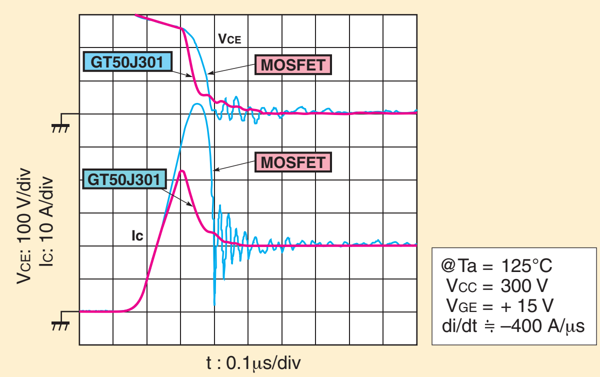
Ic - VCE Temperature Characteristics

Low saturation voltage with minimal temperature dependence



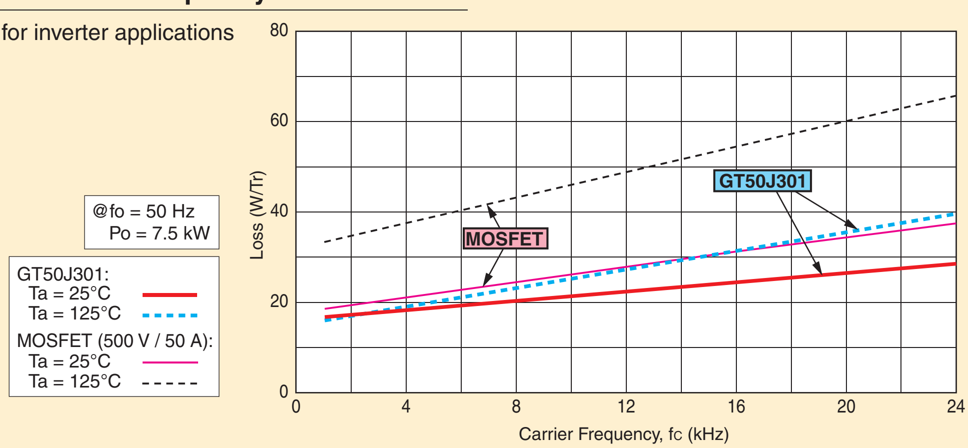
Turn-On Waveform

Fast reverse-recovery characteristics due to built-in diode with optimal characteristics



Power Loss vs. Carrier Frequency Characteristics

Simulation data for inverter applications

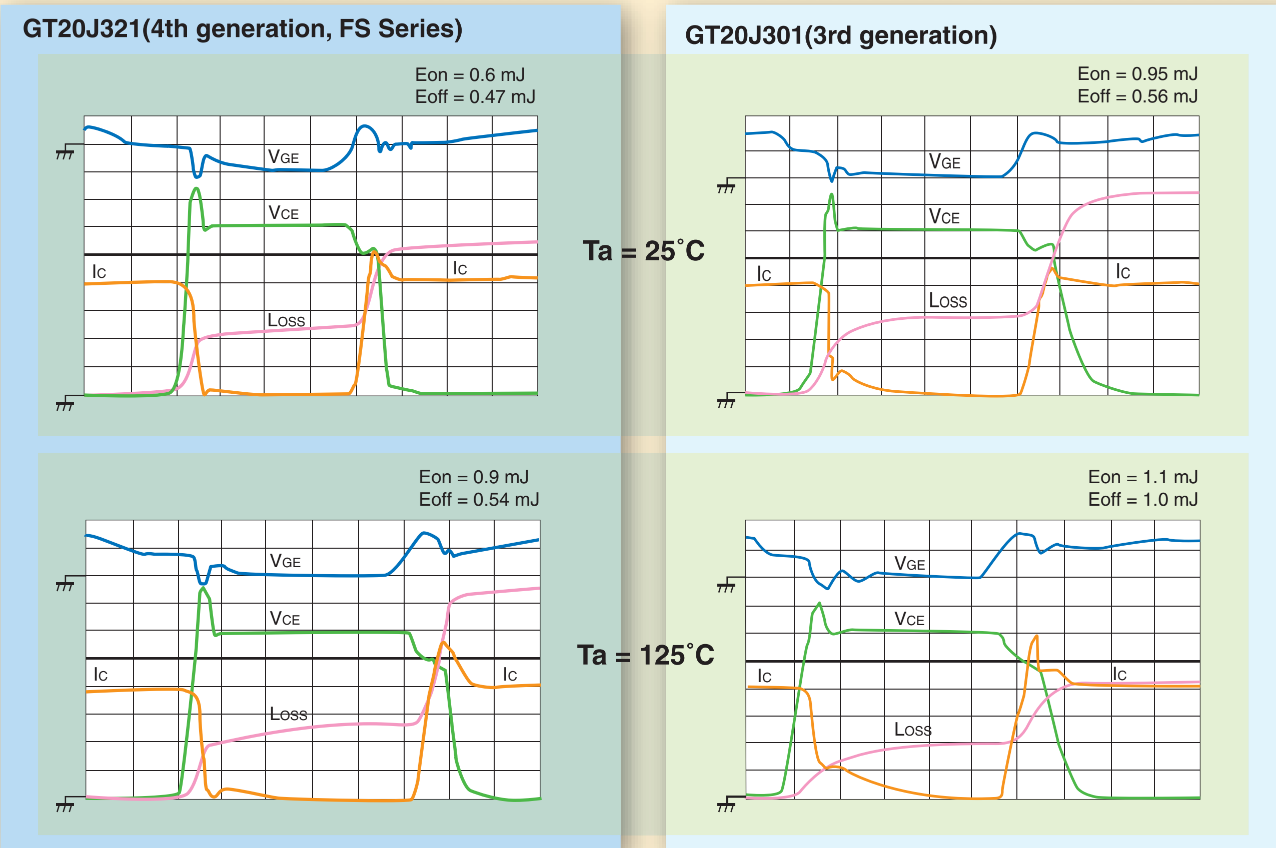


For general-purpose inverters

Fast-Switching (FS) Series

Compared to the third-generation highly rugged series, the FS series is optimized for switching speed, reducing the total switching loss (Eon + Eoff) by 30% (according to Toshiba's comparative test).

Typical Waveforms



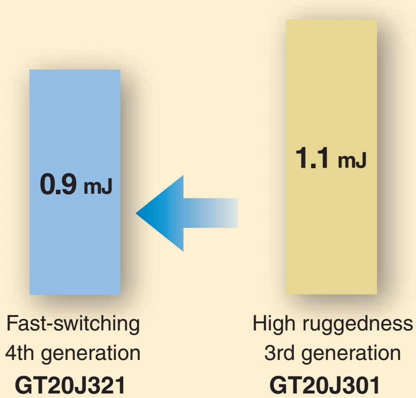
(LOSS: 0.5 mJ/div)

(V_{CE}: 50 V/div, I_C: 5 A/div, V_{GE}: 10 V/div, LOSS: 0.2 mJ/div, t: 0.2 μs/div)

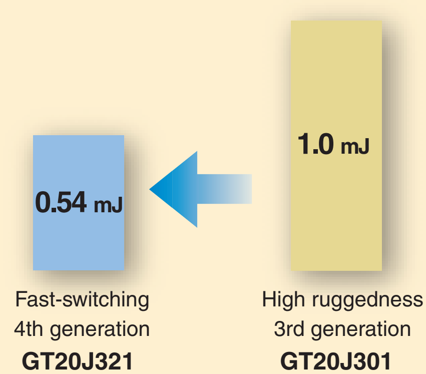
Reduced switching loss of fast-switching IGBTs in comparison with high ruggedness IGBTs

Test condition: I_C = 20 A, V_{GE} = 15 V, R_G = 33 Ω, Ta = 125˚C, with inductive load, V_{CC} = 300 V

Turn-On Loss



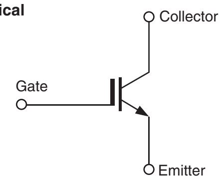
Turn-Off Loss



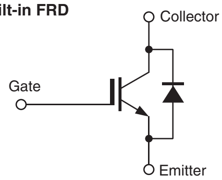
Product List

Circuit Configurations

Typical



Built-in FRD



600-V and 1200-V IGBTs (3rd Generation)

Main Applications	Features	Part Number	Absolute Maximum Ratings VCES (V)	Ic DC (A)	Ic Pulsed (A)	Pc Tc = 25°C (W)	Package	Type	Circuit Configuration (✻1)	VCE(sat) Typ. (V)	@Ic (A)	@VGE (V)	tf Typ. (µs)	Load (✻2)	Remarks
Motor driving (UPS/PFC)	High VCES (1200V)	GT10Q101	1200	10	20	140	TO-3P(N)	-	◆	2.1	10	15	0.16	L	
		GT10Q301	1200	10	20	140	TO-3P(N)	-	Built-in FRD	2.1	10	15	0.16	L	
		GT15Q102	1200	15	30	170	TO-3P(N)	-	◆	2.1	15	15	0.16	L	
		GT15Q301	1200	15	30	170	TO-3P(N)	-	Built-in FRD	2.1	15	15	0.16	L	
		GT25Q102	1200	25	50	200	TO-3P(LH)	-	◆	2.1	25	15	0.16	L	
		GT25Q301	1200	25	50	200	TO-3P(LH)	-	Built-in FRD	2.1	25	15	0.16	L	
	High VCES (600V)	GT5J301	600	5	10	28	TO-220NIS	-	Built-in FRD	2.1	5	15	0.15	L	
		GT5J311	600	5	10	45	TO-220SM	SMD	Built-in FRD	2.1	5	15	0.15	L	
		GT10J301	600	10	20	90	TO-3P(N)	-	Built-in FRD	2.1	10	15	0.15	L	
		GT10J303	600	10	20	30	TO-220NIS	-	Built-in FRD	2.1	10	15	0.15	L	
		GT10J312	600	10	20	60	TO-220SM	SMD	Built-in FRD	2.1	10	15	0.15	L	
		GT15J301	600	15	30	35	TO-220NIS	-	Built-in FRD	2.1	15	15	0.15	L	
		GT15J311	600	15	30	70	TO-220FL	-	Built-in FRD	2.1	15	15	0.15	L	
		GT15J311	600	15	30	70	TO-220SM	SMD	Built-in FRD	2.1	15	15	0.15	L	
		GT20J101	600	20	40	130	TO-3P(N)	-	◆	2.1	20	15	0.15	L	
		GT20J301	600	20	40	130	TO-3P(N)	-	Built-in FRD	2.1	20	15	0.15	L	
		GT30J101	600	30	60	155	TO-3P(N)	-	◆	2.1	30	15	0.15	L	
		GT30J301	600	30	60	155	TO-3P(N)	-	Built-in FRD	2.1	30	15	0.15	L	
		GT50J102	600	50	100	200	TO-3P(LH)	-	◆	2.1	50	15	0.15	L	
		GT50J301	600	50	100	200	TO-3P(LH)	-	Built-in FRD	2.1	50	15	0.15	L	
Power factor correction	Low-frequency switching	GT30J122	600	30	100	75	TO-3P(N)IS	-	◆	2.1	50	15	0.25	R	Intended for partial-switch

600-V Fast-Switching IGBTs (4th Generation)

(FS: Fast Switching)

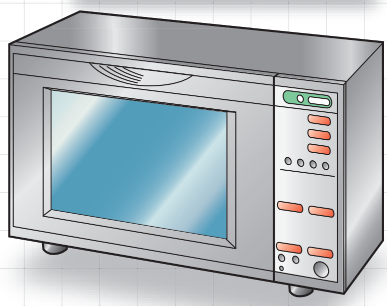
Main Applications	Features	Part Number	Absolute Maximum Ratings VCES (V)	Ic DC (A)	Ic Pulsed (A)	Pc Tc = 25°C (W)	Package	Type	Circuit Configuration (✻1)	VCE(sat) Typ. (V)	@Ic (A)	@VGE (V)	tf Typ. (µs)	Load (✻2)	Remarks
Inverter power supplies (UPS/PFC/motor)	Fast switching	GT10J321	600	10	20	29	TO-220NIS	-	Built-in FRD	2.0	10	15	0.05	L	
		GT15J321	600	15	30	30	TO-220NIS	-	Built-in FRD	1.9	15	15	0.03	L	
		GT15J331	600	15	30	70	TO-220SM	SMD	Built-in FRD	1.75	15	15	0.10	L	Low VCE(sat)
		GT20J321	600	20	40	45	TO-220NIS	-	Built-in FRD	2.0	20	15	0.04	L	
		GT30J121	600	30	60	170	TO-3P(N)	-	◆	2.0	30	15	0.05	L	
		GT30J324	600	30	60	170	TO-3P(N)	-	Built-in FRD	2.0	30	15	0.05	L	
		GT50J121	600	50	100	240	TO-3P(LH)	-	◆	2.0	50	15	0.05	L	
		GT50J325	600	50	100	240	TO-3P(LH)	-	Built-in FRD	2.0	50	15	0.05	L	

✻1 ◆ : Typical circuit configuration
✻2 R : Resistive load
L : Inductive load

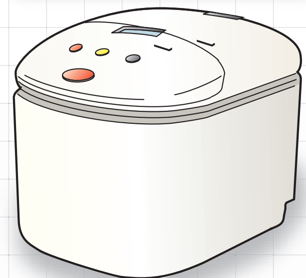
Soft-Switching Applications

Static inverters in IH cooktops, IH rice cookers and microwave ovens utilize a soft-switching technique which exhibits low switching loss. Toshiba offers IGBTs suitable for soft-switching applications.

Microwave Ovens

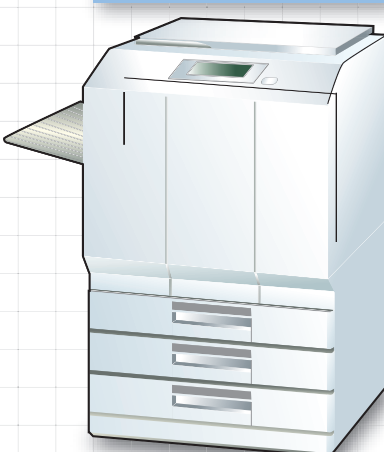


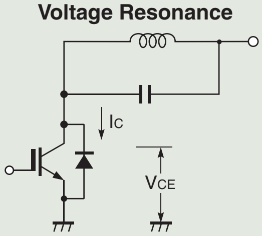
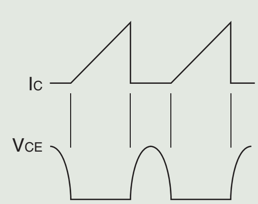
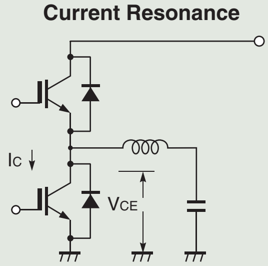
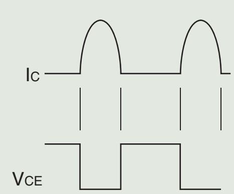
IH Rice Cookers



IH Cooktops

MFPs



<table>
<tr><th>AC Input Voltage</th><th colspan="2">Circuit</th><th>IGBT Rating</th></tr>
<tr><td>100 V to 120 V</td><td rowspan="2">Voltage Resonance

</td><td rowspan="2">Waveform

</td><td>V_{CES} = 900 V to 1050 V
I_C = 15 A to 60 A</td></tr>
<tr><td>200 V to 240 V</td><td>V_{CES} = 1200 V
I_C = 40 A</td></tr>
<tr><td rowspan="2">100 V to 240 V</td><td rowspan="2">Current Resonance

</td><td rowspan="2">Waveform

</td><td>V_{CES} = 400 V
I_C = 40 A to 50 A</td></tr>
<tr><td>V_{CES} = 600 V
I_C = 30 A to 80 A</td></tr>
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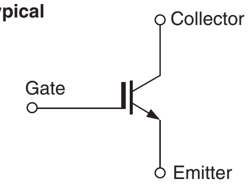
IH: Induction heating
MFP: Multifunction Printer

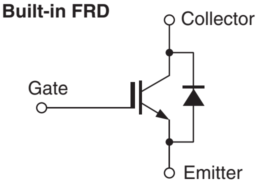
Product List

Circuit Configurations

Typical



Built-in FRD



■ IGBTs for Soft-Switching Applications

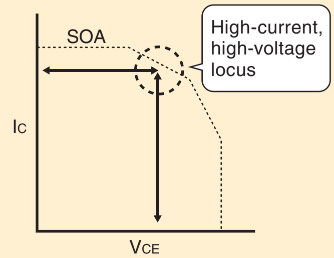
Main Applications		Features	Part Number	Absolute Maximum Ratings V_{CES} (V)	I_C DC (A)	I_C Pulsed (A)	P_C T_c = 25°C (W)	Package	Circuit Configuration (✻1)	$V_{CE(sat)}$ Typ. (V)	@I_C (A)	@V_{GE} (V)	t_f Typ. (µs)	Load (✻2)	Remarks
IH rice cookers and IH cooktops	AC 100 V	Current resonance	**GT40G121**	400	40	80	100	TO-220AB	◆	1.8	40	15	0.30		
			GT50G321		50	100	130	TO-3P(LH)		1.8	50	15	0.30		
	AC 200 V		**GT30J322**	600	30	60	75	TO-3P(N)IS		2.1	50	15	0.25		
			GT35J321		37	100	75			1.9	50	15	0.19		
			GT40J321		40	100	110	TO-3P(N)		2.1	40	15	0.15		Fast switching
			GT40J322		40	100	110			2.0	40	15	0.24		
			GT50J322		50	100	130	TO-3P(LH)	Built-in FRD	2.1	50	15	0.25		
			GT50J322H		50	100	130			2.2	50	15	0.16		Fast switching
			GT50J327		50	100	140	TO-3P(N)		1.9	50	15	0.19		
			GT50J328		50	120	140			2.0	50	15	0.10		Fast switching
			GT60J321		60	120	200	TO-3P(LH)		1.55	60	15	0.30		
			GT60J323		60	120	170			1.9	60	15	0.16	R	
			GT60J323H		60	120	170			2.1	60	15	0.12		Fast switching
	AC 100 V	Voltage resonance	**GT15M321**	900	15	30	55	TO-3P(N)IS		1.8	15	15	0.20		
			GT50M322		50	120	156	TO-3P(N)		2.1	60	15	0.25		
			GT60M303		60	120	170	TO-3P(LH)		2.1	60	15	0.25		
			GT60M323		60	120	200			2.3	60	15	0.09		Fast switching
	AC 100 V-120 V		**GT50N321**	1000	50	120	156	TO-3P(N)	Built-in FWD	2.5	60	15	0.25		
			GT50N322A		50	120	156			2.2	60	15	0.10		Fast switching
			GT60N321		60	120	170			2.3	60	15	0.25		
			GT60N322		57	120	200	TO-3P(LH)		2.4	40	15	0.11		Fast switching
			GT60N323	1050	60	120	190			2.6	60	15	0.22		
	AC 200 V		**GT40Q321**	1200	40	80	170	TO-3P(N)		2.8	60	15	0.41		

✻1 ◆: Typical circuit configuration
✻2 R: Resistive load
L: Inductive load
FRD: Fast Recovery Diode
FWD: Free Wheeling Diode

5-2 Soft-Switching Applications

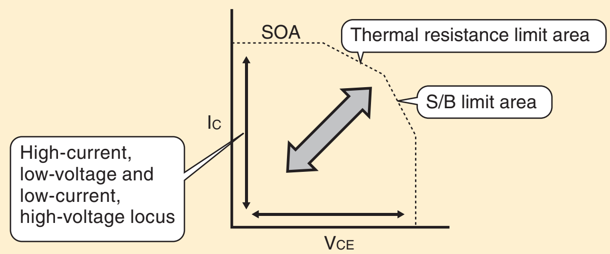
Comparisons Between Hard and Soft Switching (diagrams shown only as a guide)

Hard Switching

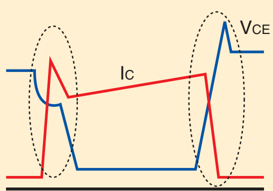


SOA Locus for Hard Switching

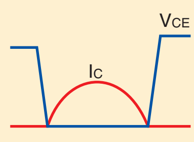
Soft Switching



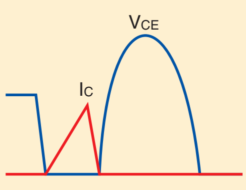
SOA Locus for Soft Switching



Switching Characteristics (Example)



Current Resonance (Example)



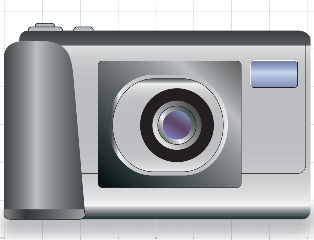
Voltage Resonance (Example)

5-3 Strobe Flash Applications

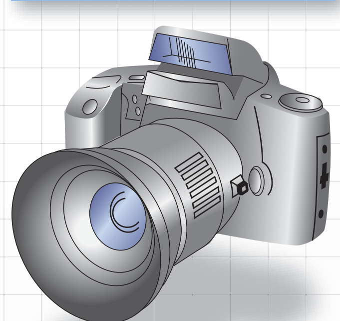
Strobe flash control is now prevalent in digital still cameras. Package sizes are getting smaller, and logic levels are increasingly used to represent the gate drive voltage. Toshiba offers compact IGBTs featuring low gate drive voltage.

- As a voltage-controlled device, the IGBT requires only a few components for drive circuitry.
- IGBTs require fewer components for the strobe flash circuit (compared to SCRs).
- Strobe flash IGBTs are capable of switching large currents.

DSC, Compact Camera



Single-Lens Reflex Camera



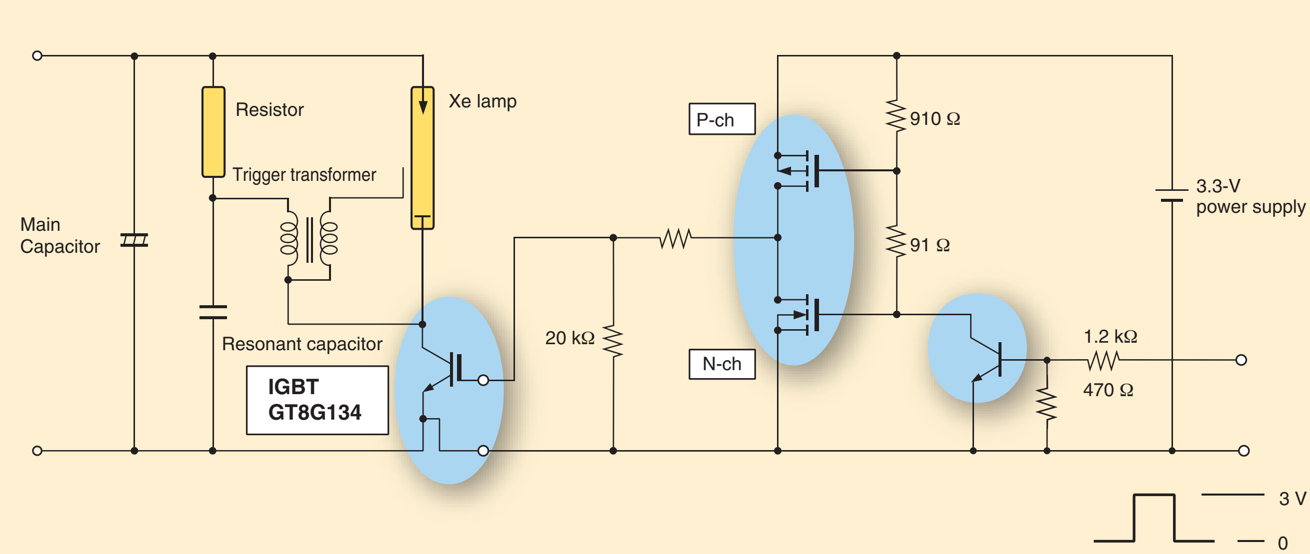
For strobe flashes

Product List

2.5-V to 4.0-V Gate Drive Series

The IGBT can operate with a gate drive voltage of 2.5 V to 4.0 V. The common 3.3-V or 5-V internal power supply in a camera can be used as a gate drive power supply to simplify the power supply circuitry. A zener diode is included between the gate and emitter to provide ESD surge protection.

Example of an IGBT Gate Drive Circuit (3.3-V Power Supply)



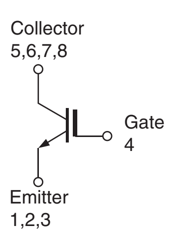
3.3-V Power Supply

Part Number	V_{CES} / I_C	$V_{CE(sat)}$ typ. (V)	$V_{CE(sat)}$ typ. V_{GE} / I_C	P_C (W) @Ta = 25˚C	Package	Remarks
GT8G136	400 V / 150 A	3.5	3 V / 150 A	1.0	**TSSOP-8**[*2]	5th generation
GT8G134	400 V / 150 A	3.4	2.5 V / 150 A	1.1	**TSSOP-8**[*2]	6th generation

5-V Power Supply

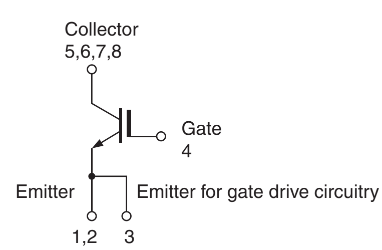
Part Number	V_{CES} / I_C	$V_{CE(sat)}$ typ. (V)	$V_{CE(sat)}$ typ. V_{GE} / I_C	P_C (W) @Ta = 25˚C	Package	Remarks
GT8G132	400 V / 150 A	2.3	4.0 V / 150 A	1.1	**SOP-8**[*1]	5th generation
GT8G133	400 V / 150 A	2.9	4.0 V / 150 A	1.1	**TSSOP-8**[*1]	5th generation
GT10G131	400 V / 200 A	2.3	4.0 V / 200 A	1.9	**SOP-8**[*1]	5th generation

*1: Board connection example



All the emitter terminals should be connected together.

*2: Board connection example

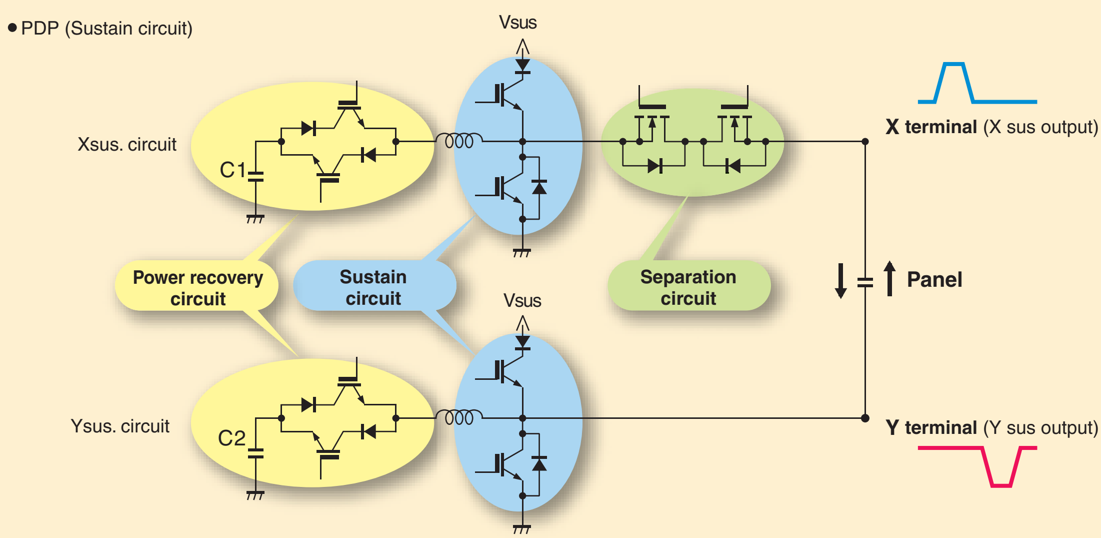


Plasma Display Panel Applications

Plasma Displays

Parallel MOSFETs have been used for the drive circuitry of plasma display panels (PDPs). Recently, however, IGBTs are commonly used in large current applications due to their superior current conduction capability.

Example of a Plasma Display Panel Power Supply



For plasma display panels — Product List

■ 300-V IGBTs

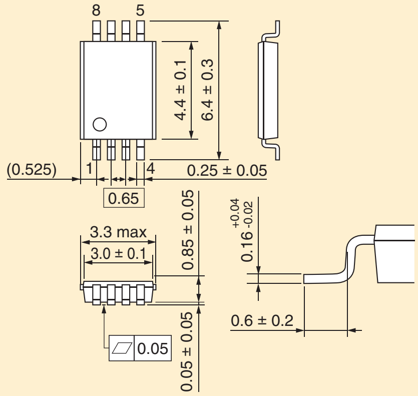
Part Number	V_{CES} / I_{cp} @100 μs	$V_{CE(sat)}$ Max (V)	Pc (W) @Ta = 25°C	Package	Remarks
GT30F122	300 V / 120 A	2.9 (@120 A)	25	**TO-220SIS**	
GT45F122	300 V / 200 A	2.7 (@120 A)	25	**TO-220SIS**	
GT45F123	300 V / 200 A	2.4 (@120 A)	26	**TO-220SIS**	
GT45F124	300 V / 200 A	2.1 (@120 A)	29	**TO-220SIS**	

■ 400-V IGBTs

Part Number	V_{CES} / I_{cp} @100 μs	$V_{CE(sat)}$ Max (V)	Pc (W) @Ta = 25°C	Package	Remarks
GT30G122	400 V / 120 A	2.6 (@120 A)	25	**TO-220SIS**	
GT45G122	400 V / 200 A	2.9 (@120 A)	25	**TO-220SIS**	
GT45G123	400 V / 200 A	2.6 (@120 A)	26	**TO-220SIS**	
GT45G124	400 V / 200 A	2.3 (@120 A)	29	**TO-220SIS**	

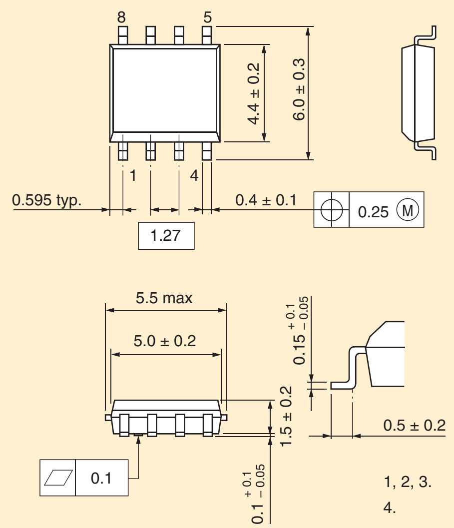
Unit: mm

TSSOP-8



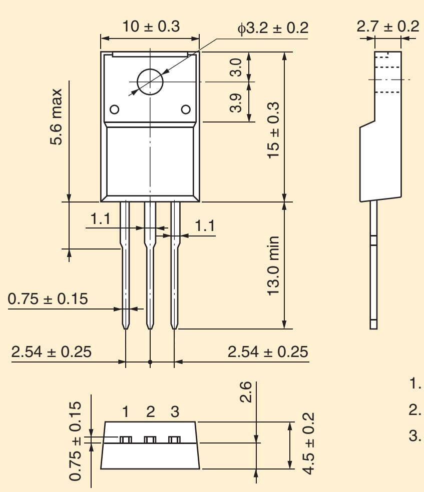
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

SOP-8



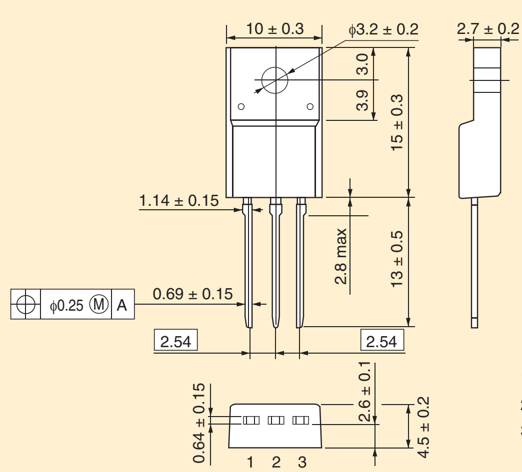
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

TO-220NIS



1. Gate
2. Collector
3. Emitter

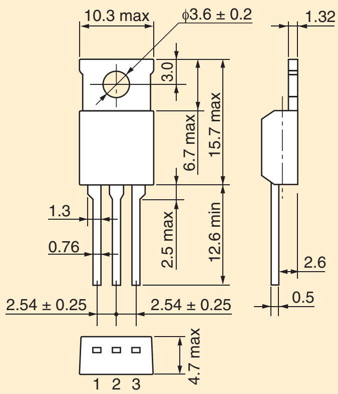
TO-220SIS



1. Gate
2. Collector
3. Emitter

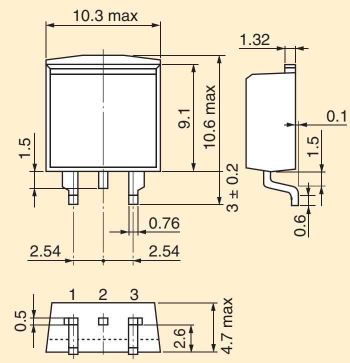
Unit: mm

TO-220AB



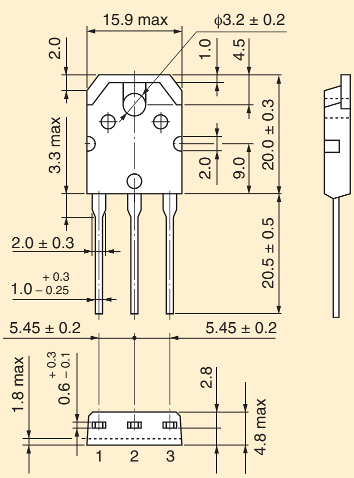
1. Gate
2. Collector
3. Emitter

TO-220SM



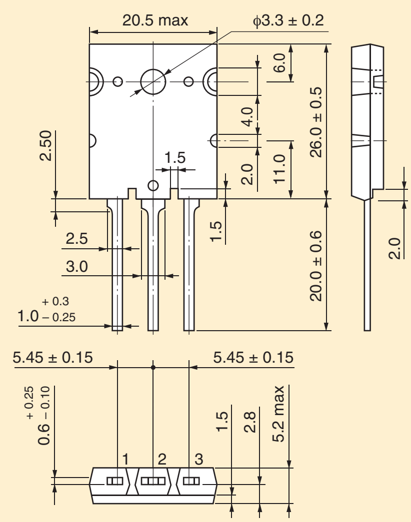
1. Gate
2. Collector
3. Emitter

TO-3P(N)



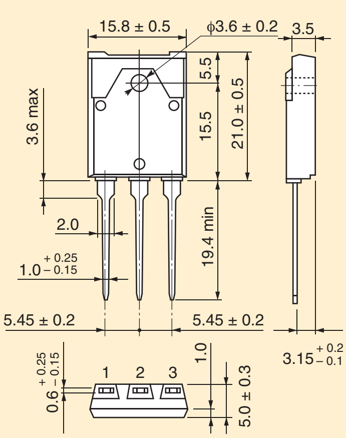
1. Gate
2. Collector
3. Emitter

TO-3P(LH)



1. Gate
2. Collector
3. Emitter

TO-3P(N)IS



1. Gate
2. Collector
3. Emitter

7

Final-Phase and Obsolete Products

The following products are in stock but are being phased out of production. The recommended replacements that continue to be available are listed in the right-hand column. However, the characteristics of the recommended replacements may not be exactly the same as those of the final-phase and obsolete products. Before using a recommended replacement, be sure to check that it is suitable for use under the intended operating conditions.

Application	Final-Phase or Obsolete Product	Absolute Maximum Ratings		Package	Recommended Obsolete Replacements	Absolute Maximum Ratings		Package
		V_{CES} (V)	I_C (A) DC			V_{CES} (V)	I_C (A) DC	
Soft switching Resonant switching	**MG30T1AL1**	1500	30	**IH**	—	—	—	—
	MG60M1AL1	900	60	**IH**	**GT60M303**	900	60	**TO-3P(LH)**
	GT40M101	900	40	**TO-3P(N)IS**	—	—	—	—
	GT40M301	900	40	**TO-3P(LH)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT40T101	1500	40	**TO-3P(LH)**	—	—	—	—
	GT50L101	800	50	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT50M101	900	50	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT50Q101	1200	50	**IH**	—	—	—	—
	GT50S101	1400	50	**IH**	—	—	—	—
	GT50T101	1500	50	**IH**	—	—	—	—
	GT60J101	600	60	**TO-3P(L)**	**GT80J101B**	600	60	**TO-3P(LH)**
	GT60J322	600	60	**TO-3P(LH)**	**GT60J321**	600	60	**TO-3P(LH)**
	GT60M101	900	60	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M102	900	60	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M103	900	60	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M104	900	60	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M105	900	60	**TO-3P(L)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M301	900	60	**TO-3P(LH)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M302	900	60	**TO-3P(LH)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M305	900	60	**TO-3P(LH)**	**GT60M303**	900	60	**TO-3P(LH)**
	GT60M322	950	60	**TO-3P(LH)**	**GT60N321**	1000	60	**TO-3P(LH)**
	GT80J101	600	80	**TO-3P(L)**	**GT80J101B**	600	80	**TO-3P(LH)**
					GT60J321	600	60	**TO-3P(LH)**
	GT80J101A	600	80	**TO-3P(LH)**	**GT80J101B**	600	80	**TO-3P(LH)**
General-purpose motors General-purpose inverters	**GT8J101**	600	8	**TO-220NIS**	**GT10J303**	600	10	**TO-220NIS**
	GT8J102	600	8	**TO-220SM**	**GT10J312**	600	10	**TO-220SM**
	GT8N101	1000	8	**TO-3P(N)**	**GT10Q101**	1200	10	**TO-3P(N)**
	GT8Q101	1200	8	**TO-3P(N)**	**GT10Q101**	1200	10	**TO-3P(N)**
	GT8Q102	1200	8	**TO-220SM**	—	—	—	—
	GT10Q311	1200	10	**TO-3P(SM)**	—	—	—	—
	GT15J101	600	15	**TO-3P(N)**	**GT20J101**	600	20	**TO-3P(N)**
	GT15J102	600	15	**TO-220NIS**	**GT15J301**	600	15	**TO-220NIS**
	GT15J103	600	15	**TO-220SM**	**GT15J311**	600	15	**TO-220SM**
	GT15N101	1000	15	**TO-3P(N)**	**GT15Q102**	1200	15	**TO-3P(N)**
	GT15Q101	1200	15	**TO-3P(N)**	**GT15Q102**	1200	15	**TO-3P(N)**
	GT15Q311	1200	15	**TO-3P(SM)**	—	—	—	—
	GT20J311	600	20	**TO-3P(SM)**	—	—	—	—
	GT25H101	500	25	**TO-3P(N)**	**GT30J101**	600	30	**TO-3P(N)**
	GT25J101	600	25	**TO-3P(N)**	**GT30J121**	600	30	**TO-3P(N)**
	GT25J102	600	25	**TO-3P(N)IS**	**GT30J121**	600	30	**TO-3P(N)**
	GT25Q101	1200	25	**TO-3P(LH)**	**GT25Q102**	1200	25	**TO-3P(LH)**
	GT30J311	600	30	**TO-3P(SM)**	—	—	—	—
	GT50J101	600	50	**TO-3P(L)**	**GT50J121**	600	50	**TO-3P(LH)**
Strobe flashes	**GT5G101**	400	130 (pulsed)	**NPM**	**GT5G103**	400	130 (pulsed)	**DP**
	GT5G102	400	130 (pulsed)	**DP**	**GT5G103**	400	130 (pulsed)	**DP**
	GT8G101	400	130 (pulsed)	**NPM**	**GT5G103**	400	130 (pulsed)	**DP**
	GT8G102	400	150 (pulsed)	**NPM**	**GT8G103**	400	150 (pulsed)	**DP**
					—	—	—	—
	GT10G101	400	130 (pulsed)	**TO-220NIS**	—	—	—	—
	GT10G102	400	130 (pulsed)	**TO-220NIS**	—	—	—	—
	GT15G101	400	170 (pulsed)	**TO-220NIS**	—	—	—	—
	GT20G101	400	130 (pulsed)	**TO-220FL**	—	—	—	—
	GT20G102	400	130 (pulsed)	**TO-220FL**	—	—	—	—
	GT25G101	400	170 (pulsed)	**TO-220FL**	—	—	—	—
	GT25G102	400	150 (pulsed)	**TO-220FL**	—	—	—	—
	GT50G101	400	100 (pulsed)	**TO-3P(N)**	—	—	—	—
	GT50G102	400	100 (pulsed)	**TO-3P(N)**	—	—	—	—
	GT75G101	400	150 (pulsed)	**TO-3P(N)**	—	—	—	—
Audio amps	**GT20D101**	250	20	**TO-3P(L)**	—	—	—	—
	GT20D201	–250	–20	**TO-3P(L)**	—	—	—	—

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(As of June 20, 2007)

2008-3

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