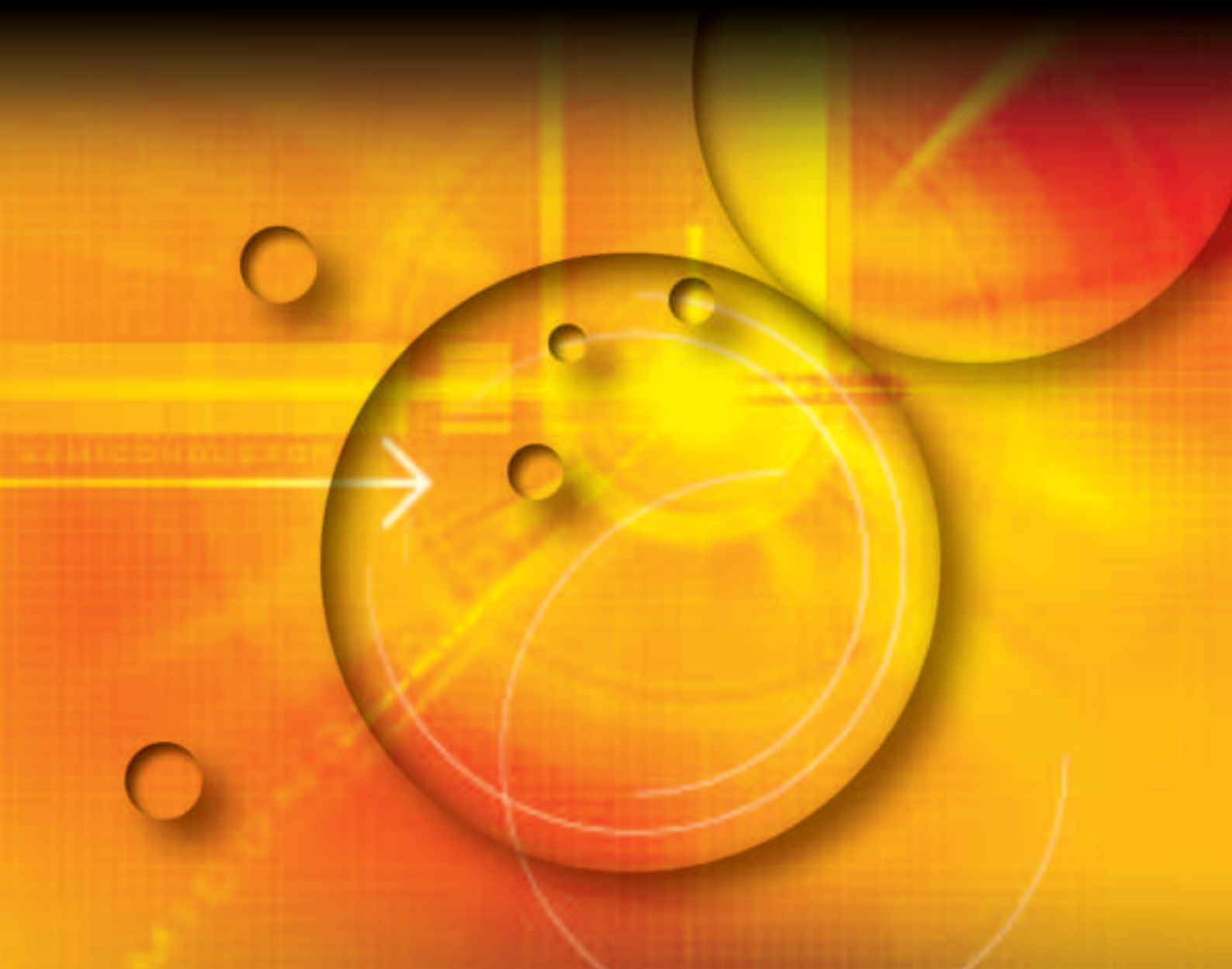


PRODUCT GUIDE

Discrete IGBTs



1 Features and Structure

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

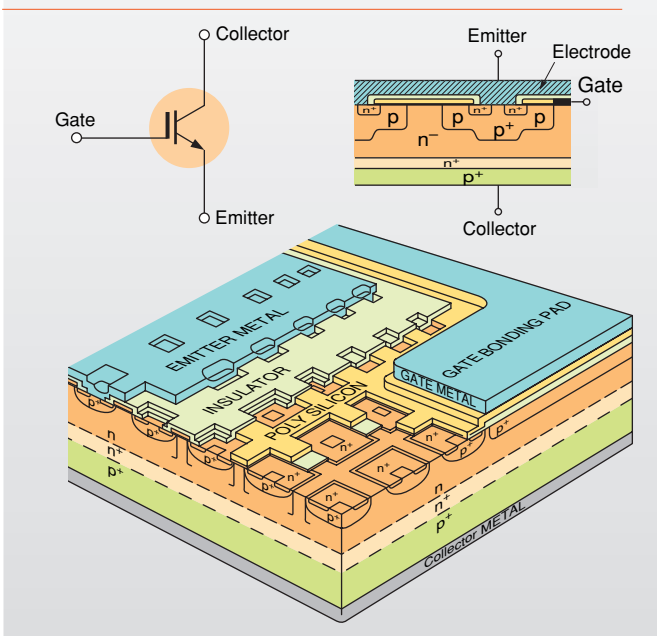
The Toshiba discrete IGBTs are available in high-voltage and high-current ratings. They are used in inverter and power conversion circuits for such diverse applications as motor drivers, uninterruptible power supply (UPS) systems, IH cookers, plasma display panels (PDPs), strobe flashes and so on.

- (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

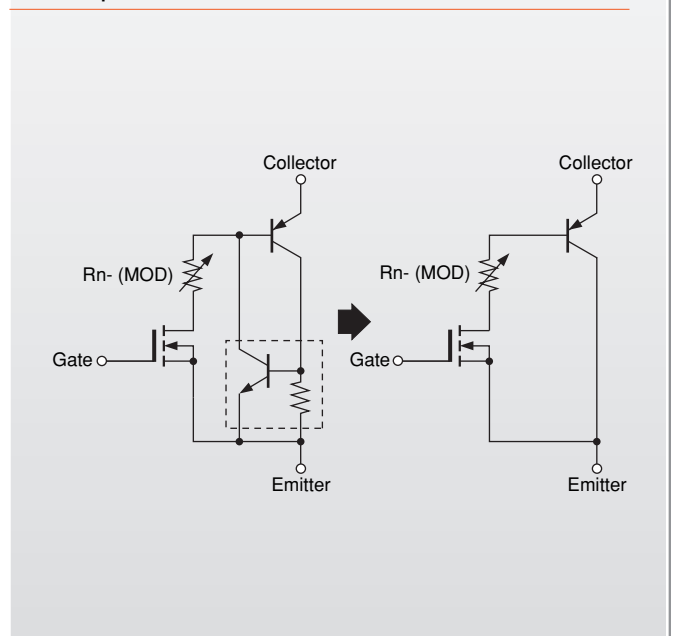
Construction

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



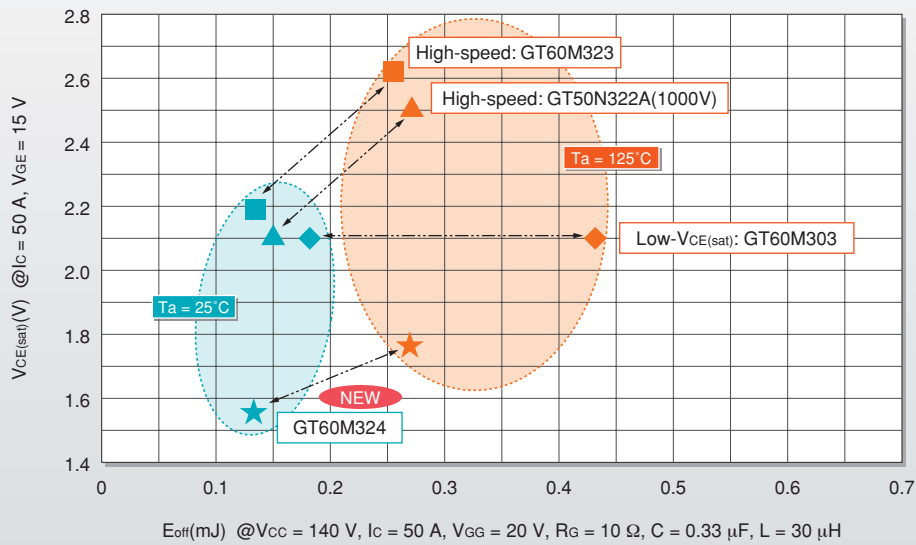
2 IGBT Technical Overview

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 layer. 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.

▶ 900-V IGBT for Soft-Switching



➔ Discrete IGBT Development Trends

1200 V	(1) High ruggedness (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 1500 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 (6th gen): Thinner wafers and finer process geometries
600 V	(1) High ruggedness (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 (5th gen): Thinner wafers and finer process geometries
400 V	(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 (7th 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 IC due to life time control	
	(2) Plasma displays (4th gen): Improved transient performance due to Cu connector	
		(3) Plasma displays (next gen): Low turn-on loss 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) @ $T_a = 25^\circ\text{C}$	IGBT Current Rating I_c (A) @ $T_a = 25^\circ\text{C}$		TSOP-8	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	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
High ruggedness Series	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	600	10	20				GT10J321								
		15	30				GT15J321								
		20	40				GT20J321								
		30	60									GT30J324	GT30J126		
		50	100									GT30J121		GT50J325 GT50J121	
General-purpose inverters Low- $V_{CE(sat)}$ IGBT	600	15	30							GT15J331					
Resonant switching Soft switching Soft-Switching Series	400	40	100								GT40G121			GT50G321	
		50	100												
		30	100										GT30J322		
	600	37	100										GT35J321		
		40	100									GT40J321	GT40J322		
												GT40J323			
		50	100									GT50J327	GT50J328	GT50J322	
												GT50J328		GT50J322H	
		120										GT50J122			
	900	60	120											GT60J321	
														GT60J323	
														GT60J323H	
	1000	80	160											GT80J101B	
		15	30										GT15M321		
		50	120									GT50M322			
60		120											GT60M303		
													GT60M323		
1200	60	120											GT60M324		
	50	120										GT50N322A			
												GT50N324			
	57	120											GT60N322		
1500	60	120											GT60N321		
	42	80										GT40Q321			
	40	80											GT40T302		
PFC	600	30	100										GT30J122		
Strobe flashes	400	130		GT5G133											
		150		GT8G133	GT8G134	GT8G132									
		200		GT8G136	GT10G131										
Plasma display panels	300	120							GF30F122						
									GF30F123						
		200							GT45F122						
									GT45F123						
	400	200							GT45F124						
									GT45F125						
									GT45F127						
									GT45F127						
430	200							GT30G122							
								GT45G122							
600	200							GT45G123							
								GT45G124							
								GT45G125							
								GT30G123							
								GT45G127							
								GT30J124							

GT5G133 : Under development

4 Part Numbering Scheme

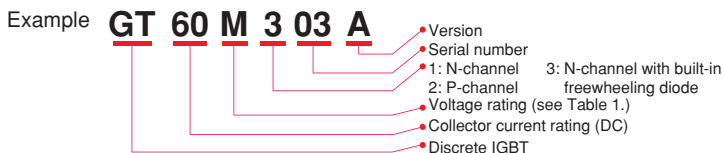


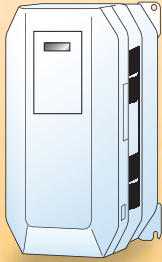
Table 1

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

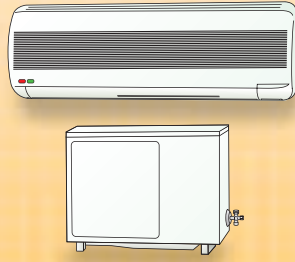
5-1 General-Purpose Inverter

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



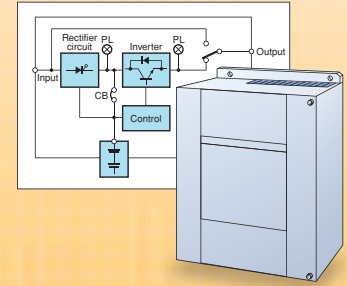
Inverter Air Conditioners



Inverter Washing Machines



UPS



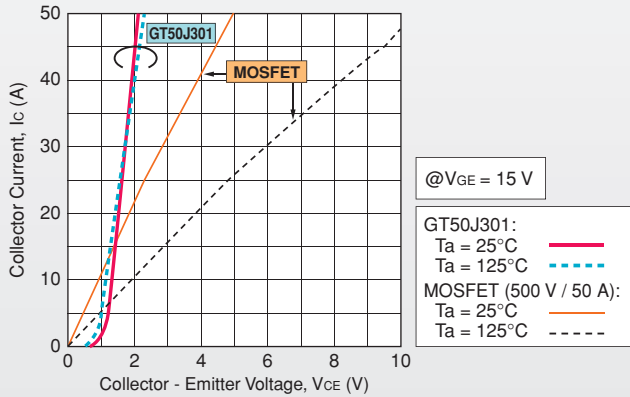
Discrete IGBT Trend

► For general-purpose inverters

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

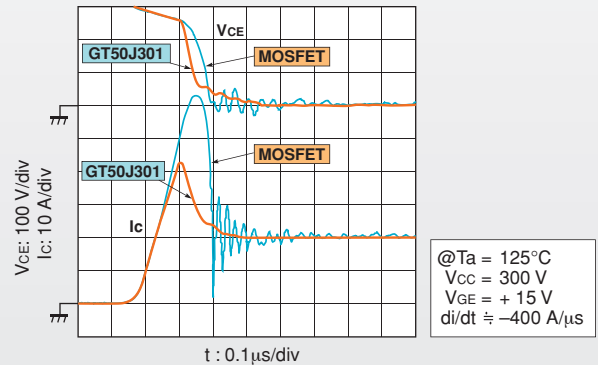
► IC - V_{CE} Temperature Characteristics

Low saturation voltage with minimal temperature dependence



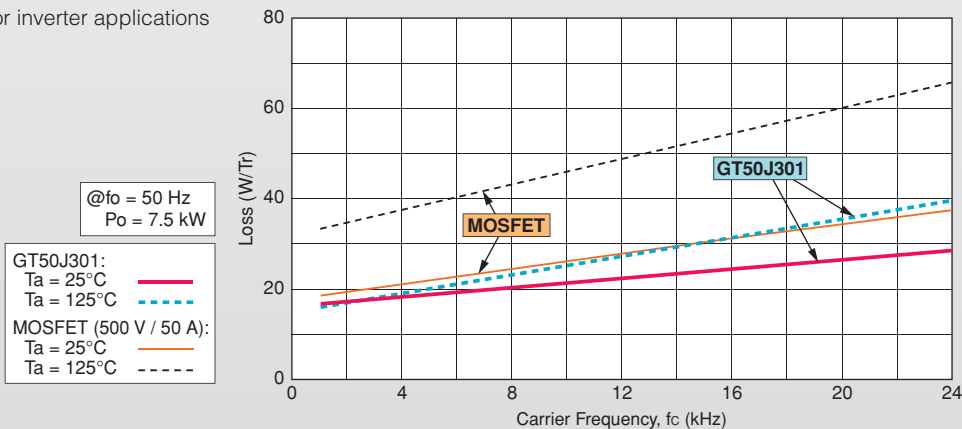
► Turn-On Waveform

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



► Power Loss vs. Carrier Frequency Characteristics

Simulation data for inverter applications



5-1 General-Purpose Inverter

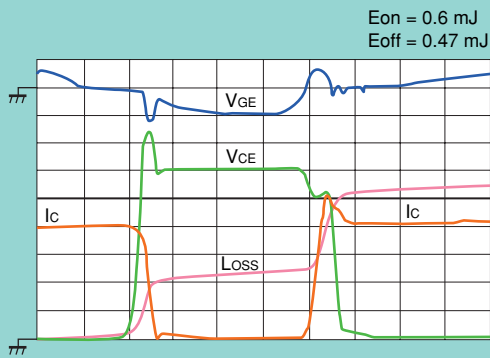
For general-purpose inverters

► Fast-Switching (FS) Series

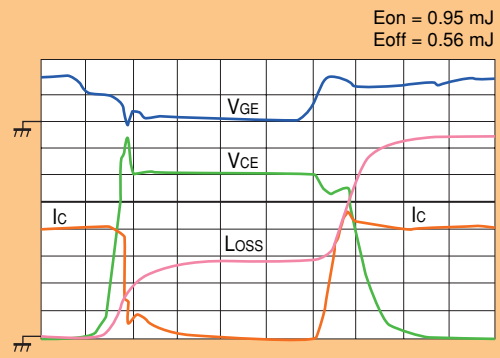
Compared to the third-generation highly rugged series, the FS series is optimized for switching speed, reducing the total switching loss ($E_{on} + E_{off}$) by 30% (according to Toshiba's comparative test).

► Typical Waveforms

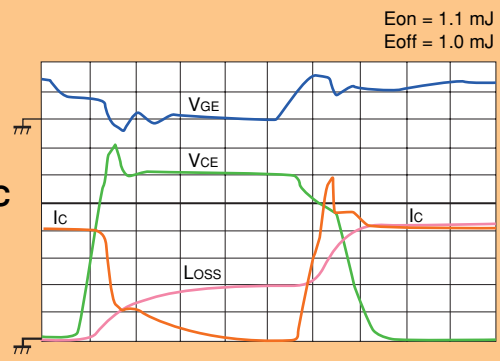
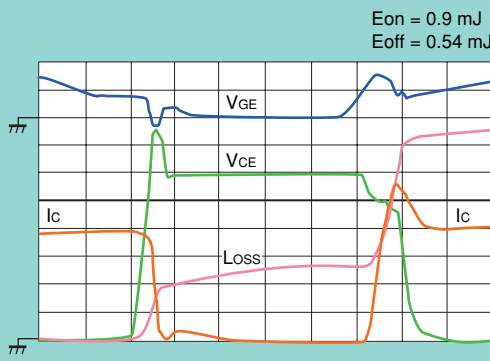
GT20J321(4th generation, FS Series)



GT20J301(3rd generation)



$T_a = 25^\circ\text{C}$



$T_a = 125^\circ\text{C}$

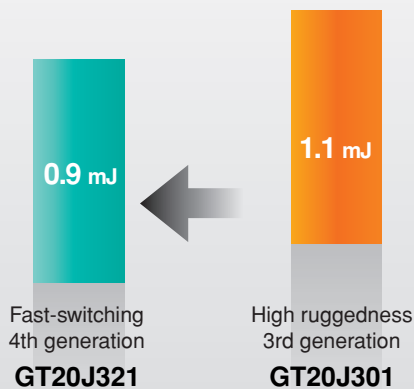
(Loss: 0.5 mJ/div)

(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)

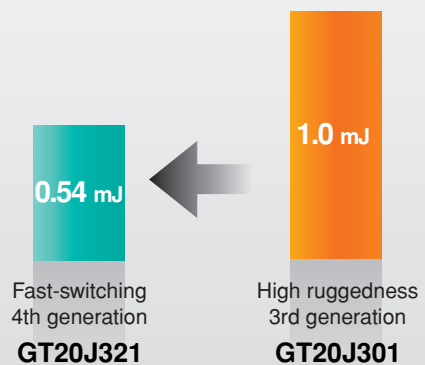
Reduced switching loss of fast-switching IGBTs in comparison with high ruggedness IGBTs

Test condition: $I_C = 20 \text{ A}$, $V_{GE} = 15 \text{ V}$, $R_G = 33 \Omega$, $T_a = 125^\circ\text{C}$, with inductive load, $V_{CC} = 300 \text{ V}$

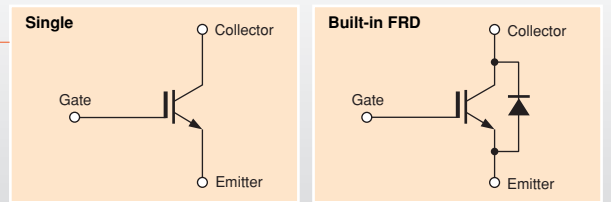
► Turn-On Loss



► Turn-Off Loss



► Circuit Configurations



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

Main Applications	Features	Part Number	Absolute Maximum Ratings				Package	Circuit Configuration (*1)	VCE(sat) Typ.			tr Typ.		Remarks	
			VCEs (V)	Ic		Pc (W)			@Ic (A)	@VGE (V)	(μs)	Load (*2)			
				DC (A)	Pulsed (A)								Tc = 25°C		
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	Partial Switching Converter

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

(FS: Fast Switching)

Main Applications	Features	Part Number	Absolute Maximum Ratings				Package	Circuit Configuration (*1)	VCE(sat) Typ.			tr Typ.		Remarks	
			VCEs (V)	Ic		Pc (W)			@Ic (A)	@VGE (V)	(μs)	Load (*2)			
				DC (A)	Pulsed (A)								Tc = 25°C		
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	
		GT30J126	600	30	60	90	TO-3P(N)IS	–	◆	1.95	30	15	0.05	L	Isolation Package
		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 ◆ : Single
FRD: Fast Recovery Diode
*2 R : Resistive load
L : Inductive load

5-2 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.

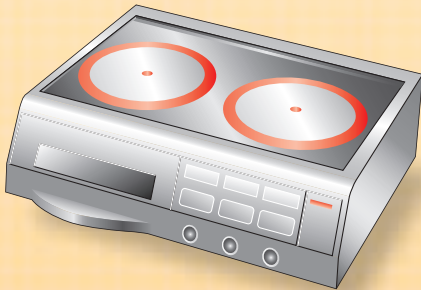
Microwave Ovens



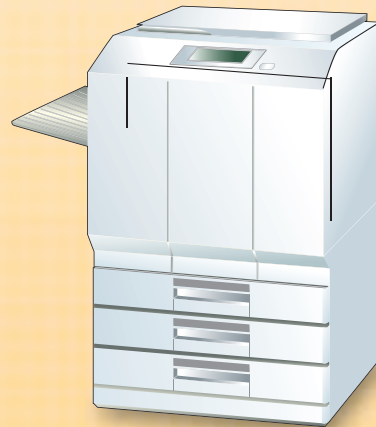
IH Rice Cookers



IH Cookers



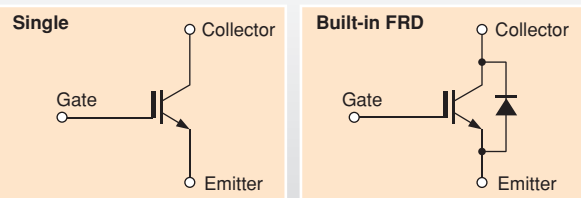
MFPs



AC Input Voltage	Circuit	IGBT Rating	
100 V to 120 V	<p>Voltage Resonance</p>	<p>Waveform</p>	<p>$V_{CES} = 900 \text{ V to } 1000 \text{ V}$ $I_c = 15 \text{ A to } 60 \text{ A}$</p>
200 V to 240 V		<p>$V_{CES} = 1200 \text{ V to } 1500 \text{ V}$ $I_c = 40 \text{ A}$</p>	
100 V to 240 V	<p>Current Resonance</p>	<p>Waveform</p>	<p>$V_{CES} = 400 \text{ V}$ $I_c = 40 \text{ A to } 50 \text{ A}$</p>
		<p>$V_{CES} = 600 \text{ V}$ $I_c = 30 \text{ A to } 80 \text{ A}$</p>	

IH: Induction heating
MFP: Multifunction Printer

► Circuit Configurations



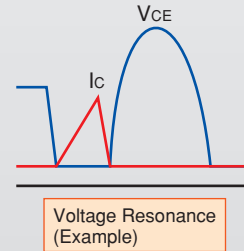
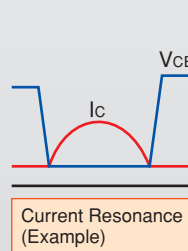
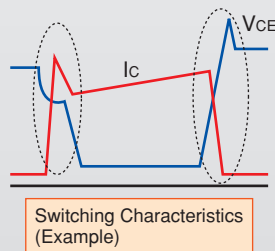
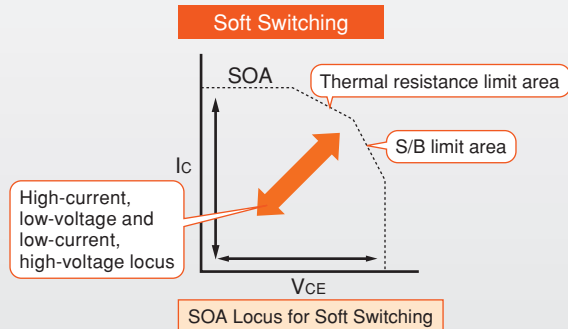
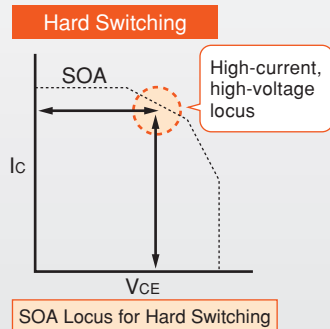
► IGBTs for Soft-Switching Applications

Main Applications	Features	Part Number	Absolute Maximum Ratings			Package	Circuit Configuration (*1)	VCE(sat) Typ.			tr Typ.		Remarks	
			VCEs (V)	Ic				Pc Tc = 25°C (W)	V	@Ic (A)	@VGE (V)	μs		Load (*2)
				DC (A)	Pulsed (A)									
IH rice cookers and IH cooktops	AC 100 V	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	Current resonance	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	
			GT40J323		40	80	120			2.0	40	15	0.06	5th generation
			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			1.55	60	15	0.30	
			GT60J323		60	120	170	TO-3P(LH)		1.9	60	15	0.16	
			GT60J323H		60	120	170			2.1	60	15	0.12	R Fast switching
			AC 100 V		Voltage resonance	GT15M321	900	15	30	55	TO-3P(N)IS		1.8	15
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	
GT60M324	60	120		150					1.65	60	15	0.11	6th generation	
GT50N321	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
GT50N324	50	120		150						1.9	60	15	0.12	6th generation
GT60N321	60	120		170		TO-3P(LH)			2.3	60	15	0.25		
GT60N322	57	120		200					2.4	40	15	0.11	Fast switching	
AC 200 V		GT40Q321	1200	40	80	170	TO-3P(N)		2.8	60	15	0.41		
		GT40T302	1500	40	80	200	TO-3P(LH)		3.7	40	15	0.23	High Vces	

*1 ◆ : Single
 FRD: Fast Recovery Diode
 FWD: Free Wheeling Diode
 *2 R : Resistive load
 L : Inductive load
 : Under development

5-2 Soft-Switching Applications

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

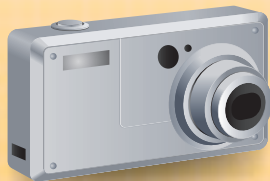


5-3 Strobe Flash Applications

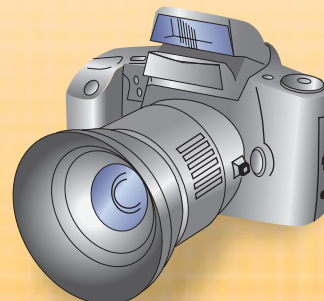
Strobe flash control is now prevalent in digital still cameras. Package sizes are getting smaller, and logic levels are increasingly used to represent the gate drive voltage. Toshiba offers compact IGBTs featuring low gate drive voltage.

- As a voltage-controlled device, the IGBT requires only a few components for drive circuit.
- 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



5-3 Strobe Flash Applications

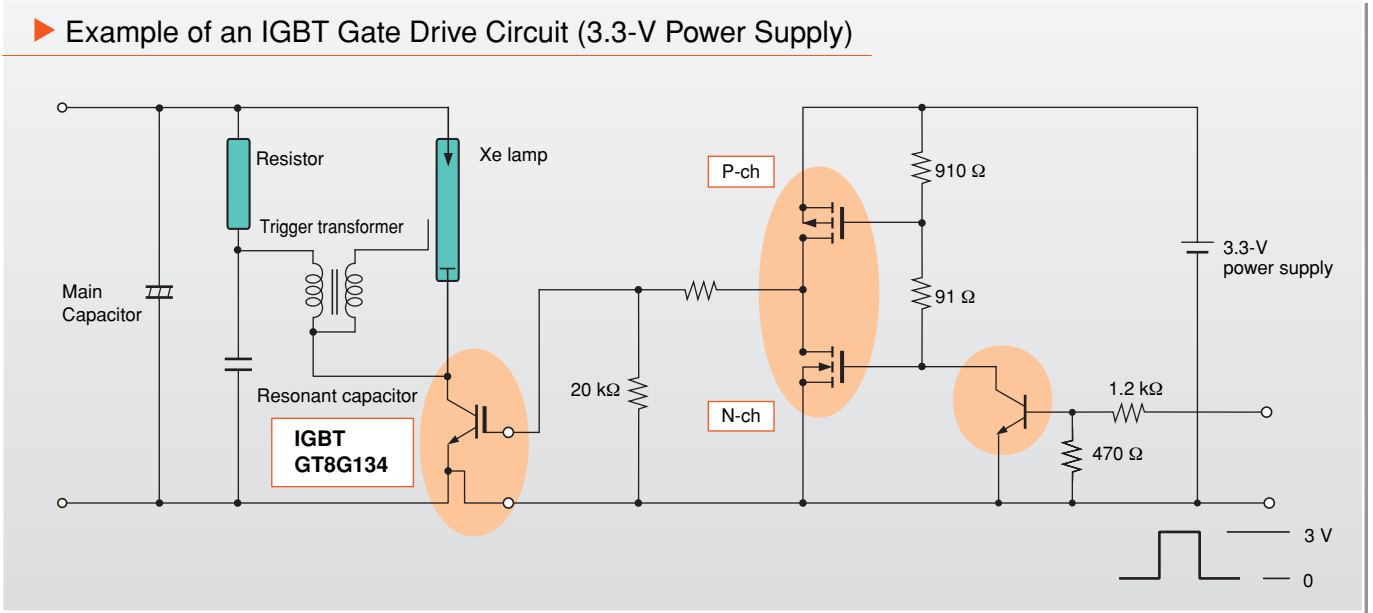
Product List

► For strobe flashes

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

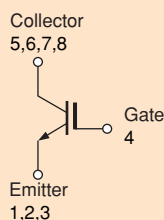
Part Number	V _{CES} / I _c	V _{CE(sat)} (V)		P _c (W) @T _a = 25°C	Package	Remarks
		(V)	V _{GE} / I _c			
GT5G133	400 V / 130 A	3.4	2.5 V / 130 A	0.9	TSON-8*1	7th generation
GT8G136	400 V / 150 A	3.5	3 V / 150 A	1.1	TSSOP-8*2	5th generation
GT8G134	400 V / 150 A	3.4	2.5 V / 150 A	1.1	TSSOP-8*2	6th generation

*1: Under development

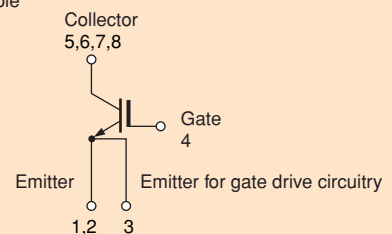
5-V Power Supply

Part Number	V _{CES} / I _c	V _{CE(sat)} (V)		P _c (W) @T _a = 25°C	Package	Remarks
		(V)	V _{GE} / I _c			
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



*2: Board connection example



All the emitter terminals should be connected together.

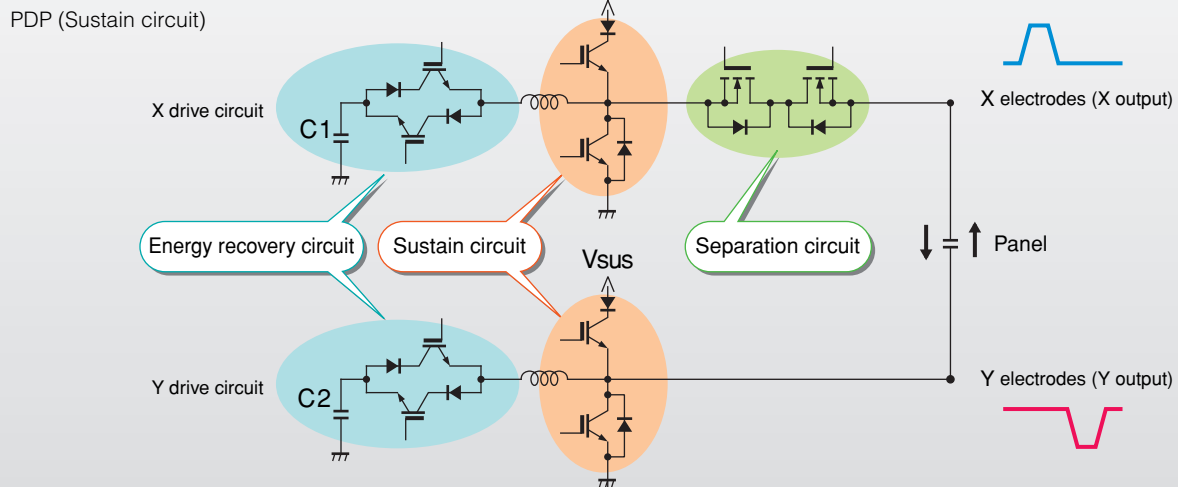
5-4 Plasma Display Panel Applications

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 Drive Circuit



Product List

► For plasma display panels

300-V IGBTs

Part Number	$V_{CES} / I_{cp} @ 3 \mu s$	$V_{CE(sat)} (V) \text{ Max}$	$P_c (W) @ T_c = 25^\circ C$	Package	Remarks
GT30F122	300 V / 120 A*	2.9 (@120 A)	25	TO-220SIS	5th generation
GT30F123	300 V / 200 A	2.1 (@120 A)	25	TO-220SIS	6th generation
GT45F122	300 V / 200 A	2.7 (@120 A)	25	TO-220SIS	5th generation
GT45F123	300 V / 200 A	2.4 (@120 A)	26	TO-220SIS	5th generation
GT45F124	300 V / 200 A	2.1 (@120 A)	29	TO-220SIS	5th generation
GT45F125	300 V / 200 A	1.45 (@120 A)	29	TO-220SIS	5th generation
GT45F127	300 V / 200 A	1.6 (@120 A)	26	TO-220SIS	6th generation
GT45F131	300 V / 200 A	2.1 (@120 A)	160	TO-220SM	5th generation

*: @100 μs

400-V IGBTs

Part Number	$V_{CES} / I_{cp} @ 3 \mu s$	$V_{CE(sat)} (V) \text{ Max}$	$P_c (W) @ T_c = 25^\circ C$	Package	Remarks
GT30G122	400 V / 120 A*	2.6 (@120 A)	25	TO-220SIS	5th generation
GT30G123	430 V / 200 A	2.2 (@120 A)	25	TO-220SIS	6th generation
GT45G122	400 V / 200 A	2.9 (@120 A)	25	TO-220SIS	5th generation
GT45G123	400 V / 200 A	2.6 (@120 A)	26	TO-220SIS	5th generation
GT45G124	400 V / 200 A	2.3 (@120 A)	29	TO-220SIS	5th generation
GT45G125	400 V / 200 A	1.6 (@120 A)	29	TO-220SIS	5th generation
GT45G127	430 V / 200 A	1.7 (@120 A)	26	TO-220SIS	6th generation
GT45G131	400 V / 200 A	2.3 (@120 A)	160	TO-220SM	5th generation

*: @100 μs

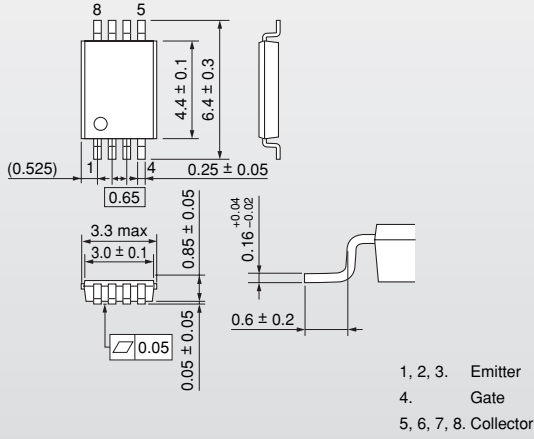
600-V IGBTs

Part Number	$V_{CES} / I_{cp} @ 3 \mu s$	$V_{CE(sat)} (V) \text{ Max}$	$P_c (W) @ T_a = 25^\circ C$	Package	Remarks
GT30J124	600 V / 200 A	2.4 (@120 A)	26	TO-220SIS	5th generation

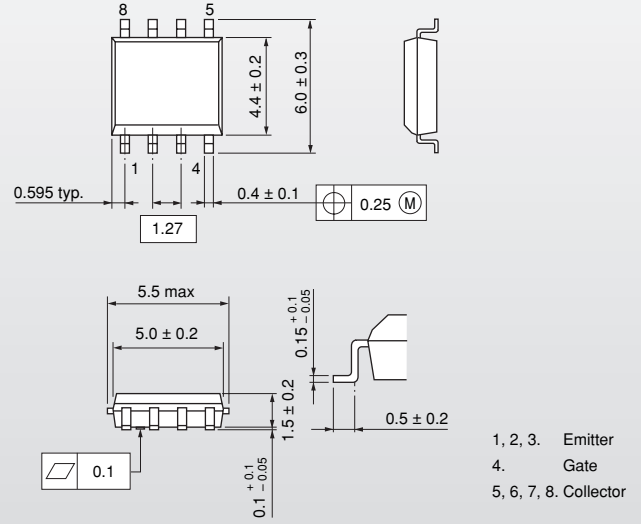
6 Package Dimensions

Unit: mm

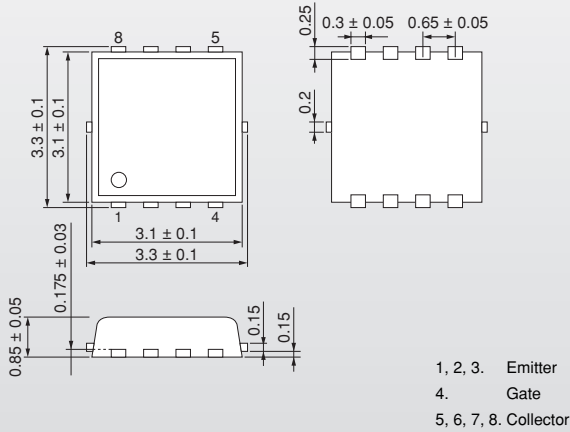
TSSOP-8



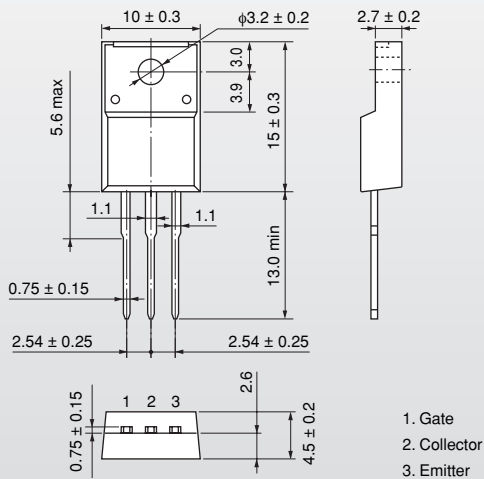
SOP-8



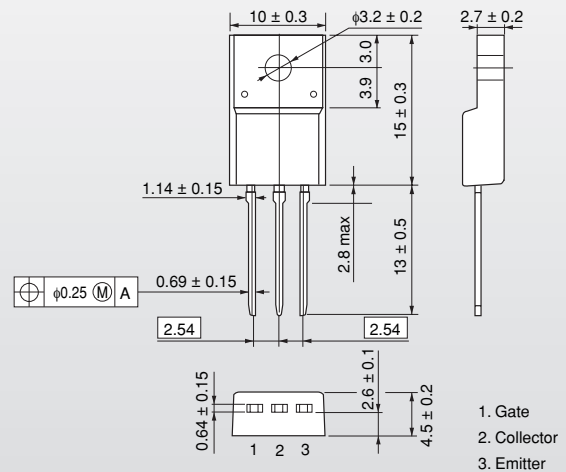
TSOP-8



TO-220NIS



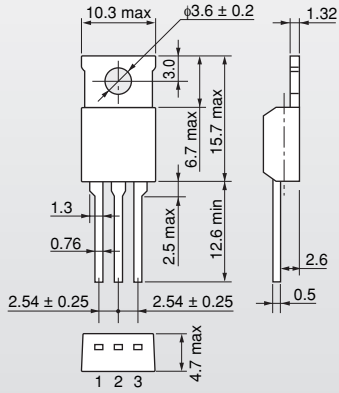
TO-220SIS



6 Package Dimensions

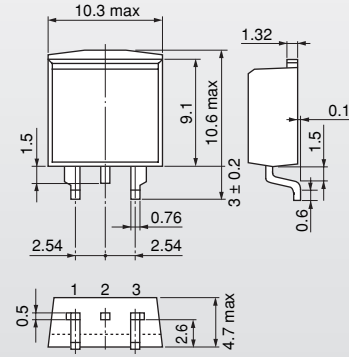
Unit: mm

▶ TO-220AB



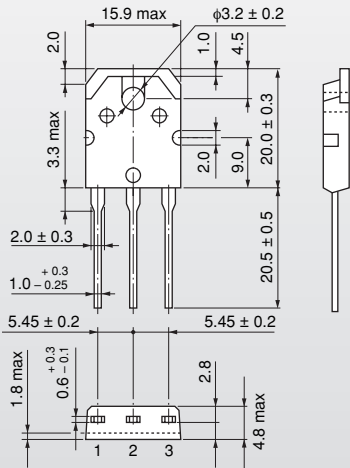
1. Gate
2. Collector
3. Emitter

▶ TO-220SM



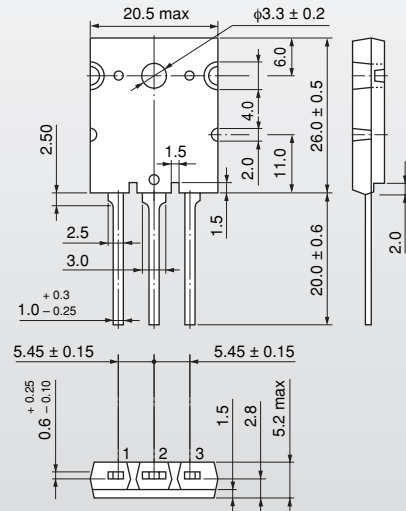
1. Gate
2. Collector
3. Emitter

▶ TO-3P(N)



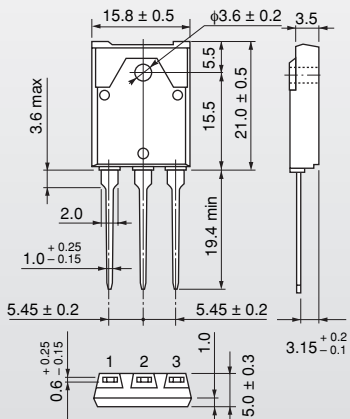
1. Gate
2. Collector
3. Emitter

▶ 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.

Audio amps	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)
	GT40Q322	1200	39	TO-3P(N)	GT40Q321	1200	42	TO-3P(N)
	GT40Q323	1200	39	TO-3P(N)	GT40Q321	1200	42	TO-3P(N)
	GT40T101	1500	40	TO-3P(LH)	–	–	–	–
	GT40T301	1500	40	TO-3P(LH)	GT40T302	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)
	GT60N323	1050	60	TO-3P(LH)	GT60N322	1000	57	TO-3P(LH)
	GT80J101	600	80	TO-3P(L)	GT80J101B	600	80	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)	GT30J121	600	30	TO-3P(N)
	GT25J101	600	25	TO-3P(N)	GT30J121	600	30	TO-3P(N)
	GT25J102	600	25	TO-3P(N)IS	GT30J126	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	–	–	–
GT5G102		400	130 (pulsed)	DP	–	–	–	–
GT5G103		400	130 (pulsed)	DP	–	–	–	–
GT8G101		400	130 (pulsed)	NPM	–	–	–	–
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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