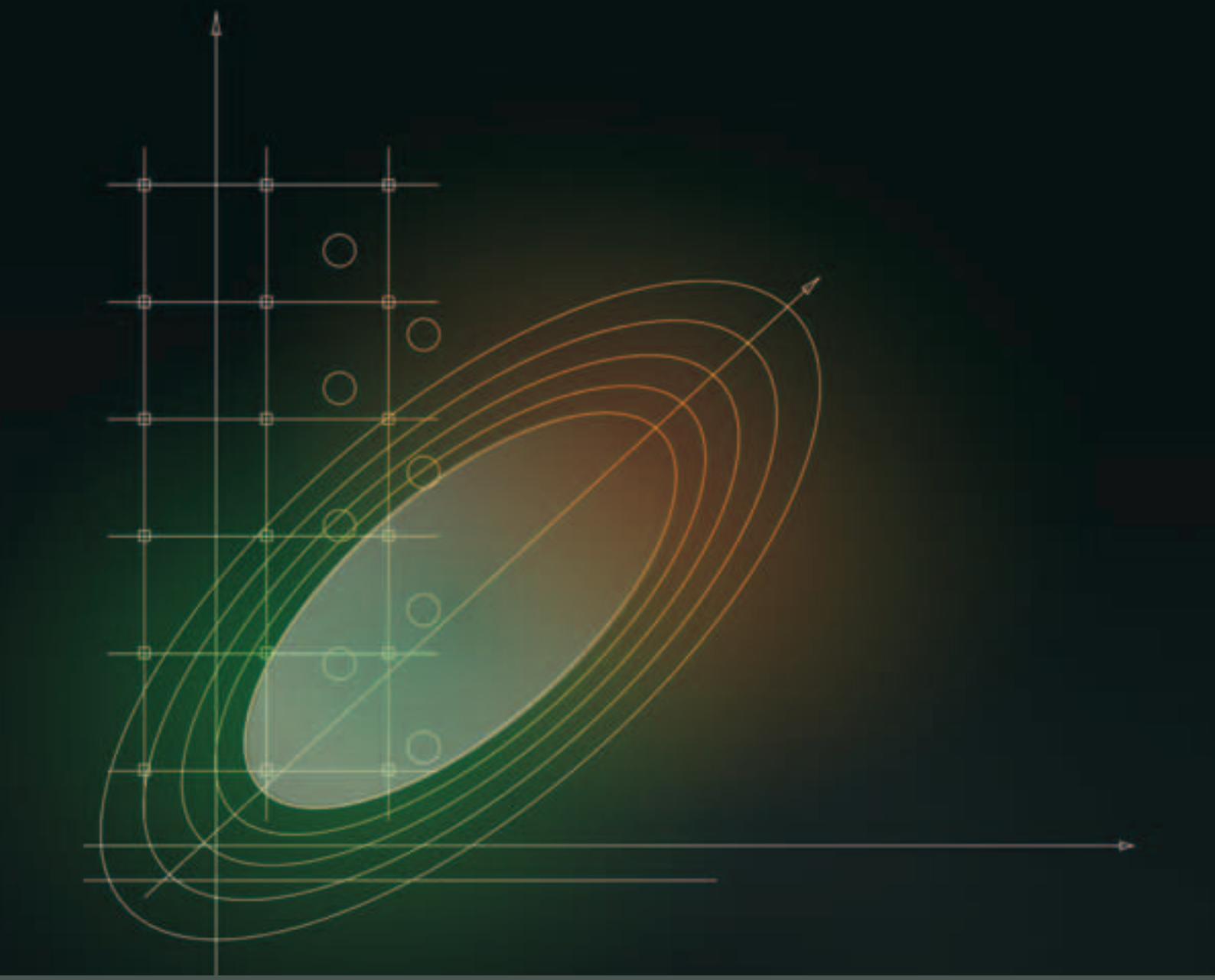
TOSHIBA

Leading Innovation

2007-3

PRODUCT GUIDE

Discrete IGBTs



SEMICONDUCTOR

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

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 injection and recombination in the carrier.

Features of the Toshiba Discrete IGBTs

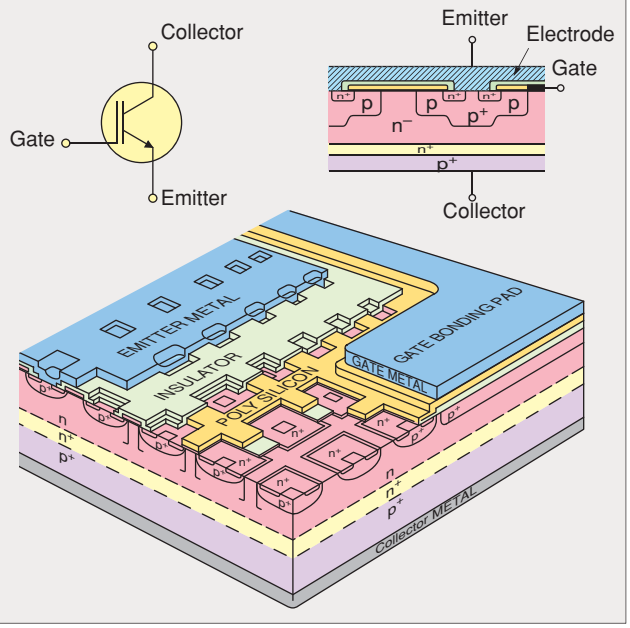
The Toshiba discrete IGBTs are available in high-voltage and high-current ratings. They are used in inverter and power conversion circuits for such diverse applications as motor drivers, uninterruptible power supply (UPS) systems, IH cookers, plasma display panels (PDPs), strobe flashes and so on.

(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

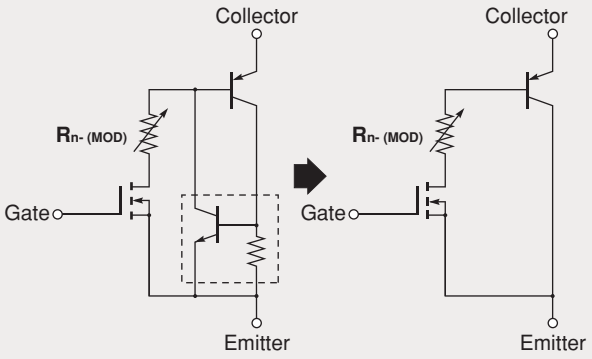
Construction

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 a MOSFET, the IGBT does not have an integral reverse diode, since the collector contact is mede on the p^+ layer.

Structure



Equivalent Circuit



2 IGBT Technical Overview

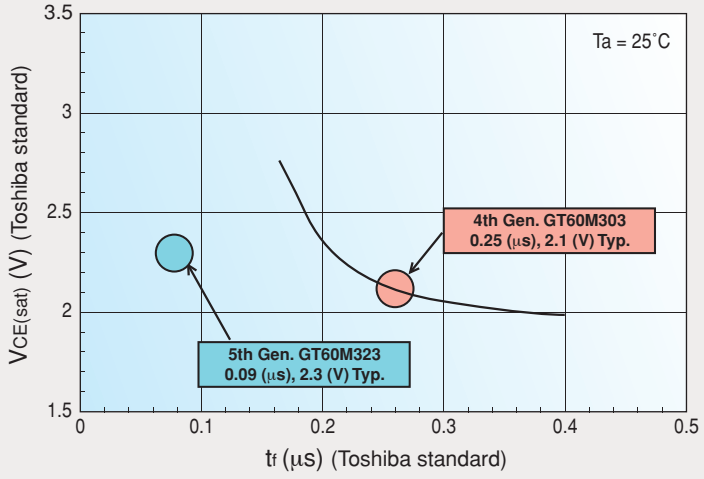
Prior to the development of IGBTs, power MOSFETs were used for power amplifier applications which require high input impedance and fast switching. However, at high voltages, the on-state resistance rapidly increases as the breakdown voltage increases. It is thus difficult to improve the conduction loss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

On the other hand, the IGBT structures 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 offers IGBTs featuring low saturation voltage and fast switching by using carrier lifetime control techniques.

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.

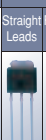
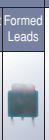
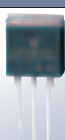
Soft-Switching 900-V IGBT (Example)



Discrete IGBT Development Trends

1200 V	(1) High breakdown voltage (3rd generation): low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and reduced wafer thickness	2000
	(2) Soft switching (5th generation): improved tradeoff between $V_{CE(sat)}$ and tf due to adoption of the trench gate structure	2002
900 V	(1) Soft switching (4th generation): improved tradeoff between $V_{CE(sat)}$ and tf due to adoption of the trench gate structure	2000
	(2) Soft switching (5th generation): optimized wafers and design rules	2002
600 V	(1) High breakdown voltage (3rd generation): low $V_{CE(sat)}$ and high ruggedness due to fine process geometries (up to 20 kHz)	2000
	(2) Fast switching (FS): trench gate structure and carrier injection optimization (up to 50 kHz)	2000
	(3) Soft switching (4th generation): improved tradeoff between $V_{CE(sat)}$ and tf due to adoption of the trench gate structure	2000
400 V	(1) Strobe flash (4th generation): trench gate structure and reduced gate drive voltage (4-V drive voltage, Icp = 150 A, package: SOP-8)	2000
	(2) Strobe flash (5th generation) : Optimized wafers and design rules Aluminum strap bonding technology (4-V drive voltage, Icp = 200 A, package: SOP-8) Low-profile package (3-V drive voltage, Icp = 150 A, package: TSSOP-8)	2002
300 to 400 V	(1) Plasma display panel (PDP): Low losses due to optimized wafer design	2004
	(2) New package structure (Cu connectors)	2006
	(3) Low losses due to submicron process technology	2008

3 Discrete IGBT Product List

Applications and Features	Breakdown Voltage V_{CES}(V) @Ta = 25°C	IGBT Current Rating Ic(A) @Ta = 25°C		TSSOP-8	SOP-8	DP		TO-220NIS	TO-220SIS	TO-220FL	TO-220SM	TO-220AB	TO-3P(N)	TO-3P(N)IS	TO-3P(LH)
						 Straight Leads	 Formed Leads								
		DC	Pulse												
Hard-switching series Highly rugged products 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
	1200	10	20										GT10Q301 GT10Q101		
		15	30										GT15Q301 GT15Q102		
		25	50												GT25Q301 GT25Q102
Hard-switching series Fast-switching (FS) series fc: up to 50 kHz	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				
Soft-switching series	400	40	100									GT40G121			
		50	100												GT50G321
	600	30	100											GT30J322	
		37	100											GT35J321	
		50	100										GT50J327		GT50J322 GT50J322H
			120										GT50J122		
		60	120												GT60J321 GT60J323 GT60J323H
		80	160												GT80J101B
	900	15	30											GT15M321	
		60	120												GT60M303 GT60M323
	1000	50	120										GT50N321		
		57	120												GT60N322
		60	120												GT60N321
	1050	60	120												GT60N323
	1200	39	80										GT40Q323		
		42	80										GT40Q321		
	1500	40	80												GT40T301
PFC	600	30	100											GT30J122	
Strobe flash	400		130		GT5G131	GT5G103									
			150	GT8G133 GT8G136	GT8G132	GT8G103									
			170							GT25G101	GT25G101				
			200	GT10G131											
Plasma display panels	300		120						GF30F121 GF30F122						
			140									GT35F131			
	400		120						GT30F121 GT30F122			GT30G131			

4 Part Numbering Scheme

Example **GT 60 M 3 03 A**

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

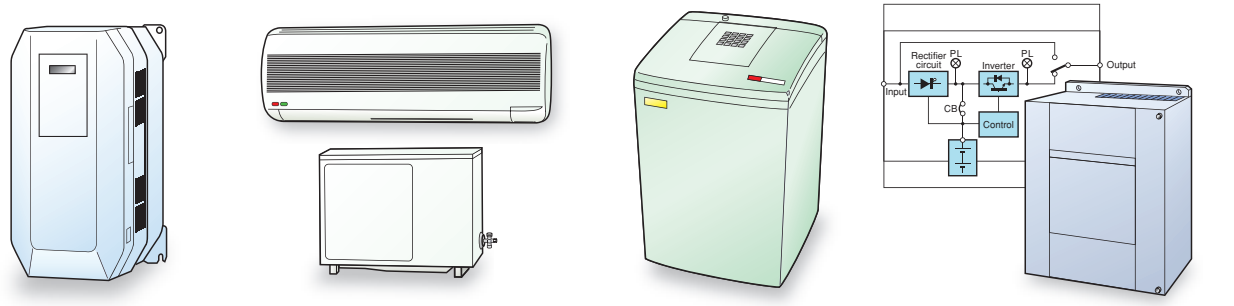
Table 1

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

5-1 Hard-Switching Applications

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

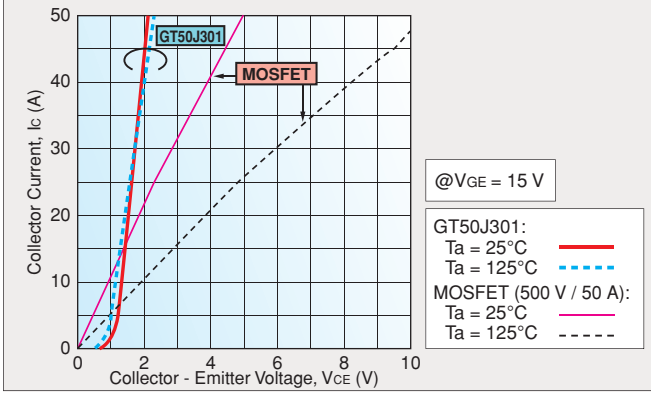


Hard-switching series — Highly Rugged IGBTs

Our third-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 third-generation IGBTs and 500-V MOSFETs

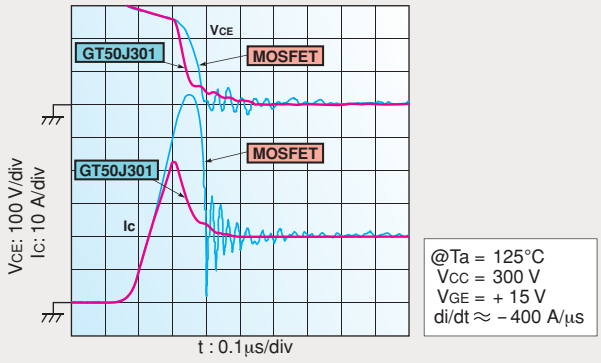
I_C - V_{CE} Temperature Characteristics

▶ Low saturation voltage with minimal temperature dependence



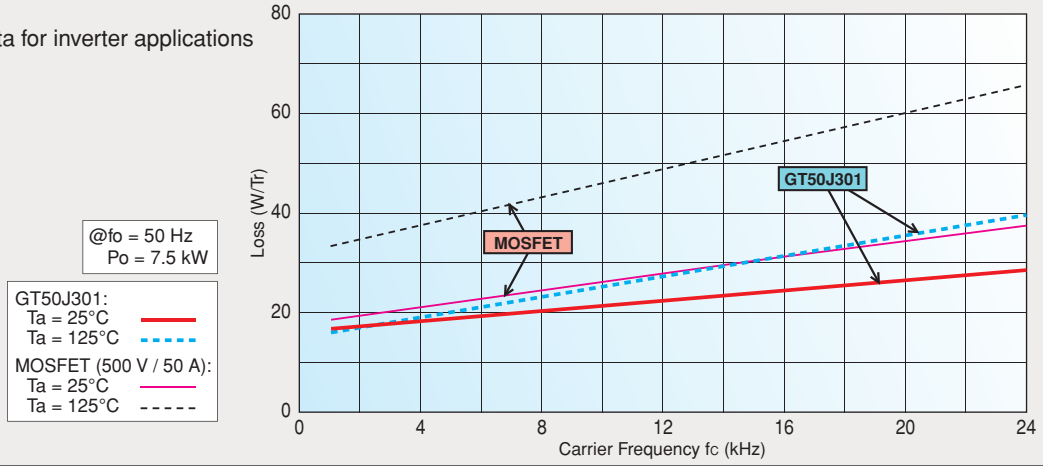
Turn-On Waveform

▶ Superior reverse-recovery characteristics due to built-in diode with optimal characteristics



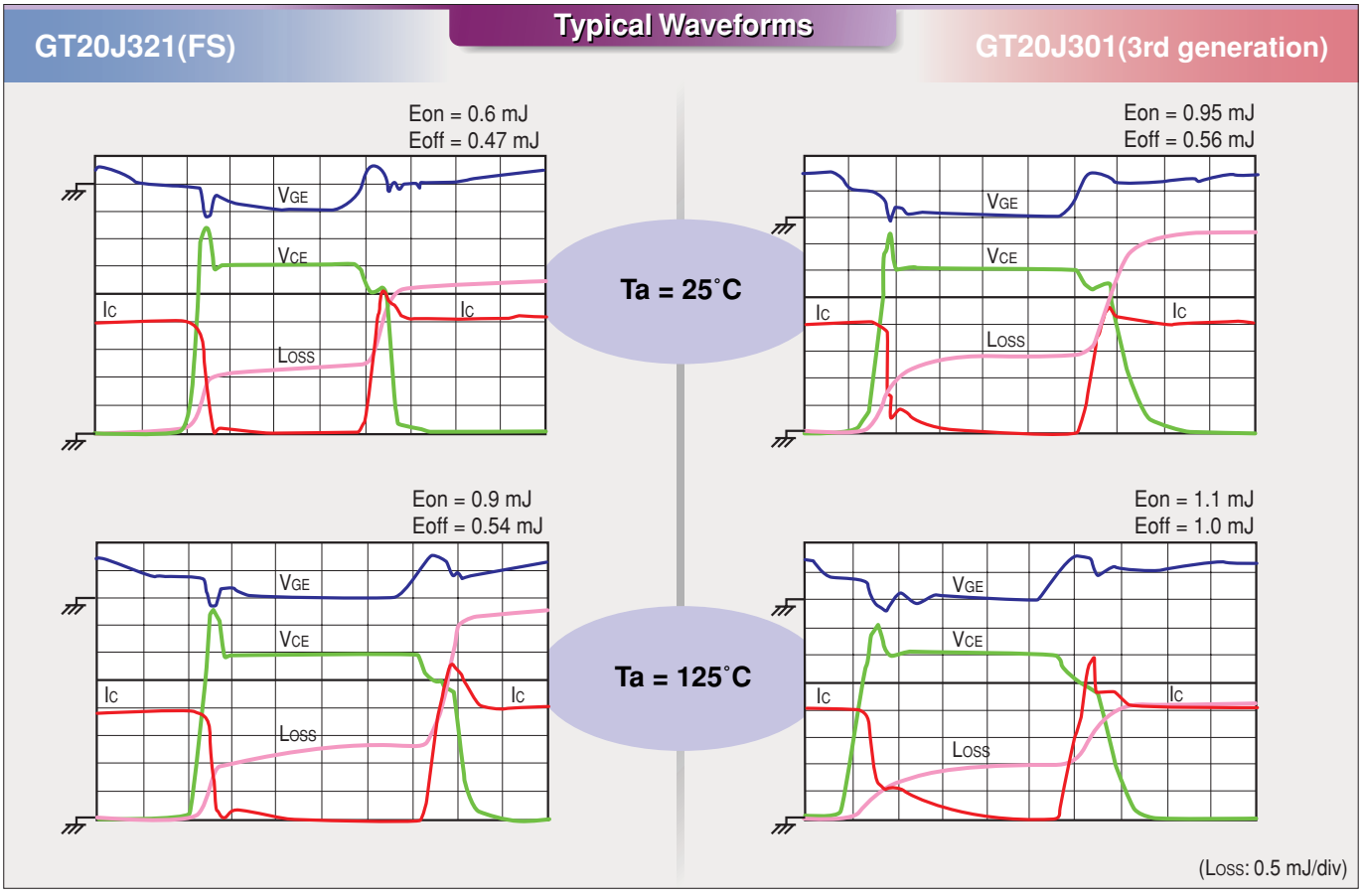
Power Loss vs. Carrier Frequency Characteristics

▶ Simulation data for inverter applications



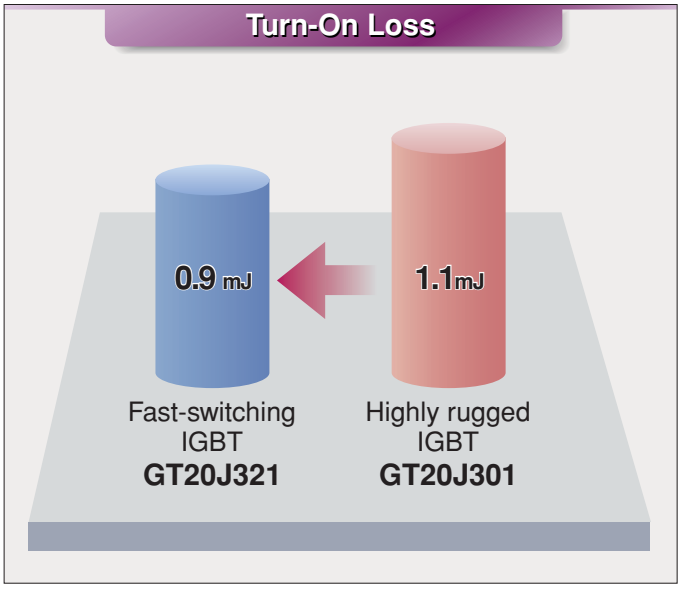
Hard-switching series — Fast-Switching (FS) Series

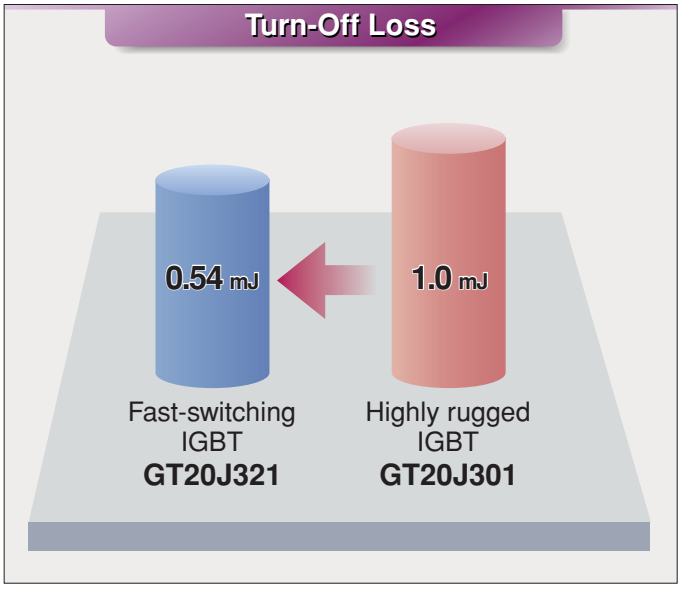
Compared to the hard-switching series, the FS series is optimized for switching speed, reducing the total switching loss (Eon + Eoff) by 30% (according to Toshiba's comparative test).



(VCE: 50 V/div, IC: 5 A/div, VGE: 10 V/div, LOSS: 0.2 mJ/div, t: 0.2 µs/div)

Reduced switching loss of fast-switching IGBTs in comparison with highly rugged 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

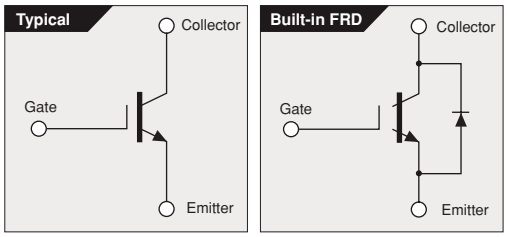




Hard-switching series

Product list for Hard-Switching Applications

Circuit Configuration



■ 600-V and 1200-V Highly Rugged Series (3rd Generation)

Main Applications	Features	Part Number	Absolute Maximum Ratings				Package		Circuit Configuration (*1)	$V_{CE(sat)}$ Typ.			t_f Typ.		Remarks
			V_{CES}	I_C		P_C					@I_C	@V_{GE}		Load (*2)	
				DC	Pulse	T_C = 25°C		Type							
			(V)	(A)	(A)	(W)				(V)	(A)	(V)	(μs)		
Motor driving (UPS/PFC)	High ruggedness (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 ruggedness (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-Switcing Series (4th Generation)

(FS: Fast Switching)

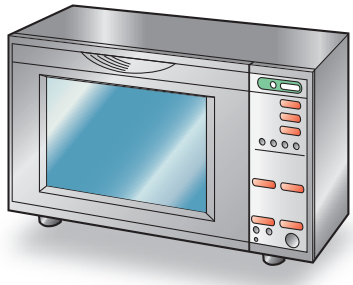
Main Applications	Features	Part Number	Absolute Maximum Ratings				Package		Circuit Configuration (*1)	$V_{CE(sat)}$ Typ.			t_f Typ.		Remarks
			V_{CES}	I_C		P_C					@I_C	@V_{GE}		Load (*2)	
				DC	Pulse	T_C = 25°C		Type							
			(V)	(A)	(A)	(W)				(V)	(A)	(V)	(μs)		
Inverter power supplies (UPS/PFC/motor)	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 $V_{CE(sat)}$
		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 ciruit configuration
*2 R : Resistive load
L : Inductive load

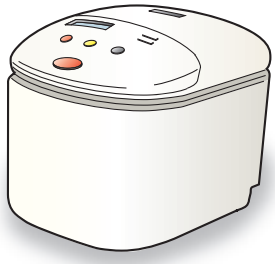
5-2 Soft-Switching Applications

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

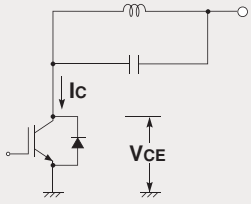
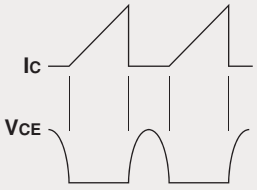
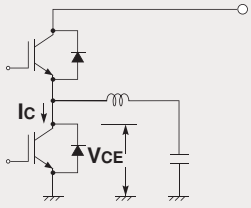
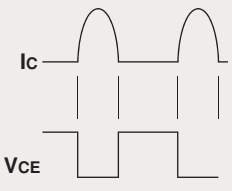


IH Rice Cookers



IH Cooktops

MFP

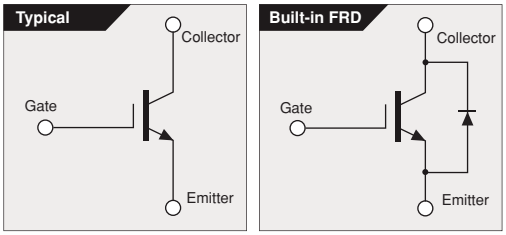
AC Input Voltage	Circuit		IGBT Rating
100 V to 120 V	Voltage Resonance 	Waveform 	VCES = 900 V to 1000 V Ic = 15 A to 60 A
200 V to 240 V			VCES = 1200 V to 1500 V Ic = 40 A
100 V to 240 V	Current Resonance 	Waveform 	VCES = 400 V Ic = 40 A to 50 A
			VCES = 600 V Ic = 30 A to 80 A

IH: Induction heating
MFP: Multifunction Printer

Soft-switching series

Product List for Soft-Switching Applications

Circuit Configuration

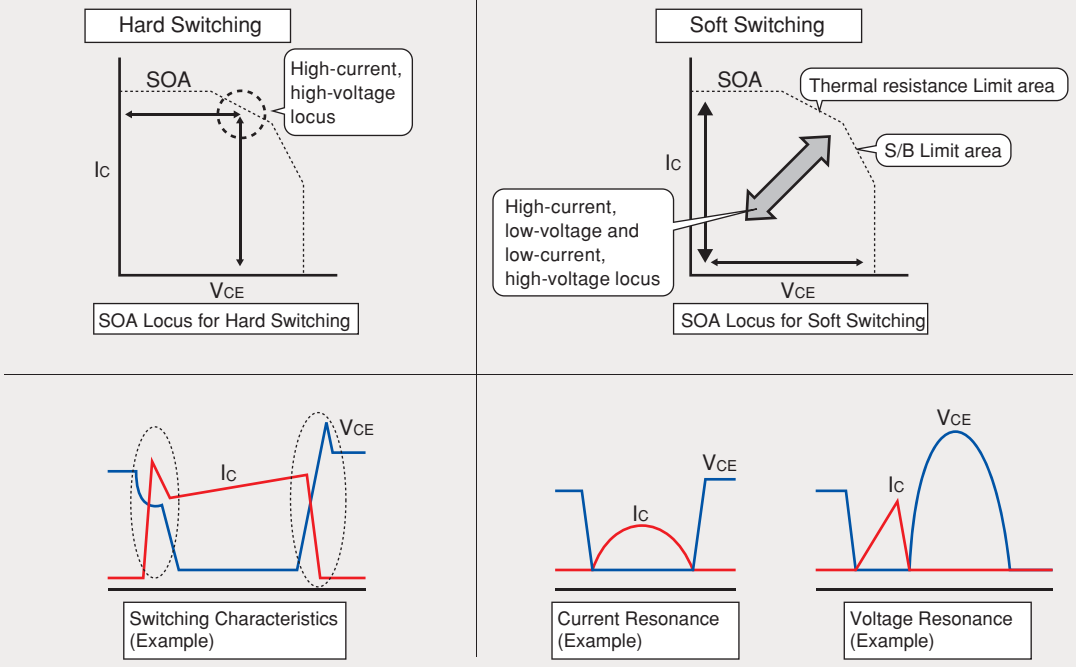


■ IGBTs for Soft-Switching

Main Applications		Features	Part Number	Absolute Maximum Ratings				Package	Circuit Configuration (*1)	$V_{CE(sat)}$ Typ.			t_f Typ.		Remarks
				V_{CES} (V)	I_C DC (A)	I_C Pulse (A)	P_C T_C = 25°C (W)			(V)	@I_C (A)	@V_{GE} (V)	(μs)	Load (*2)	
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	Built-in FRD	2.1	50	15	0.25		
			GT35J321		37	100	75			1.9	50	15	0.19		
			GT50J322		50	100	130	TO-3P(LH)		2.1	50	15	0.25		
			GT50J322H		50	100	130	TO-3P(N)		2.2	50	15	0.16		Fast switching
			GT50J327		50	100	140			1.9	50	15	0.19		
			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	Built-in FWD	1.8	15	15	0.20		
			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
	AC100-120V		**GT50N321**	1000	50	120	156	TO-3P(N)		2.5	60	15	0.25		
			GT60N321		60	120	170			2.3	60	15	0.25		
			GT60N322		57	120	200	TO-3P(LH)		2.4	60	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	40	15	0.41		
			GT40Q323		39	80	200	TO-3P(N)		3.0	40	15	0.14		
			GT40T301	1500	40	80	200	TO-3P(LH)		3.7	40	15	0.25		

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

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

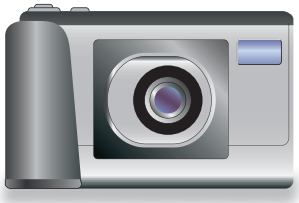


5-3 Strobe Flash Applications

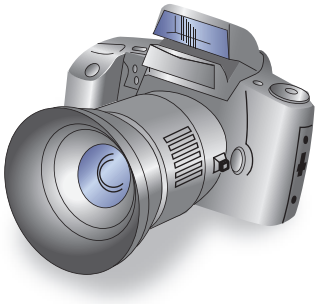
Strobe flash control is now prevalent in digital still cameras. Package sizes are getting smaller, and logic levels are increasingly used to represent the gate drive voltage. Toshiba offers compact IGBTs featuring low gate drive voltage.

- As a voltage-controlled device, the IGBT requires low drive power dissipation.
- IGBTs help reduce the number of components required for the strobe flash circuit. (compared with SCRs)
- Strobe flash IGBTs are capable of switching large currents.

DSC, Compact Camera



Single-Lens Reflex Camera

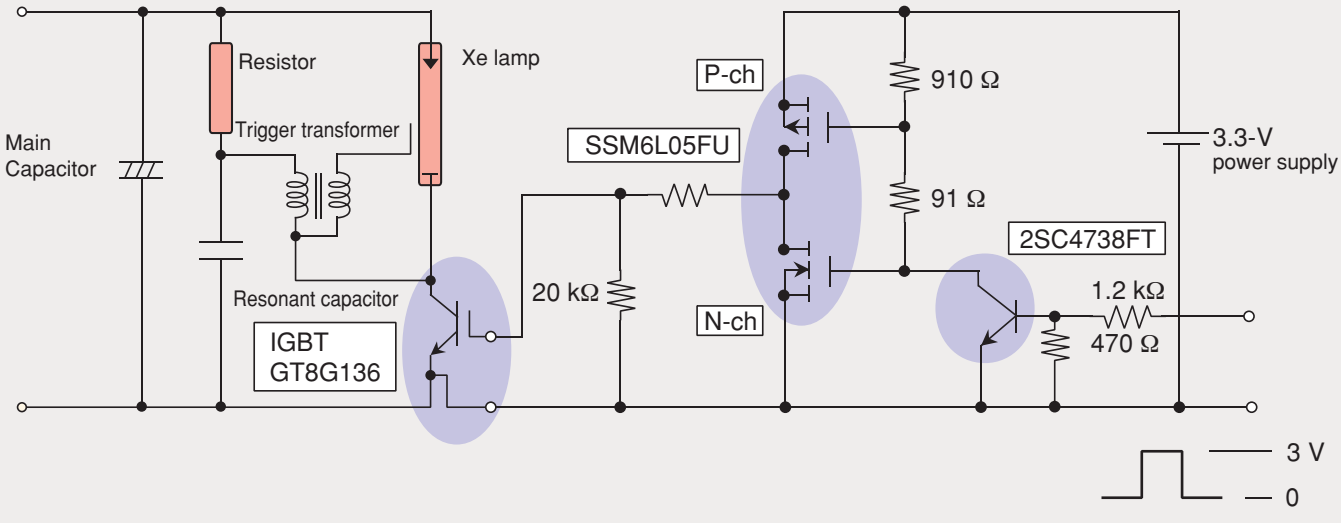


Product List for Strobe Applications

■ 3-V to 4.5-V Gate Drive Series

The IGBT can operate with a gate drive voltage of 3 V to 4.5 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-V Gate Drive Series

Part Number	VCES / IC	VCE(sat) Max (V)	VCE(sat) Max VGE / IC	PC (W) @Ta = 25°C	Package	Remarks
GT5G131	400 V / 130 A	7	3 V / 130 A	1.1	**SOP-8**	5th generation
GT8G136	400 V / 150 A	7	3 V / 150 A	1.0	**TSSOP-8**	5th generation

■ 4-and 4.5-V Gate Drive Series

Part Number	VCES / IC	VCE(sat) Max (V)	VCE(sat) Max VGE / IC	PC (W) @Ta = 25°C	Package	Remarks
GT5G103	400 V / 130 A	8	4.5 V / 130 A	1.3	**DP**	3th generation
GT8G103	400 V / 150 A	8	4.5 V / 150 A	1.3	**DP**	3th generation
GT8G132	400 V / 150 A	7	4.0 V / 150 A	1.1	**SOP-8**	5th generation
GT8G133	400 V / 150 A	7	4.0 V / 150 A	1.1	**TSSOP-8**	5th generation

■ 20-V Gate Drive Series

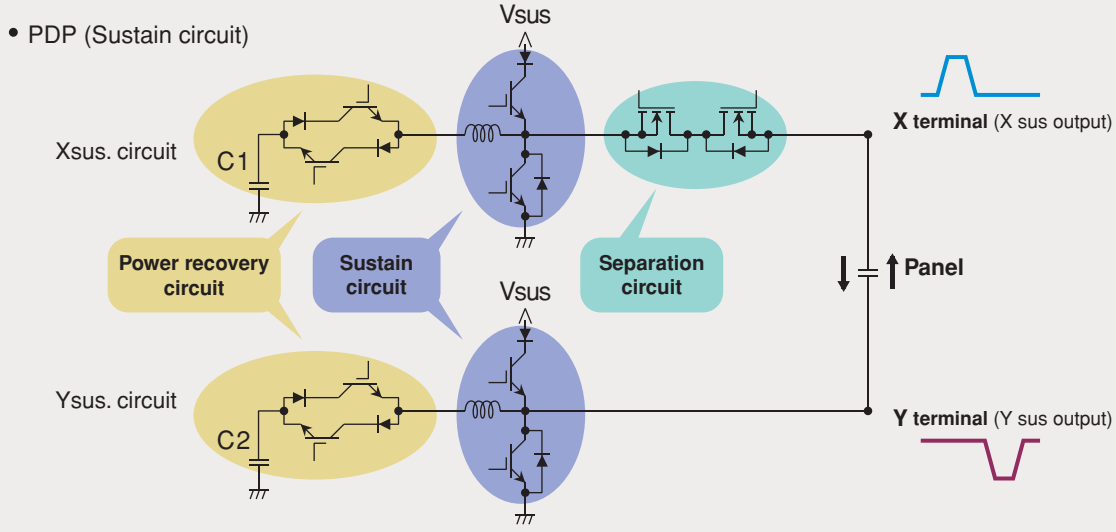
Part Number	VCES / IC	VCE(sat) Max (V)	VCE(sat) Max VGE / IC	PC (W) @Ta = 25°C	Package	Remarks
GT25G101	400V / 170 A	8	20 V / 170 A	1.3	**TO-220FL**	

5-4 Plasma Display Panel Applications

Plasma Display

Previously, MOSFETs were used for the power supplies of plasma display panels (PDPs). Recently, however, MOSFETs are being replaced by IGBTs, which have lower $V_{CE(sat)}$ in a large current area.

Example of a Plasma Display Panel Power Supply



Plasma display panel series — Product List for Plasma Display Panel Applications

■ 300-V Series

Part Number	V_{CES} / Icp @100 μs	$V_{CE(sat)}$ Max (V)	P_C (W) @Ta = 25°C	Package	Remarks
GT35F131	300 V / 140 A	3.4 (@140 A)	60	**TO-220AB**	
GT30F121	300 V / 120 A	2.9 (@120 A)	35	**TO-220SIS**	
GT30F122	300 V / 120 A	2.9 (@120 A)	25	**TO-220SIS**	

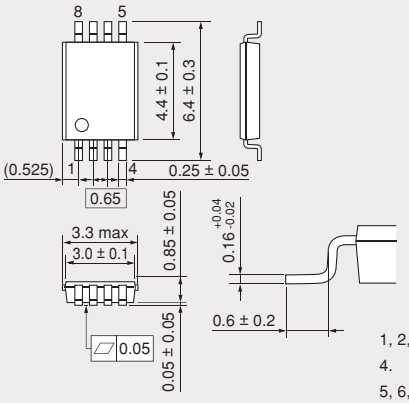
■ 400-V Series

Part Number	V_{CES} / Icp @100 μs	$V_{CE(sat)}$ Max (V)	P_C (W) @Ta = 25°C	Package	Remarks
GT30G131	400 V / 120 A	3.2 (@120 A)	60	**TO-220AB**	
GT30G121	400 V / 120 A	2.9 (@120 A)	35	**TO-220SIS**	
GT30G122	400 V / 120 A	2.6 (@120 A)	25	**TO-220SIS**	

6 Package Dimensions

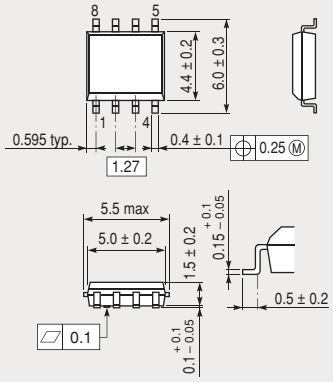
Unit: mm

TSSOP-8



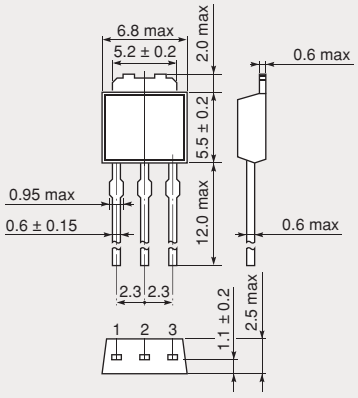
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

SOP-8



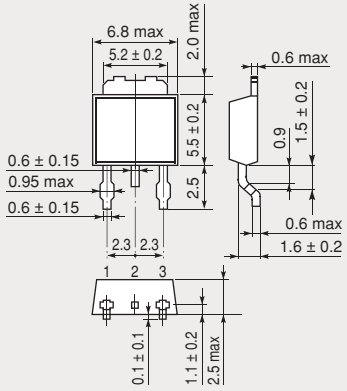
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

DP (Straight Leads)



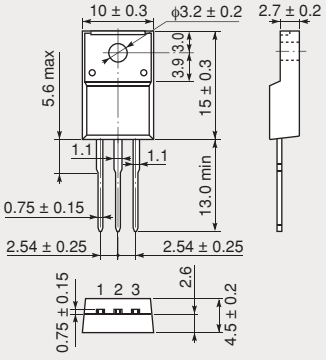
1. Gate
2. Collector
3. Emitter

DP (Bend Leads)



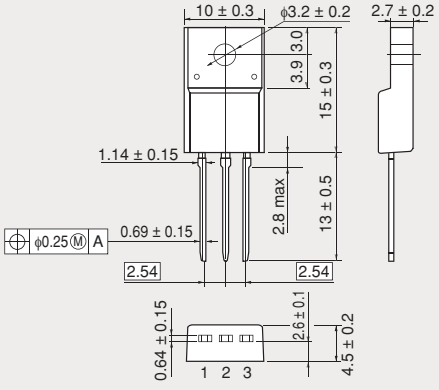
1. Gate
2. Collector
3. Emitter

TO-220NIS



1. Gate
2. Collector
3. Emitter

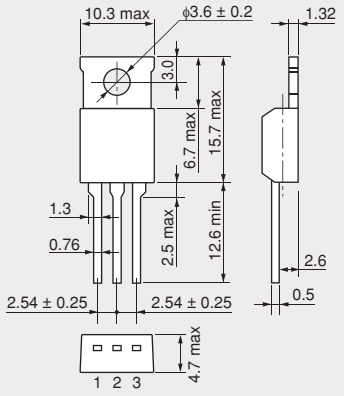
TO-220SIS



1. Gate
2. Collector
3. Emitter

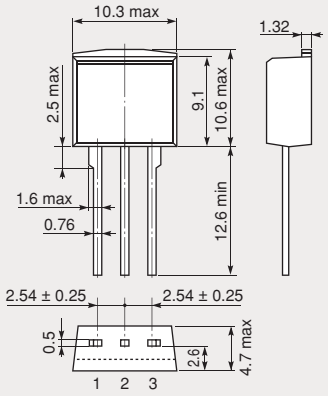
Unit: mm

TO-220AB



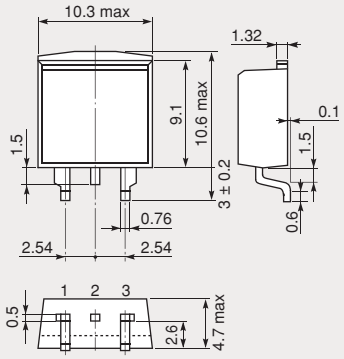
1. Gate
2. Collector
3. Emitter

TO-220FL



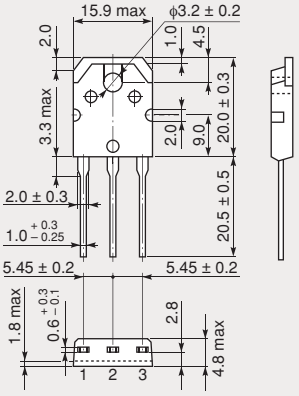
1. Gate
2. Collector
3. Emitter

TO-220SM



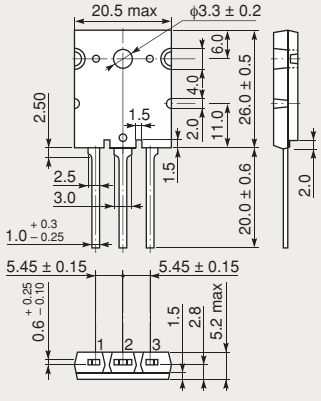
1. Gate
2. Collector
3. Emitter

TO-3P(N)



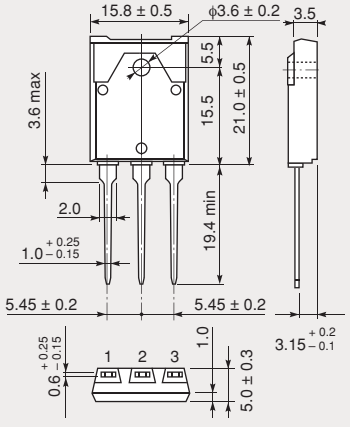
1. Gate
2. Collector
3. Emitter

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 applications	**MG30T1AL1**	1500	30	IH	**GT40T301**	1500	40	TO-3P(LH)
	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)	**GT40T301**	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	**GT40T301**	1500	40	TO-3P(LH)
	GT50S101	1400	50	IH	**GT40T301**	1500	40	TO-3P(LH)
	GT50T101	1500	50	IH	**GT40T301**	1500	40	TO-3P(LH)
	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)
Hard-switching applications	**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 flash applications	**GT5G101**	400	130 (pulse)	NPM	**GT5G103**	400	130 (pulse)	DP
	GT5G102	400	130 (pulse)	DP	**GT5G103**	400	130 (pulse)	DP
	GT8G101	400	130 (pulse)	NPM	**GT5G103**	400	130 (pulse)	DP
	GT8G102	400	150 (pulse)	NPM	**GT8G103**	400	150 (pulse)	DP
					—	—	—	—
	GT10G101	400	130 (pulse)	TO-220NIS	**GT25G101**	400	170 (pulse)	TO-220FL
	GT10G102	400	130 (pulse)	TO-220NIS	**GT25G102**	400	150 (pulse)	TO-220FL
	GT15G101	400	170 (pulse)	TO-220NIS	**GT25G101**	400	170 (pulse)	TO-220FL
	GT20G101	400	130 (pulse)	TO-220FL	**GT25G101**	400	170 (pulse)	TO-220FL
	GT20G102	400	130 (pulse)	TO-220FL	**GT8G103**	400	150 (pulse)	DP
	GT25G102	400	150 (pulse)	TO-220FL	**GT8G103**	400	150 (pulse)	DP
	GT50G101	400	100 (pulse)	TO-3P(N)	**GT25G101**	400	170 (pulse)	TO-220FL
	GT50G102	400	100 (pulse)	TO-3P(N)	**GT8G103**	400	150 (pulse)	DP
	GT75G101	400	150 (pulse)	TO-3P(N)	**GT25G101**	400	170 (pulse)	TO-220FL
Audio amp applications	**GT20D101**	250	20	TO-3P(L)	—	—	—	—
	GT20D201	–250	–20	TO-3P(L)	—	—	—	—

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Previous edition: BCE0010C
2007-3(0.3k)PC-DQ