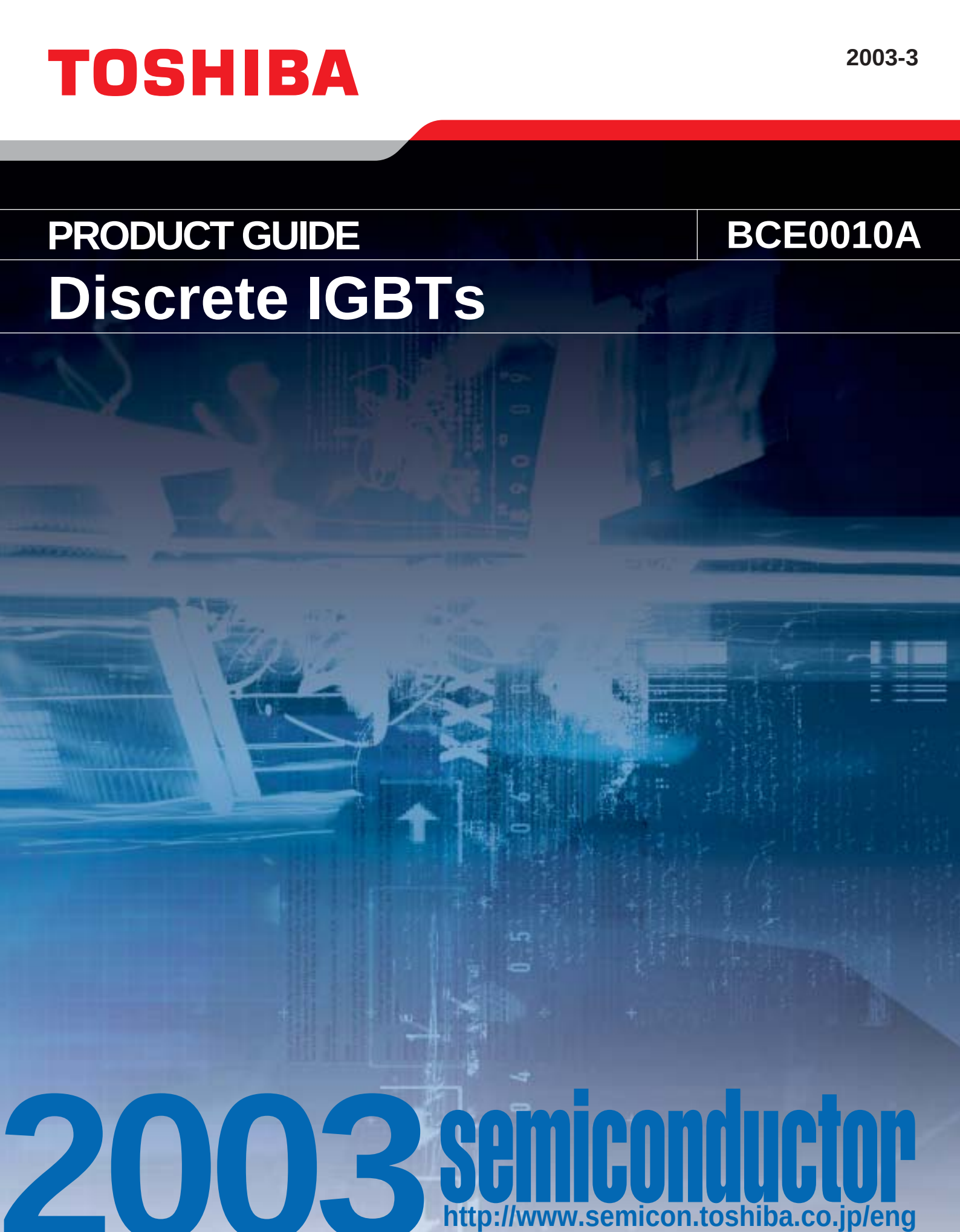
TOSHIBA

2003-3

PRODUCT GUIDE

BCE0010A

Discrete IGBTs



2003 semiconductor

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

1. Features and Structure

IGBT: Insulated Gate Bipolar Transistor

- MOSFET-like high input impedance characteristics enable voltage drive
- With the conductivity modulation characteristics of a bipolar transistor, ideal for applications that require low-saturation voltage, high-withstanding voltage and high current
- Low carrier accumulation, excellent frequency and switching characteristics, suitable for use in high-current amplification

■ Features

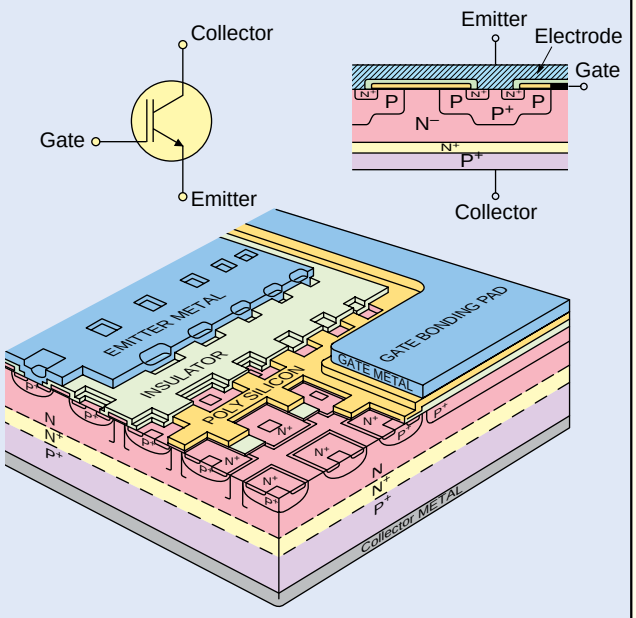
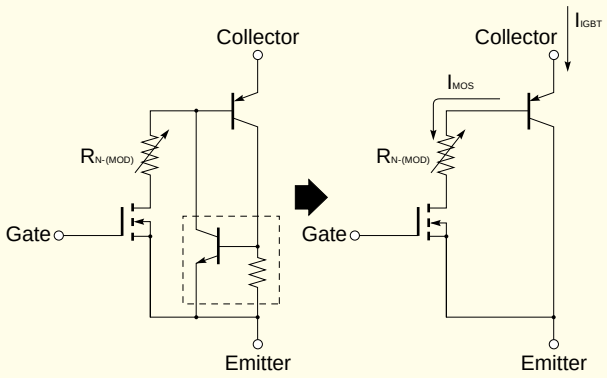
Rated at 1500 V and 80 A, Toshiba discrete IGBTs are excellent as power converters in such diverse applications as motor drives, uninterruptible power supply (UPS) units and induction heaters.

Some features of Toshiba IGBTs are:

(1) High switching speed
(2) Low-saturation voltage
(3) Built-in diode with optimal characteristics
(4) High input impedance characteristics enable voltage drive
(5) A variety of package types is available

■ Construction

Basic structure consists of four layers (PNPN), as shown in the following figure.
Low-saturation voltage is achieved by using the PNP transistor to modulate conductivity.
Unlike a MOSFET, a four-layer transistor does not incorporate a reverse-conducting diode, since the P-layer forms the collector electrode.

Structure	Equivalent Circuit
	

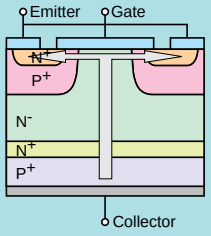
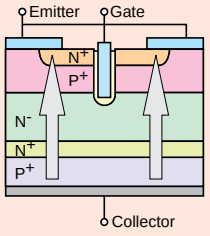
2. IGBT Engineering Advances

Power MOSFETs have long provided both high-speed and high-input impedance. However, various disadvantages such as increased resistance with increased breakdown voltage, as well as difficulties handling high breakdown voltages and high currents, are also associated with MOSFETs.
The cross-section of the IGBT on the previous page shows how IGBT resistance is reduced by injecting holes into the N^- layer from the P^+ substrate collector to change the conductivity.

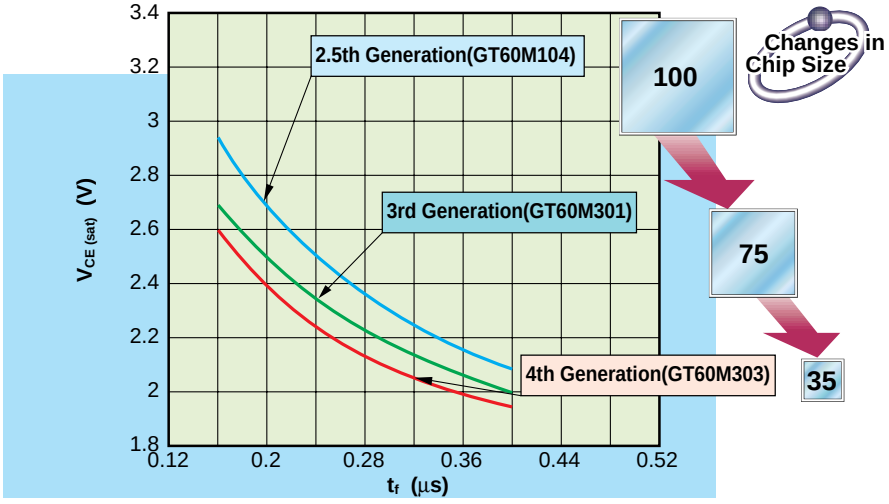
Toshiba have miniaturized unit cells and optimized wafers to decrease $V_{CE(sat)}$ switching loss. The following data demonstrates the progress made thus far:

2.5th-generation IGBTs ($V_{CE(sat)}$ = 2.5 V typ.)
↓
3rd-generation IGBTs ($V_{CE(sat)}$ = 2.3 V typ.)
↓
Trench IGBTs ($V_{CE(sat)}$ = 2.1 V typ.)
(V_{CES} = 900 V type)

In addition to wafer optimization, Toshiba are applying trench gate technology and developing improved lifetime control to optimize the $V_{CE(sat)}$ versus switching speed trade-off.

Gate Process		Planar		Trench
Generation		2.5th generation	3rd generation	4th generation
Structure				
$V_{CE(sat)}$(@600 V)		2.5 V typ.	2.1 V typ.	2.1 V typ.
Cell Size	Up to 900 V	1.00	0.43	0.06
	1200 V	1.00	0.75	–

Trade-Off Characteristics Evolution (V_{CES} = 900 V type)



Discrete IGBT development trends

1200 V
- (1) High breakdown capability (3rd generation): low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and reduced wafer thickness
- (2) Soft switching(5th generation): improved trade-off between $V_{CE(sat)}$ and t_f due to adoption of trench gate

900 V
- (1) Soft switching (4th generation): improved trade-off between $V_{CE(sat)}$ and t_f due to adoption of trench gate
- (2) Soft switching(5th generation): adoptions of wafer and design rule optimizations

600 V
- (1) High breakdown capability (3rd generation): low $V_{CE(sat)}$ and high ruggedness due to miniaturization (up to 20 kHz).
- (2) Fast switching (FS): trench gate and carrier injection optimization (up to 50 kHz)
- (3) Soft switching (4th generation): improved trade-off between $V_{CE(sat)}$ and tf due to adoption of trench gate

400 V
- (1) Strobe flash (3rd generation): reduced gate drive voltage (V_{GE} = 4.5 V @I_C = 130 A, V_{GE} = 4.5 V @I_C = 150 A)
- (2) Strobe flash (4th generation): trench gate and gate drive voltage reduction (V_{GE} = 4 V @I_C = 150 A)
- (3) Strobe flash (5th generation) : adoptions of wafer and design rule optimizations
  low gate drive voltage (V_{GE} = 3 V @I_C = 130 A, V_{GE} = 4 V @I_C = 150 A)

2000 2002 2004

3. Discrete IGBT Line-up

Applications and Features	Withstanding Voltage $V_{CES(V)}$ @Tc = 25°C	IGBT Current Rating Ic(A)@Tc = 25°C		SOP-8	DP		TO-220NIS	TO-220FL	TO-220SM	TO-220AB	TO-3P(N)	TO-3P(N)IS	TO-3P(SM)	TO-3P(LH)
					straight leads	formed leads								
		DC	Pulse											
Strobe flash	400		130	GT5G131	GT5G103									
			150	GT8G131 GT8G132	GT8G103 GT8G121			GT25G102	GT25G102					
			170					GT25G101	GT25G101					
Soft switching series	400	40	100							GT40G121				
		50												GT50G321
	600	30										GT30J322		
		50												GT50J322
		60	120											GT60J321 GT60J322
		80	160											GT80J101A
	900	15	30									GT15M321		
		60	120											GT60M302 GT60M303 GT60M323(*)
	1000													GT60N321
	1200	40	80								GT40Q321			
	1500													GT40T301 GT40T101
Hard switching series High rugged products	600	5	10				GT5J301		GT5J311					
		10	20				GT10J303		GT10J312		GT10J301		GT10J311	
		15	30				GT15J301		GT15J311					
		20	40								GT20J301 GT20J101		GT20J311	
		30	60								GT30J301 GT30J101		GT30J311	
		50	100											GT50J301 GT50J102
	1200	10	20								GT10Q301 GT10Q101			
		15	30								GT15Q301 GT15Q102		GT15Q311	
		25	50											GT25Q301 GT25Q102
Hard switching series Fast switching (FS) series	600	15	30				GT15J321							
		20	40				GT20J321							
		30	60								GT30J324 GT30J121			
		50	100											GT50J325 GT50J121
General-purpose inverters for low-$V_{CE(sat)}$ products	600	15	30						GT15J331					

(*) Under development

4. Product Number Format

(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

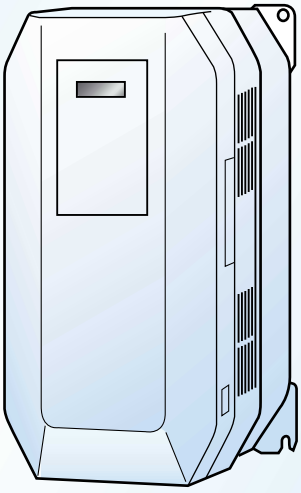
Mark	Voltage (V)	Mark	Voltage (V)
C	150	M	900
D	200	N	1000
E	250	P	1100
F	300	Q	1200
G	400	R	1300
H	500	S	1400
J	600	T	1500
K	700	U	1600
L	800	V	1700

5. Characteristics

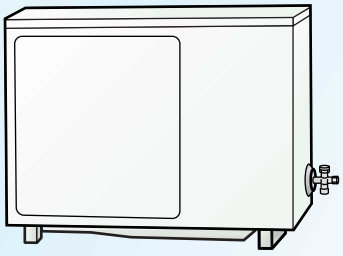
1. Hard Switching Applications

The addition of the fast switching (FS) series to the third-generation devices (high ruggedness) allows the construction of more efficient electronic equipment.

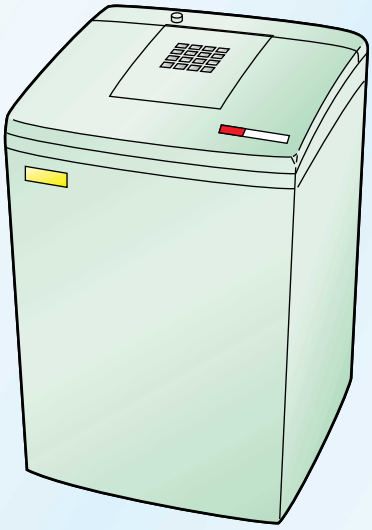
General-Purpose Inverters



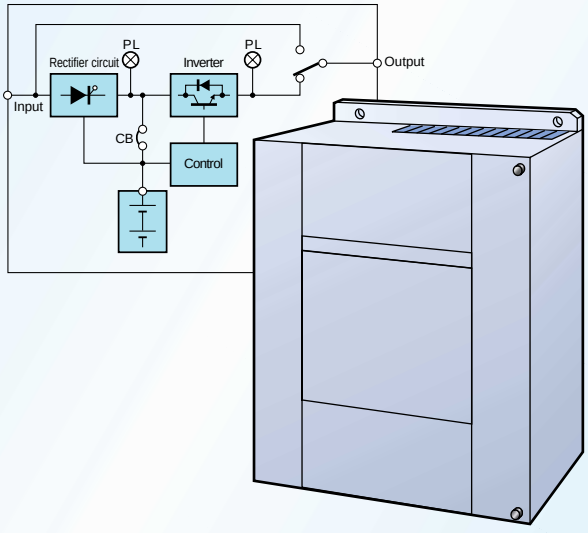
Inverter Air Conditioners



Inverter Washing Maschines



UPS

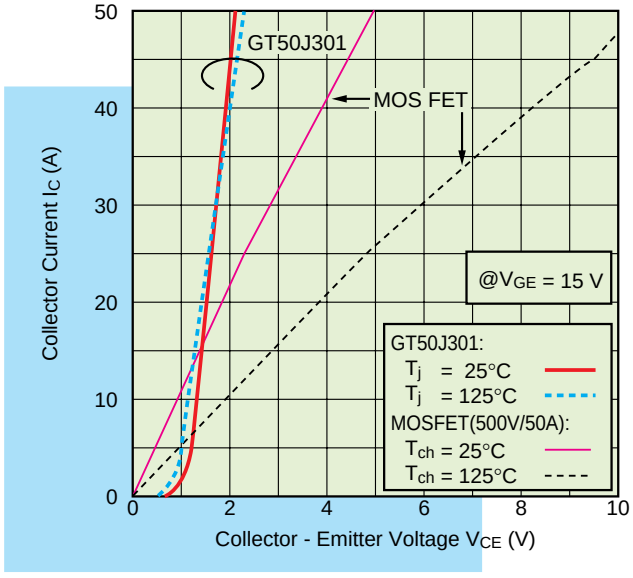


Characteristics

As shown below, third-generation IGBT is low-loss and low-noise when it use for inverter applications because of high switching speed, low-saturation voltage and high-efficiency diodes. (comparision with Toshiba MOSFET)

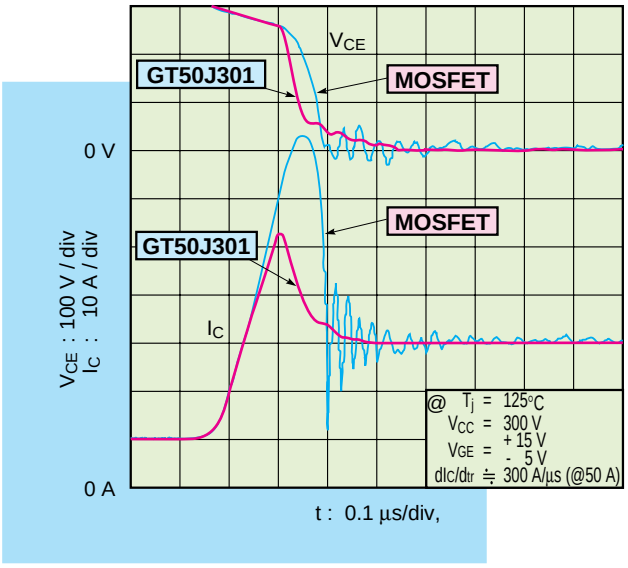
Low-saturation voltage with minimal temperature dependence

● I_C - V_{CE} temperature characteristics



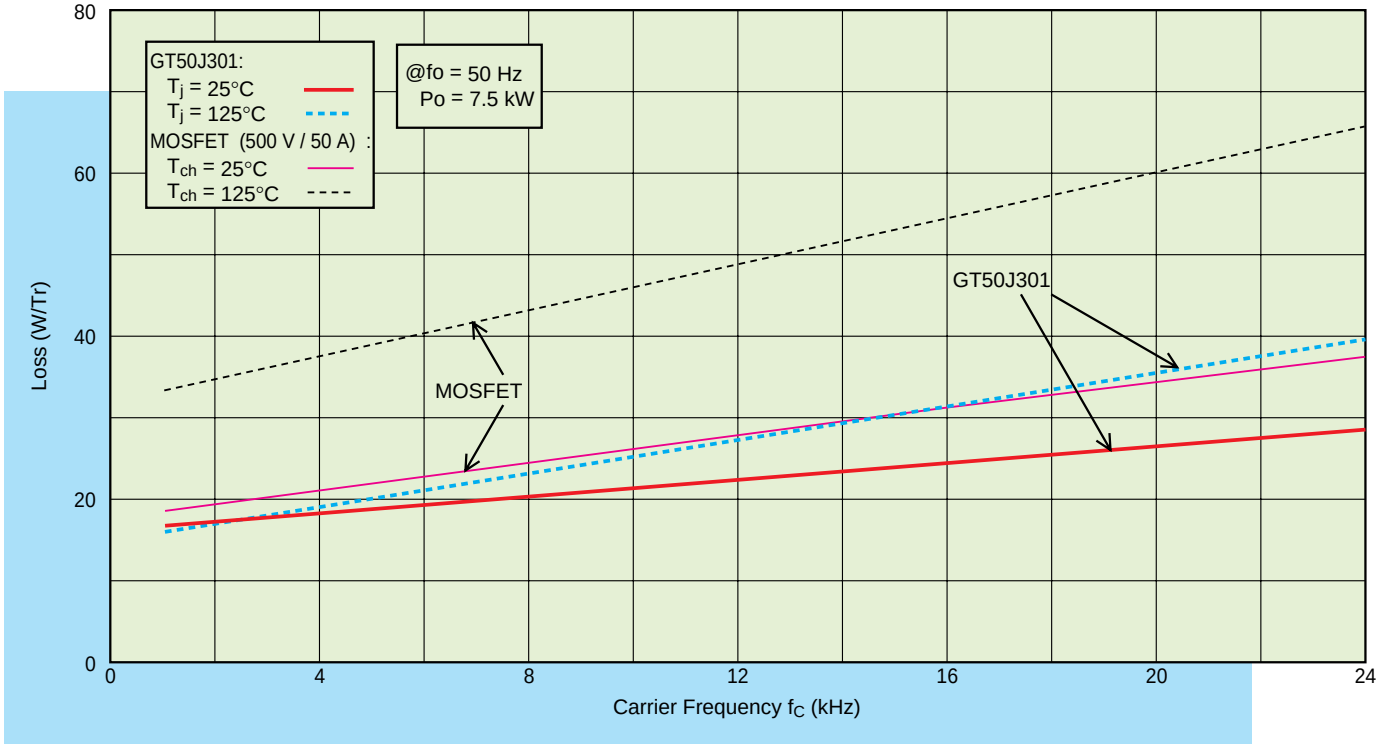
Superior reverse-recovery characteristics due to built-in diode with optimal characteristics

● Turn-on waveform



Simulation data of inverter application

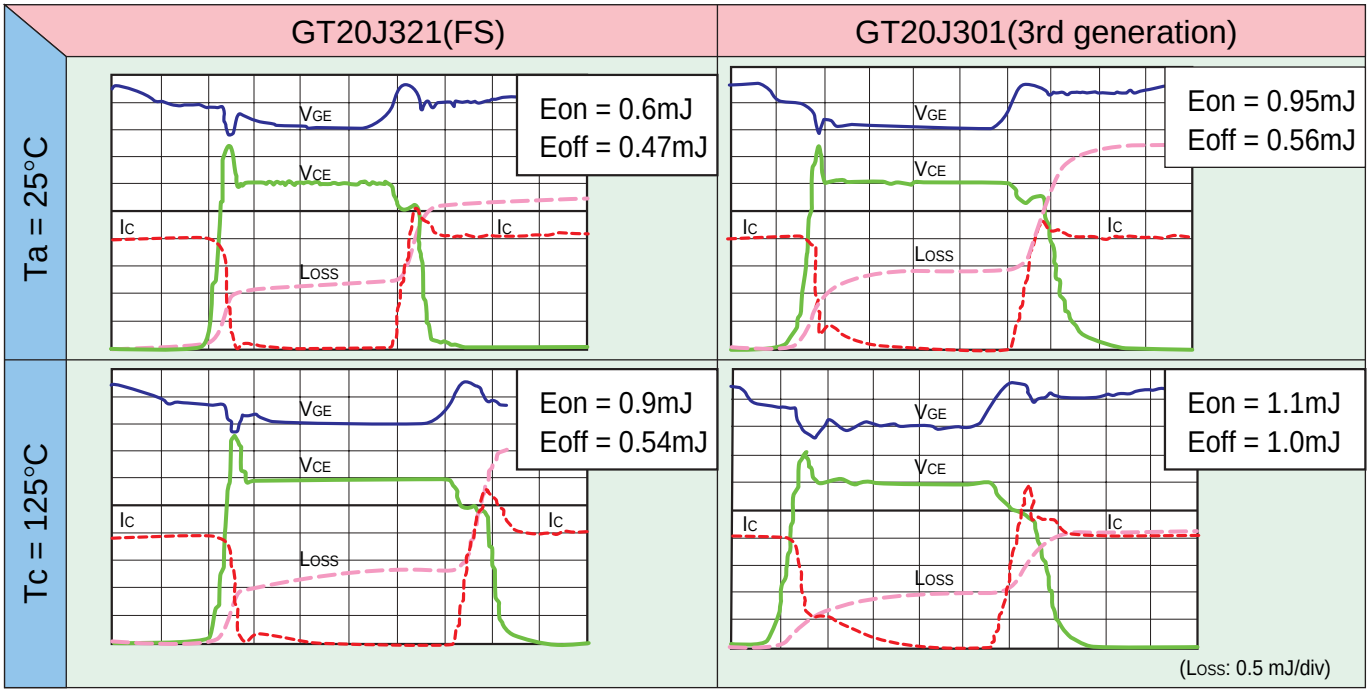
● Power loss vs. frequency characteristics



Fast switching IGBTs

With a design geared to high-speed operation, fast switching IGBTs reduce switching loss (E_{on} + E_{off}) by 30% compared to high-rugged-products (according to Toshiba's comparative tests).

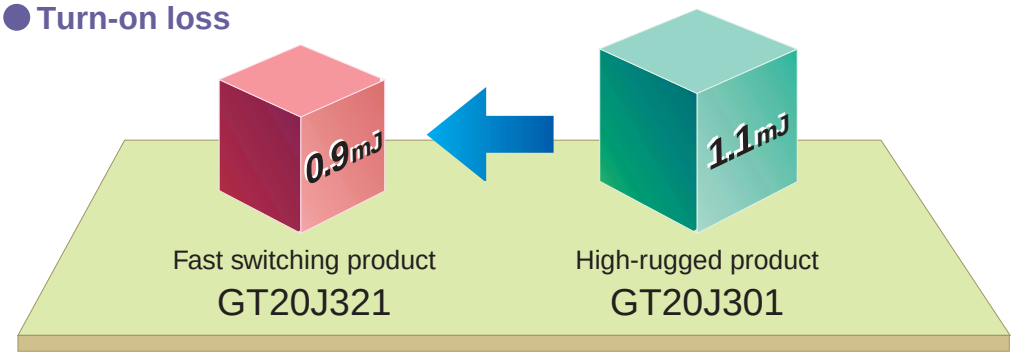
Typical waveforms



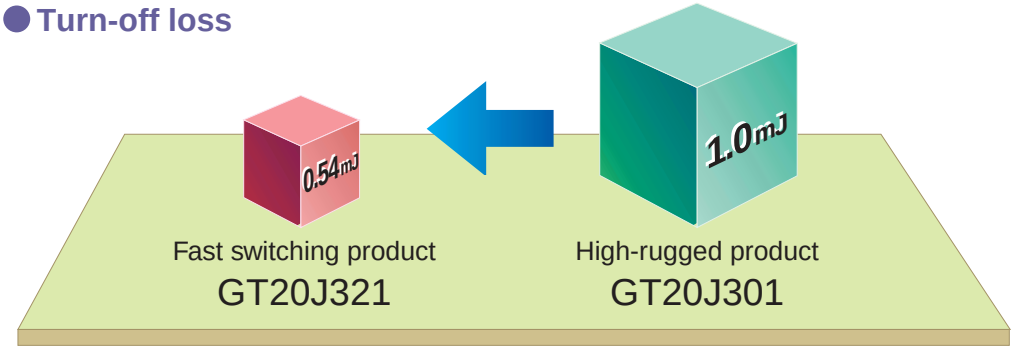
(VCE: 50 V/div, IC: 5 A/div, VGE: 10 V/div, Loss: 0.2 mJ/div, t: 0.2 µs/div)

Reduced switching loss of fast switching products in comparison with high rugged products
Test condition: I_C = 20 A, V_{GE} = 15 V, R_G = 33 Ω, T_C = 125°C
with inductive load V_{CC} = 300 V

Turn-on loss



Turn-off loss



Characteristics

High-rugged products with 600 V and 1200 V voltage ratings (third generation)

With built-in diode

Package	Product No.	V_{CES} (V) max	I_C (A) DC max	P_C (W) max	$V_{CE(sat)}$ (V) typ.	t_r (μs) typ.	t_f (μs) typ.	V_F (V) max	t_{rr} (ns) max	Remarks
TO-220NIS	GT5J301	600	5	28	2.1	0.12	0.15	2.0	200	
	GT10J303		10	30	2.1	0.12	0.15	2.0	200	
	GT15J301		15	35	2.1	0.12	0.15	2.0	200	
TO-220SM	GT5J311	600	5	45	2.1	0.12	0.15	2.0	200	
	GT10J312		10	60	2.1	0.12	0.15	2.0	200	
	GT15J311		15	70	2.1	0.12	0.15	2.0	200	
TO-3P(N)	GT10J301	600	10	90	2.1	0.12	0.15	2.0	200	
	GT20J301		20	130	2.1	0.12	0.15	2.0	200	
	GT30J301		30	155	2.1	0.12	0.15	2.0	200	
	GT10Q301	1200	10	140	2.1	0.07	0.16	3.0	350	
	GT15Q301		15	170	2.1	0.05	0.16	3.0	350	
TO-3P(SM)	GT10J311	600	10	80	2.1	0.12	0.15	2.0	200	
	GT20J311		20	120	2.1	0.12	0.15	2.0	200	
	GT30J311		30	145	2.1	0.12	0.15	2.0	200	
	GT15Q311	1200	15	160	2.1	0.05	0.16	3.0	350	
TO-3P(LH)	GT50J301	600	50	200	2.1	0.12	0.15	3.5	200	
	GT25Q301	1200	25	200	2.1	0.10	0.16	3.0	350	

Without built-in diode

Package	Product No.	V_{CES} (V) max	I_C (A) DC max	P_C (W) max	$V_{CE(sat)}$ (V) typ.	t_r (μs) typ.	t_f (μs) typ.	Remarks
TO-3P(N)	GT20J101	600	20	130	2.1	0.12	0.15	
	GT30J101		30	155	2.1	0.12	0.15	
	GT10Q101	1200	10	140	2.1	0.07	0.16	
	GT15Q102		15	170	2.1	0.05	0.16	
TO-3P(LH)	GT50J102	600	50	200	2.1	0.12	0.15	
	GT25Q102	1200	25	200	2.1	0.10	0.16	

Fast switching (FS) series with 600 V voltage rating (fourth generation)

With built-in diode

Package	Product No.	V_{CES} (V) max	I_C (A) DC max	P_C (W) max	$V_{CE(sat)}$ (V) typ.	t_r (μs) typ.	t_f (μs) typ.	V_F (V) max	t_{rr} (ns) typ.	Remarks
TO-220NIS	GT10J321	600	10	29	2.0	0.04	0.04	2.0	200(max)	Currently being planned
	GT15J321		15	30	1.9	0.04	0.03	2.0	200(max)	
	GT20J321		20	45	2.0	0.04	0.04	2.1	100	
TO-3P(N)	GT30J324		30	170	2.0	0.07	0.05	3.8	60	
TO-3P(LH)	GT50J325		50	240	2.0	0.07	0.05	4.2	65	

Without built-in diode

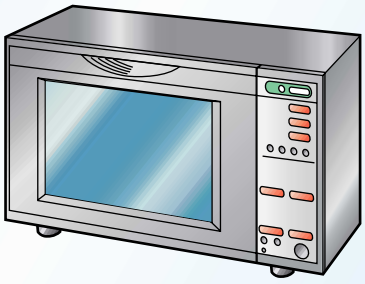
Package	Product No.	V_{CES} (V) max	I_C (A) DC max	P_C (W) max	$V_{CE(sat)}$ (V) typ.	t_r (μs) typ.	t_f (μs) typ.	Remarks
TO-3P(N)	GT30J121	600	30	170	2.0	0.07	0.05	
TO-3P(LH)	GT50J121		50	240	2.0	0.07	0.05	

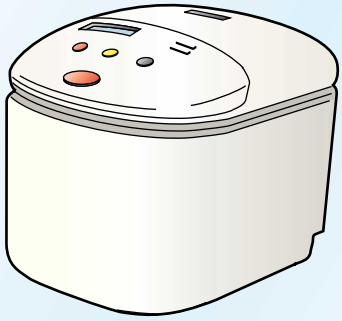
2. Soft Switching Applications

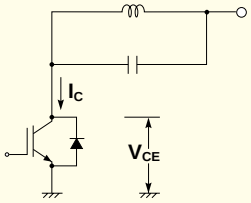
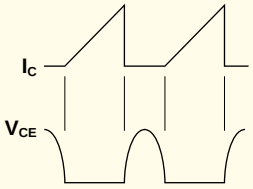
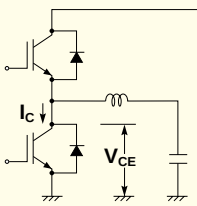
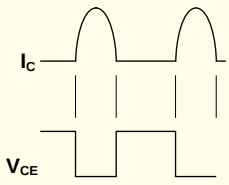
Soft-switching circuits (current and voltage resonance type) that exhibit low switching loss are used in applications such as induction heaters (IHs) and IH rice cookers and microwave ovens.

Toshiba offers a line of IGBTs with optimally low $V_{CE(sat)}$ and high switching speed which are especially suited to soft-switching circuits.

Microwave Ovens | IH Rice Cookers | Induction Heaters





AC Input Voltage	Circuit	IGBT Rating
100 V to 120 V	Valtage Resonance  Waveform  	V_{CES} = 900 V, 1000 V I_C = 15 A, 60 A
200 V to 240 V		V_{CES} = 1200 V, 1500 V I_C = 40 A
100 V to 240 V	Current Resonance  Waveform  	V_{CES} = 400 V I_C = 40 A, 50 A
		V_{CES} = 600 V I_C = 30 A to 80 A

Characteristics

●IGBTs and Diodes for Voltage Resonance Circuits (with soft switching)

IGBT

AC Input Voltage	Product No.	V_{CES} / I_C	FRD	t_f (μs) max	$V_{CE\ (sat)}$ (V) max	V_{GE} / I_C	Package	Remarks
100 V to 120 V	GT15M321	900 V / 15 A	I	0.4	2.5	15 V / 15 A	TO-3P (N)IS	For low power
	GT60M302	900 V / 60 A	I	0.37	3.3	15 V / 60 A	TO-3P (LH)	
	GT60M303	900 V / 60 A	I	0.4	2.7	15 V / 60 A	TO-3P (LH)	
	GT60M323	900 V / 60 A	I	–	–	15 V / 60 A	TO-3P (LH)	Under development
	GT60N321	1000 V / 60 A	I	0.4	2.8	15 V / 60 A	TO-3P (LH)	1000 V rating voltage
200 V to 240 V	GT40Q321	1200 V / 40 A	I	0.72(typ.)	3.6	15 V / 40 A	TO-3P (N)	New product
	GT40T101	1500 V / 40 A		0.4	5.0	15 V / 40 A	TO-3P (LH)	1500 V rating voltage
	GT40T301	1500 V / 40 A	I	0.4	5.0	15 V / 40 A	TO-3P (LH)	1500 V rating voltage

I : Included

High-Speed Rectifiers (FRDs)

AC Input Voltage	Product No.	V_{RRM} / I_{FSM}	C_j (pF) typ.	t_{rr} (μs) max	V_{FM} (V) max	I_F	Package	Remarks
100 V to 120 V	S5J12	900 V / 120 A	30	3.0	2.0	15 A	TO-220NIS	
200 V to 240 V	S5J25	1500 V / 120 A	75	3.0	2.5	30 A	TO-3P (N)	
	S5J53	1500 V / 120 A	75	2.0	2.5	30 A	TO-220NIS	
100 V to 240 V	S5783F	900 V / 250 A	60	3.5	1.6	60 A	TO-3P (N)IS	

● IGBTs for Current Resonance Circuits (with soft switching)

IGBT

AC Input Voltage	Product No.	V_{CES} / I_C	FRD	t_f (μs) max	$V_{CE\ (sat)}$ (V) max	V_{GE} / I_C	Package	Remarks
100 V to 240 V	GT40G121	400 V / 40 A		0.4	2.5	15 V / 60 A	TO-220AB	Compact package
	GT50G321	400 V / 50 A	I	0.4	2.5	15 V / 60 A	TO-3P (LH)	400 V rating voltage
	GT30J322	600 V / 30 A	I	0.4	2.8	15 V / 50 A	TO-3P (N)IS	Isolated package
	GT50J301	600 V / 50 A	I	0.3	2.7	15 V / 50 A	TO-3P (LH)	High rugged product
	GT50J322	600 V / 50 A	I	0.4	2.8	15 V / 50 A	TO-3P (LH)	
	GT50J325	600 V / 50 A	I	0.05(typ.)	2.45	15 V / 50 A	TO-3P (LH)	Fast switching
	GT80J101A	600 V / 80 A		0.4	3.0	15 V / 80 A	TO-3P (LH)	

I : Included

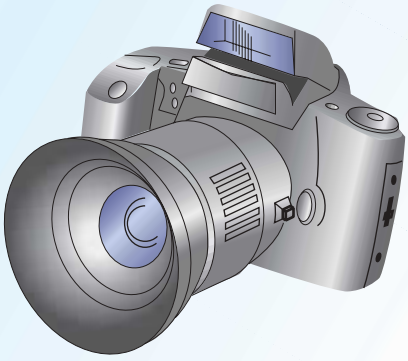
3. Strobe Applications

Thyristors previously used in strobe control circuits are today increasingly being replaced by IGBTs which have the following advantages.

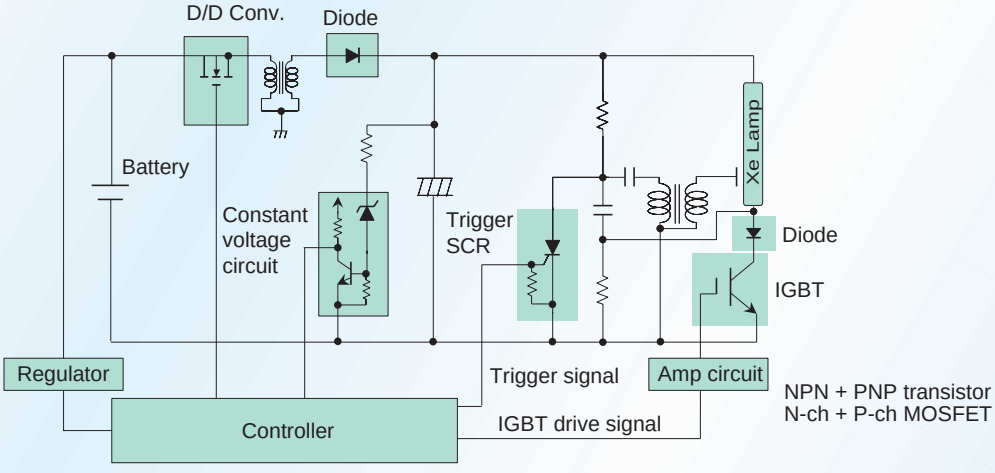
- ○As a voltage-controlled device, the IGBT requires few drive circuit components.
- ○The small circuits possible with IGBTs fit compactly into small camera bodies.
- ○Strobe flash IGBTs are capable of switching large currents.

DSC, Compact Camera

Single-Lens Reflex Camera



Example of strobe flash circuit

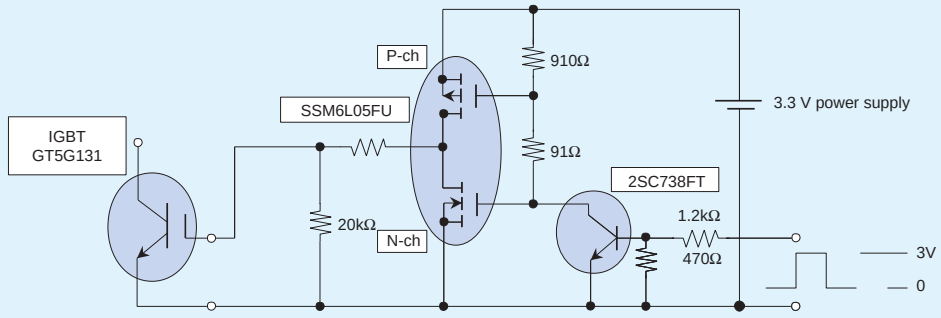


Characteristics

3 V to 4.5 V Gate Drive Series

The IGBT can be operated using a 3 to 4.5 V gate drive voltage.
A gate drive power supply can be used as the common 5 V internal power supply in a camera, enabling the power supply circuitry to be simplified.
A zener diode is included between the gate and emitter to provide ESD surge protection.

Example of IGBT gate drive circuit (3.3 V power supply voltage)



3 V Gate Drive Series

Product No.	V_{CES} / I_C	V_{CE} (sat) (V) max	V_{GE} / I_C	P_C (W) @Ta=25°C	Package	Remarks
GT5G131	400 V / 130 A	7	3V / 130 A	1.1	SOP-8	5th generation

4 and 4.5 V Gate Drive Series

Product No.	V_{CES} / I_C	V_{CE} (sat) (V) max	V_{GE} / I_C	P_C (W) @Ta=25°C	Package	Remarks
GT5G103	400 V / 130 A	8	4.5 V / 130 A	1.3	DP	
GT8G103	400 V / 150 A	8	4.5 V / 150 A	1.3	DP	
GT8G121	400 V / 150 A	7	4.0 V / 150 A	1.1	DP	4 V Gate Drive
GT8G131	400 V / 150 A	7	4.0 V / 150 A	1.1	SOP-8	4 V Gate Drive
GT8G132	400 V / 150 A	7	4.0 V / 150 A	1.1	SOP-8	5th generation

12 V Gate Drive Series

Product No.	V_{CES} / I_C	V_{CE} (sat) (V) max	V_{GE} / I_C	P_C (W) @Ta=25°C	Package	Remarks
GT25G102	400 V / 130 A	8	12 V / 130 A	1.3	TO-220 (FL)	

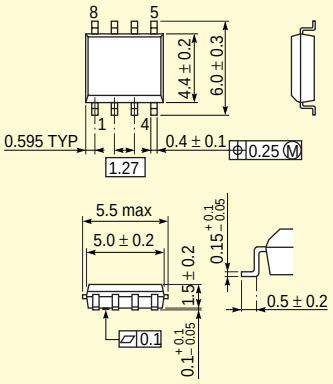
20 V Gate Drive Series

Product No.	V_{CES} / I_C	V_{CE} (sat) (V) max	V_{GE} / I_C	P_C (W) @Ta=25°C	Package	Remarks
GT25G101	400 V / 170 A	8	20 V / 170 A	1.3	TO-220 (FL)	

6. Package Dimensions

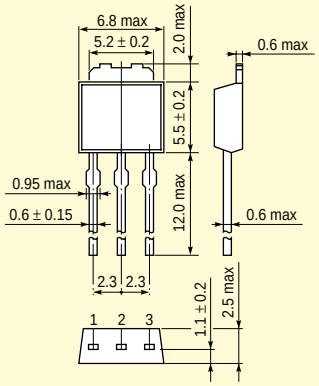
Unit: mm

SOP-8



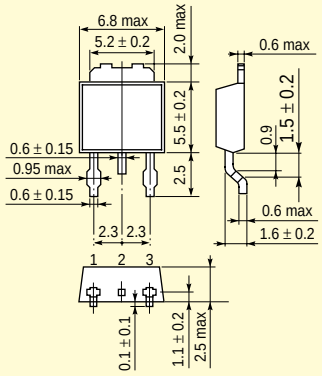
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

DP (through-hole)



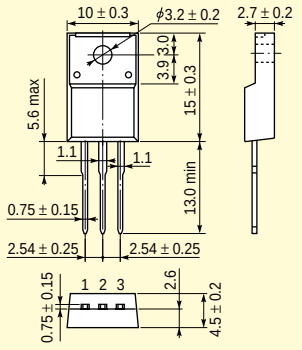
1. Gate
2. Collector
3. Emitter

DP (SMD)



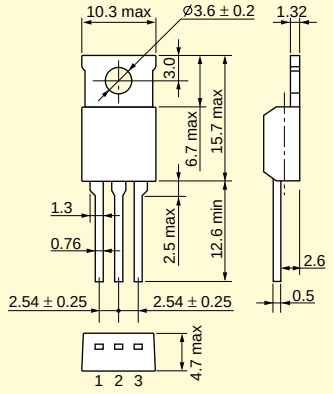
1. Gate
2. Collector
3. Emitter

TO-220NIS



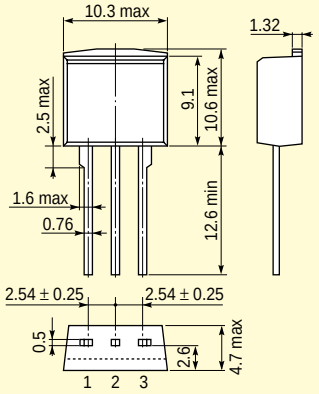
1. Gate
2. Collector
3. Emitter

TO-220AB



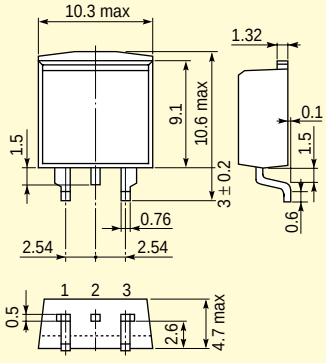
1. Gate
2. Collector
3. Emitter

TO-220FL



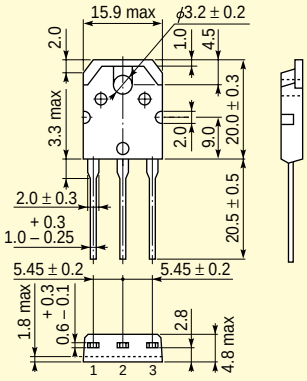
1. Gate
2. Collector
3. Emitter

TO-220SM



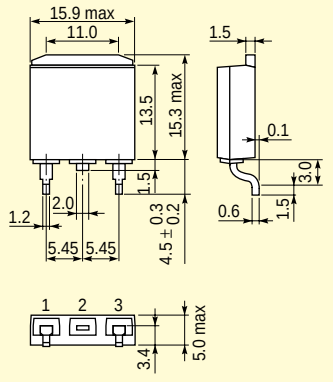
1. Gate
2. Collector
3. Emitter

TO-3P (N)



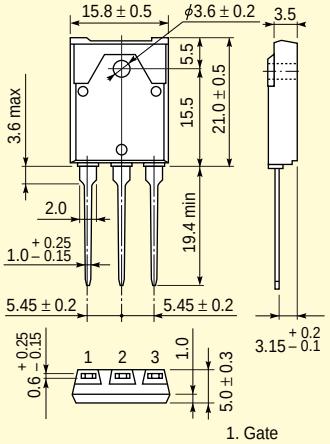
1. Gate
2. Collector
3. Emitter

TO-3P (SM)



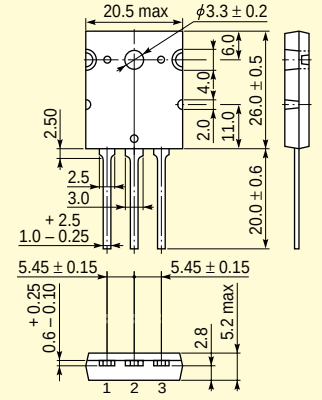
1. Gate
2. Collector
3. Emitter

TO-3P (N)IS



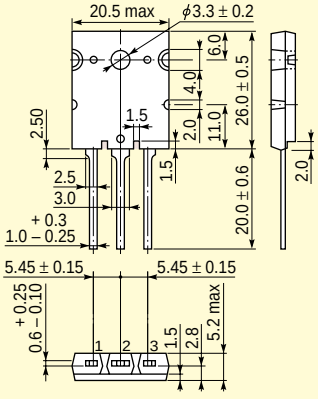
1. Gate
2. Collector
3. Emitter

TO-3P (L)



1. Gate
2. Collector
3. Emitter

TO-3P (LH)



1. Gate
2. Collector
3. Emitter

7. Final-phase and Discontinued Products

The following products are in stock but are being phased out of production.
Recommended equivalent products which can be used in their place are shown.
However, the characteristics of a recommended equivalent product may not be exactly the same as those of the final-phase-production or discontinued product.
Before using a recommended equivalent product, please check it is suitable for use under the intended operating conditions.

Application	Final-Phase-Production or Discontinued Product	Maximum Ratings		Package	Recommended Equivalent Product	Maximum Ratings		Package
		V_{CES} (V)	I_C (A) DC			V_{CES} (V)	I_C (A) DC	
Soft switching Applications	MG60M1AL1	900	60	IH	GT60M303	900	60	TO-3P(LH)
	MG30T1AL1	1500	30	IH	GT40T301	1500	40	TO-3P(LH)
	GT40M101	900	40	TO-3P(N)IS	–	–	–	–
	GT40M301	900	40	TO-3P(LH)	GT60M303	900	60	TO-3P(LH)
	GT50M101	900	50	TO-3P(L)	GT60M303	900	60	TO-3P(LH)
	GT50L101	800	50	TO-3P(L)	GT60M303	900	60	TO-3P(LH)
	GT50Q101	1200	50	IH	GT40T301	1500	40	TO-3P(LH)
					GT40T101	1500	40	TO-3P(LH)
	GT50S101	1400	50	IH	GT40T301	1500	40	TO-3P(LH)
					GT40T101	1500	40	TO-3P(LH)
	GT50T101	1500	50	IH	GT40T301	1500	40	TO-3P(LH)
					GT40T101	1500	40	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)
	GT60M305	900	60	TO-3P(LH)	GT60M303	900	60	TO-3P(LH)
	GT60J101	600	60	TO-3P(L)	GT50J102	600	50	TO-3P(LH)
	GT80J101	600	80	TO-3P(L)	GT80J101A	600	80	TO-3P(LH)
					GT60J321	600	60	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	GT15Q311	1200	15	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)
	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(IS)	GT30J121	600	30	TO-3P(N)
	GT25Q101	1200	25	TO-3P(LH)	GT25Q102	1200	25	TO-3P(LH)
	GT50J101	600	50	TO-3P(L)	GT50J121	600	50	TO-3P(LH)
Strobe Applications	GT5G101	400	130(pulse)	NPM	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
					GT8G121	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	GT25G102	400	150(pulse)	TO-220FL
	GT50G101	400	100(pulse)	TO-3P(N)	GT25G101	400	170(pulse)	TO-220FL
	GT50G102	400	100(pulse)	TO-3P(N)	GT25G102	400	150(pulse)	TO-220FL
	GT75G101	400	150(pulse)	TO-3P(N)	GT25G101	400	170(pulse)	TO-220FL

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