

PRODUCT GUIDE

Discrete IGBTs

1 Features and Structure

IGBT: Insulated Gate Bipolar Transistor

- MOSFET-like high input impedance characteristics enable voltage drive.
- The conductivity modulation characteristics of a bipolar transistor make it ideal for applications that require low-saturation voltage, high-withstanding voltage and high current.
- Low carrier accumulation and excellent frequency and switching characteristics make it 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:

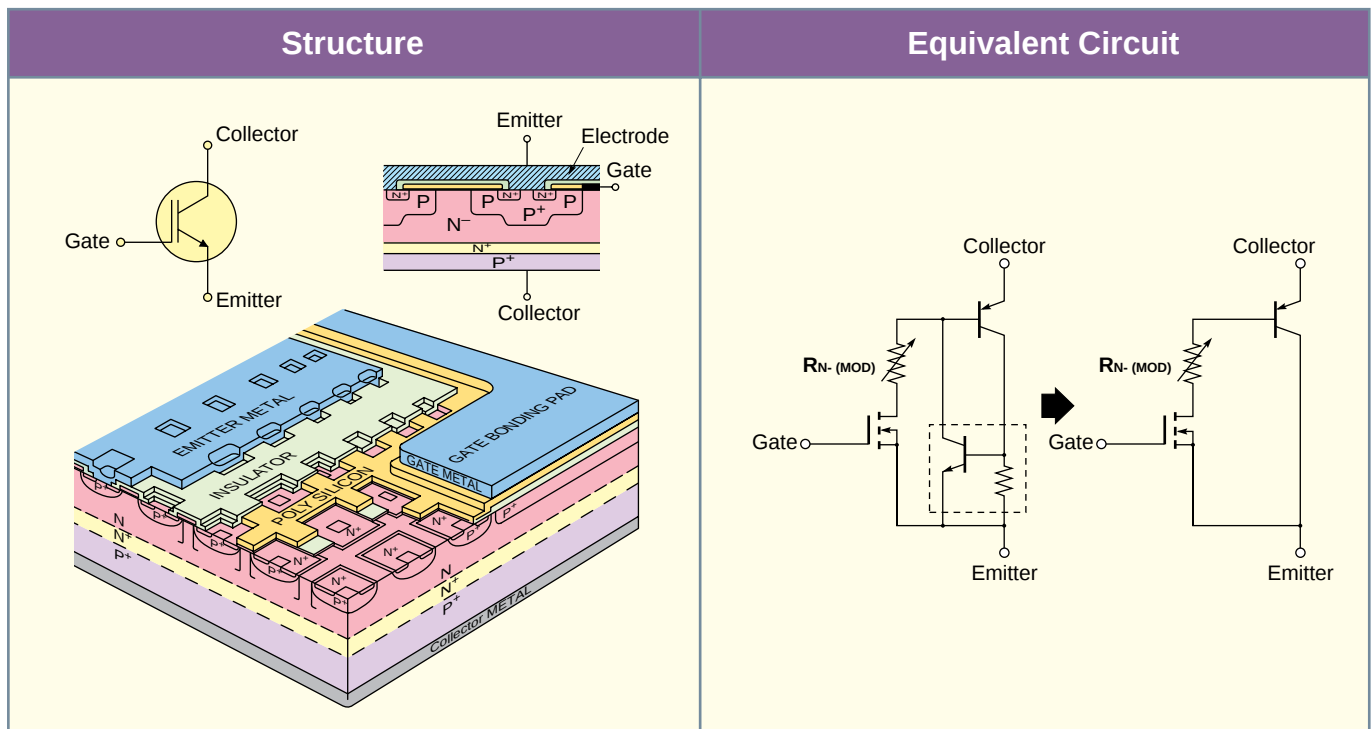
- (1) High switching speed
- (2) Low-saturation voltage
- (3) Built-in diode with optimal characteristics
- (4) High input impedance characteristics enabling voltage drive
- (5) Availability in a variety of package types

Construction

The 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.



2 IGBT Engineering Advances

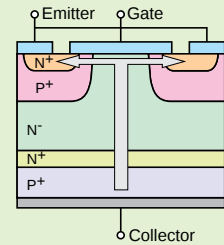
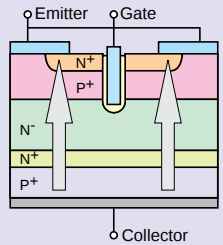
Power MOSFETs have long provided both high-input impedance and high speed. However, various disadvantages, such as increased resistance with increased breakdown voltage as well as difficulties handling high breakdown voltages and high currents, are also associated with MOSFETs.

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.

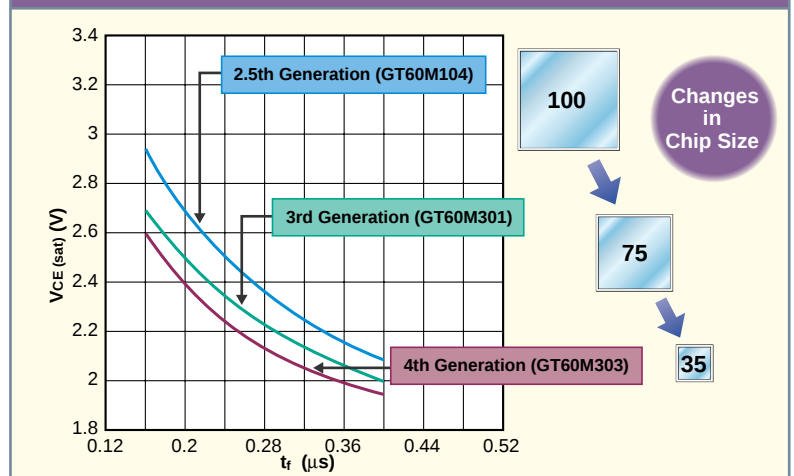
Toshiba have miniaturized unit cells and optimized wafers to decrease $V_{CE(sat)}$ switching loss. The following data demonstrates the progress made thus far:

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 Series)

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

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.	(1.6 V typ.)
Cell Size	Up to 900 V	1.00	0.43
	1200 V	1.00	0.75
			0.06
			—

Tradeoff 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 tradeoff between $V_{CE(sat)}$ and t_f due to adoption of trench gate
900 V	(1) Soft switching (4th generation): improved tradeoff between $V_{CE(sat)}$ and t_f due to adoption of trench gate
	(2) Soft switching (5th generation): adoption 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 tradeoff between $V_{CE(sat)}$ and t_f 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) : adoption 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

2005

3 Discrete IGBT Lineup

Applications and Features	Withstanding Voltage V _{CES} (V) @T _C = 25°C	IGBT Current Rating I _C (A) @T _C = 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(SM)	TO-3P(LH)
		DC	Pulse			straight leads	formed leads									
Hard switching series Highly rugged products fc: up to 20 kHz	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			
		25	50													GT25Q301 GT25Q102
Hard switching series	600	10	20					GT10J321								
		15	30					GT15J321								
		20	40					GT20J321								
Fast switching (FS) series fc: up to 50 kHz		30	60										GT30J324 GT30J121			
		50	100													GT50J325 GT50J121
General-purpose inverters Low-V _{CE(sat)} products	600	15	30								GT15J331					
Soft switching series	400	40	100									GT40G121				GT50G321
		50	100													
		30	100										GT30J322			GT50J322
	600	50	100										GT50J122			GT60J321 GT60J323 GT80J101B
		60	120													
		80	160													
		15	30										GT15M321			
	900	60	120													GT60M303 GT60M323 GT60M322
	950	60	120													
		50	120										GT50N321			
	1000	57	120													GT60N322 GT60N321
		60	120													
	1200	39	80										GT40Q323 GT40Q321			
		42	80													
		40	80													GT40T301
PFCs	600	30	100											GT30J122		
Strobe flash	400		130		GT5G131	GT5G103										
			150	GT8G133	GT8G131	GT8G103										
			170		GT8G132	GT8G121										
Plasma display panels	300		120							GT25G101	GT25G101					
			140													
			120							GT30F121			GT35F131			
	400									GT30G121			GT30G131			

4 Product Number Format

(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

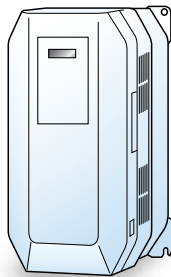
Table 1

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

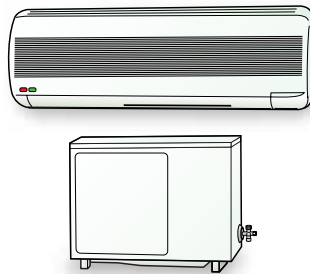
5-1 Hard-Switching Applications

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

General-Purpose Inverters



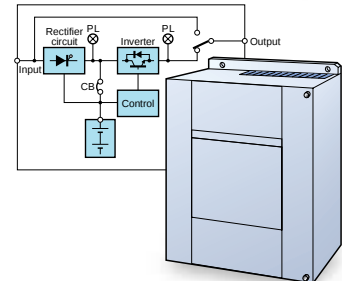
Inverter Air Conditioners



Inverter Washing Machines



UPS



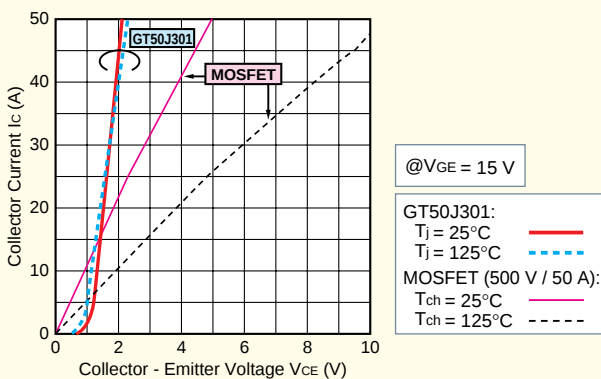
Hard-switching series

Highly Rugged Products

As shown below, our third-generation IGBT is low-loss and low-noise when used for inverter applications because of its higher switching speed, lower saturation voltage and high-efficiency diodes (as compared with Toshiba's MOSFET).

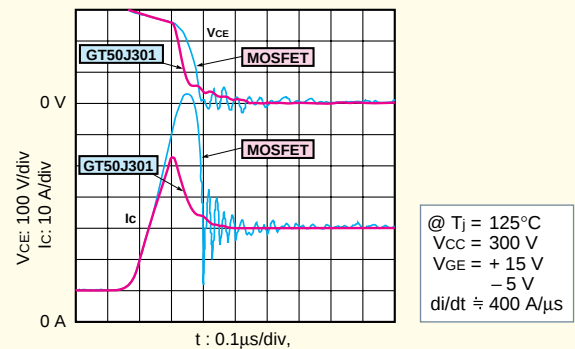
Ic - VCE Temperature Characteristics

► Low-saturation voltage with minimal temperature dependence



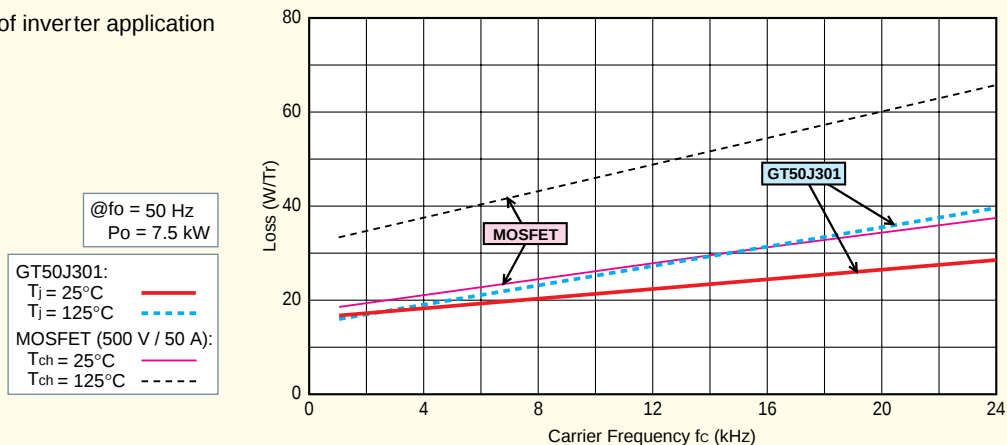
Turn-On Waveform

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



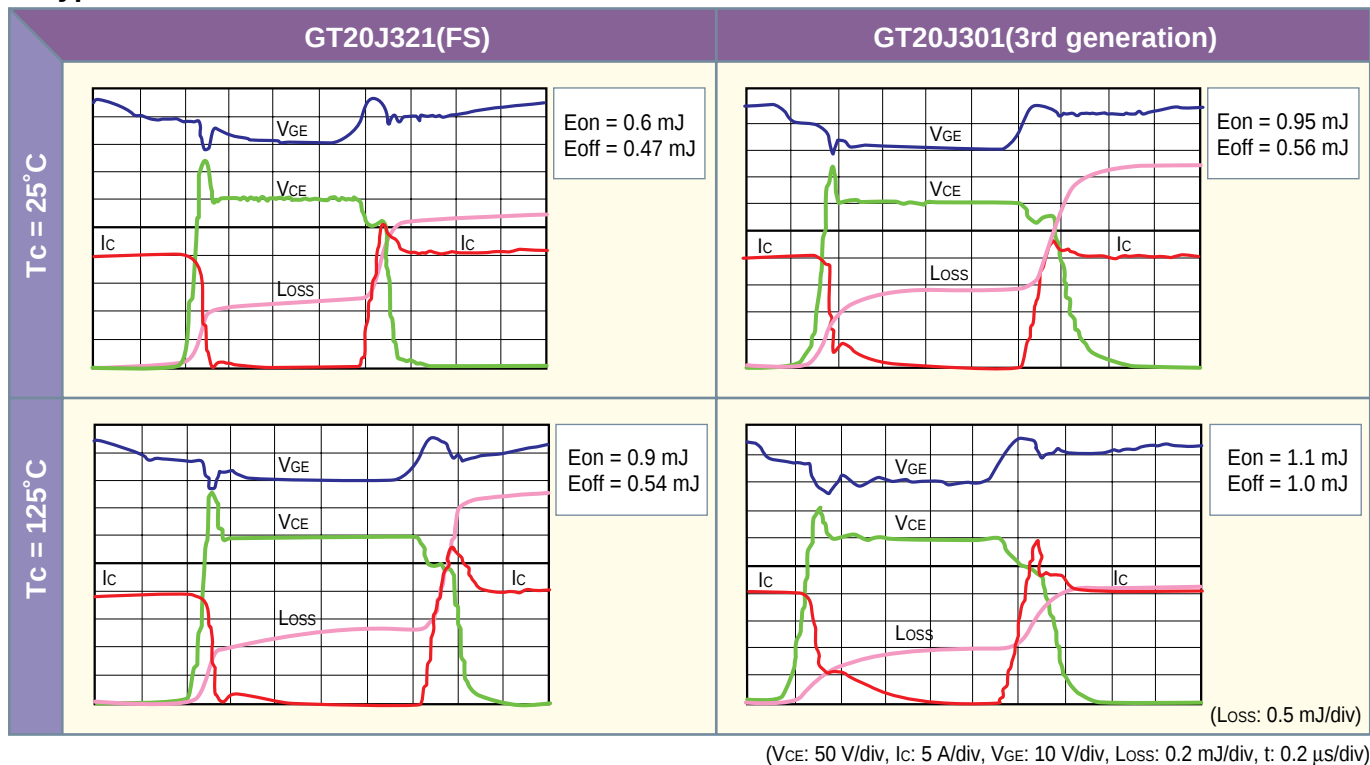
Power Loss vs. Frequency Characteristics

► Simulation data of inverter application



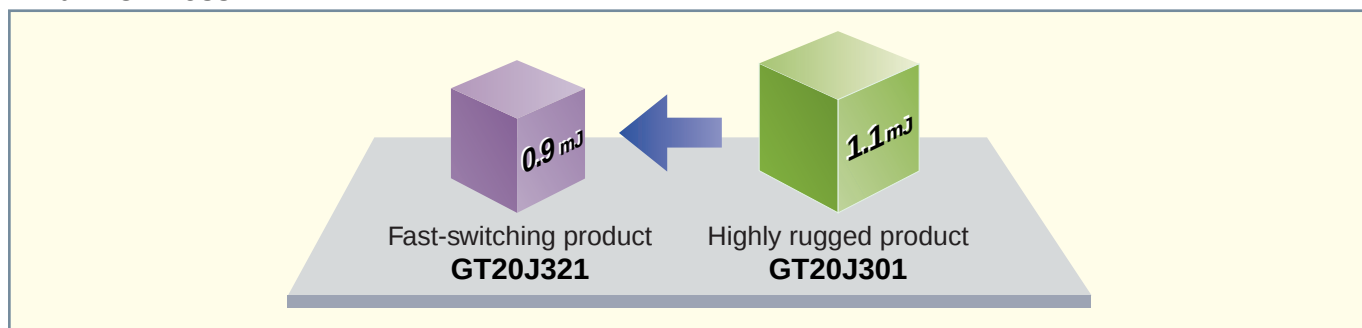
With a design geared to high-speed operation, fast-switching IGBTs reduce switching loss ($E_{on} + E_{off}$) by 30% compared to highly rugged products (according to Toshiba's comparative tests).

Typical Waveforms

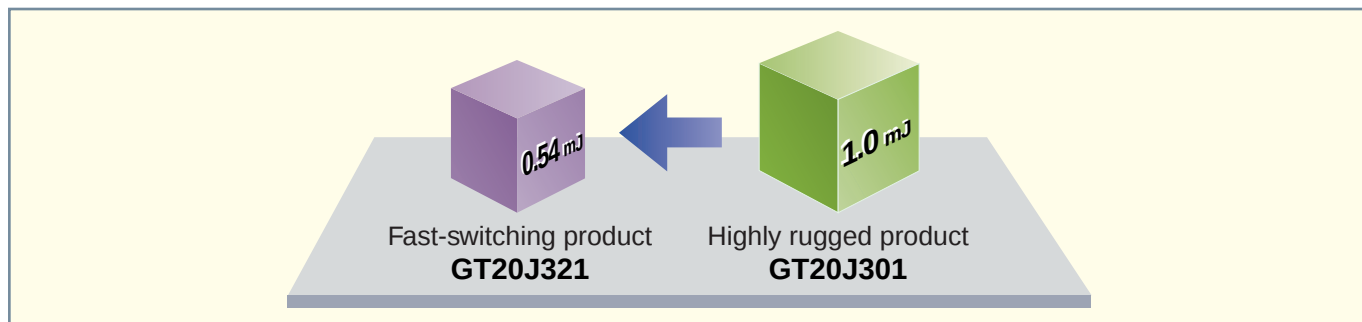


Reduced switching loss of fast-switching products in comparison with highly rugged products
Test condition: $I_c = 20 \text{ A}$, $V_{GE} = 15 \text{ V}$, $R_G = 33 \Omega$, $T_c = 125^\circ\text{C}$ with inductive load $V_{CC} = 300 \text{ V}$

Turn-On Loss



Turn-Off Loss



Lineup for Hard-Switching Applications

■ Highly Rugged Products with 600 V and 1200 V Voltage Ratings (3rd generation)

With built-in diode

Package	Part No.	V _{CES} (V)	I _C (A) DC	P _C (W)	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	Part No.	V _{CES} (V)	I _C (A) DC	P _C (W)	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 (4th generation)

With built-in diode

(FS: Fast Switching)

Package	Part No.	V _{CES} (V)	I _C (A) DC	P _C (W)	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	0.03	0.03	2.0	100	
	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

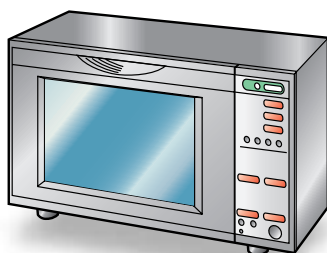
Package	Part No.	V _{CES} (V)	I _C (A) DC	P _C (W)	V _{CE(sat)} (V) typ.	t _r (μs) typ.	t _f (μs) typ.	Remarks
TO-3P(N)	GT30J121	600	30	170	2.0	0.07	0.05	
TO-3P(LH)	GT50J121		50	240	2.0	0.07	0.05	

5-2 Soft-Switching Applications

Soft-switching circuits (current- and voltage-resonance types) 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

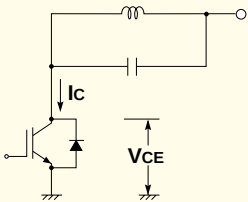
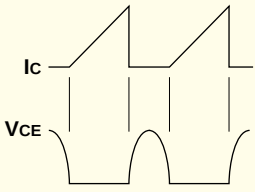
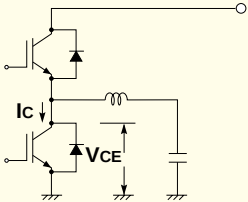
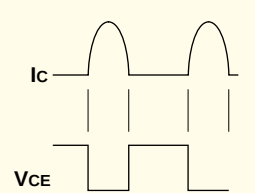


IH Rice Cookers



Induction Heaters



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

Lineup for Soft-Switching Applications

■ IGBTs and Diodes for Voltage-Resonance Circuits (with Soft Switching)

IGBT

AC Input Voltage	Part No.	V _{CES} / I _C	FRD	t _r (μs) max	V _{CE(sat)} (V)		Package	Remarks
					max	V _{GE} / I _C		
100 V to 120 V	GT15M321	900 V / 15 A	○	0.4	2.5	15 V / 15 A	TO-3P(N)IS	For low power
	GT60M303	900 V / 60 A	○	0.4	2.7	15 V / 60 A	TO-3P(LH)	
	GT60M323	900 V / 60 A	○	0.20	2.8	15 V / 60 A	TO-3P(LH)	Thin PT
	GT60M322	950 V / 60 A	○	0.21	2.7	15 V / 60 A	TO-3P(LH)	950 V rating voltage
	GT50N321	1000 V / 50 A	○	0.33	2.9	15 V / 60 A	TO-3P(N)	1000 V rating voltage
	GT60N322	1000 V / 57 A	○	0.22	2.9	15 V / 60 A	TO-3P(LH)	Thin PT
	GT60N321	1000 V / 60 A	○	0.4	2.8	15 V / 60 A	TO-3P(LH)	1000 V rating voltage
200 V to 240 V	GT40Q323	1200 V / 39 A	○	0.21	3.7	15 V / 40 A	TO-3P(N)	
	GT40Q321	1200 V / 42 A	○	0.72	3.6	15 V / 40 A	TO-3P(N)	
	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	○	0.4	5.0	15 V / 40 A	TO-3P(LH)	1500 V rating voltage

○: Included

■ IGBTs for Current-Resonance Circuits (with Soft Switching)

IGBT

AC Input Voltage	Part No.	V _{CES} / I _C	FRD	t _r (μs) max	V _{CE(sat)} (V)		Package	Remarks
					max	V _{GE} / I _C		
100 V to 120 V	GT40G121	400 V / 40 A		0.4	2.5	15 V / 60 A	TO-220AB	Compact package
	GT50G321	400 V / 50 A	○	0.4	2.5	15 V / 60 A	TO-3P(LH)	400 V rating voltage
200 V to 240 V	GT30J322	600 V / 30 A	○	0.4	2.8	15 V / 50 A	TO-3P(N)IS	Isolated package
	GT50J322	600 V / 50 A	○	0.4	2.8	15 V / 50 A	TO-3P(LH)	
	GT50J122	600 V / 50 A		0.26	2.5	15 V / 60 A	TO-3P(N)	
	GT50J325	600 V / 50 A	○	0.05 (typ.)	2.45	15 V / 50 A	TO-3P(LH)	Fast switching
	GT60J323	600 V / 60 A	○	0.26	2.5	15 V / 60 A	TO-3P(LH)	
	GT80J101B	600 V / 80 A		(0.4)	(3.0)	15 V / 80 A	TO-3P(LH)	
PFC	GT30J122	600 V / 30 A		0.4	2.8	15 V / 50 A	TO-3P(N)IS	

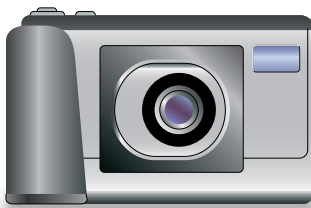
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5-3 Strobe Applications

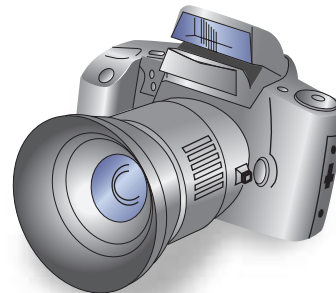
Thyristors previously used in strobe control circuits are today increasingly being replaced by IGBTs, which have the following advantages.

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

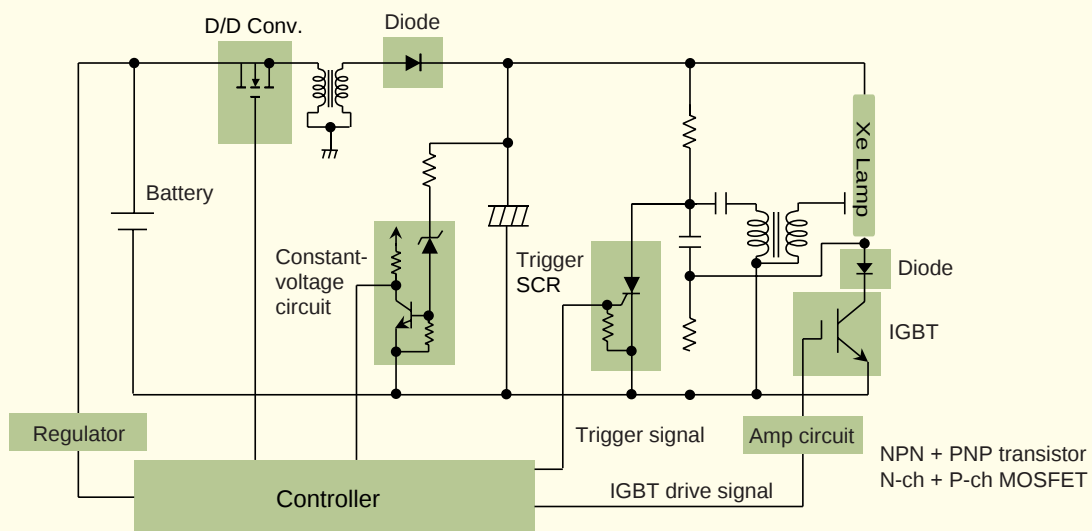
DSC, Compact Camera



Single-Lens Reflex Camera



Example of a strobe-flash circuit



Lineup for Strobe Applications

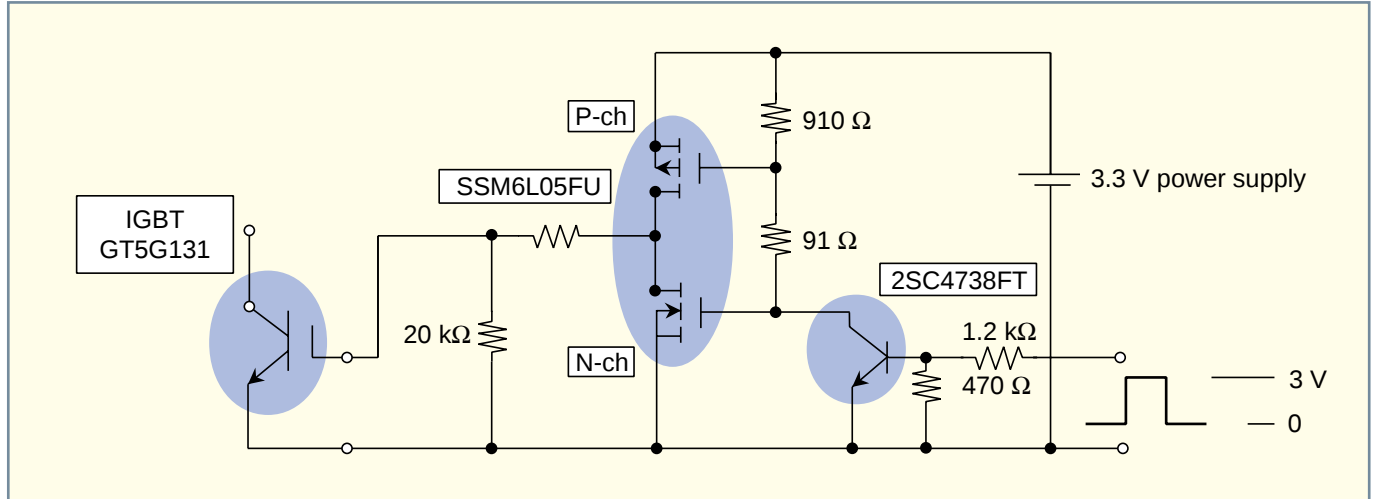
■ 3 V to 4.5 V Gate Drive Series

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 an IGBT Gate Drive Circuit (3.3 V Power Supply Voltage)



■ 3 V Gate Drive Series

Part No.	V_{CES} / I_C	$V_{CE(sat)} (V)$		$P_c (W)$ @ $T_a = 25^\circ C$	Package	Remarks
		max	V_{GE} / I_C			
GT5G131	400 V / 130 A	7	3 V / 130 A	1.1	SOP-8	5th generation

■ 4 and 4.5 V Gate Drive Series

Part No.	V_{CES} / I_C	$V_{CE(sat)} (V)$		$P_c (W)$ @ $T_a = 25^\circ C$	Package	Remarks
		max	V_{GE} / I_C			
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
GT8G133	400 V / 150 A	7	4.0 V / 150 A	1.1	TSSOP-8	

■ 20 V Gate Drive Series

Part No.	V_{CES} / I_C	$V_{CE(sat)} (V)$		$P_c (W)$ @ $T_a = 25^\circ C$	Package	Remarks
		max	V_{GE} / I_C			
GT25G101	400V / 170 A	8	20 V / 170 A	1.3	TO-220FL	

5-4 Plasma Display Panel Applications

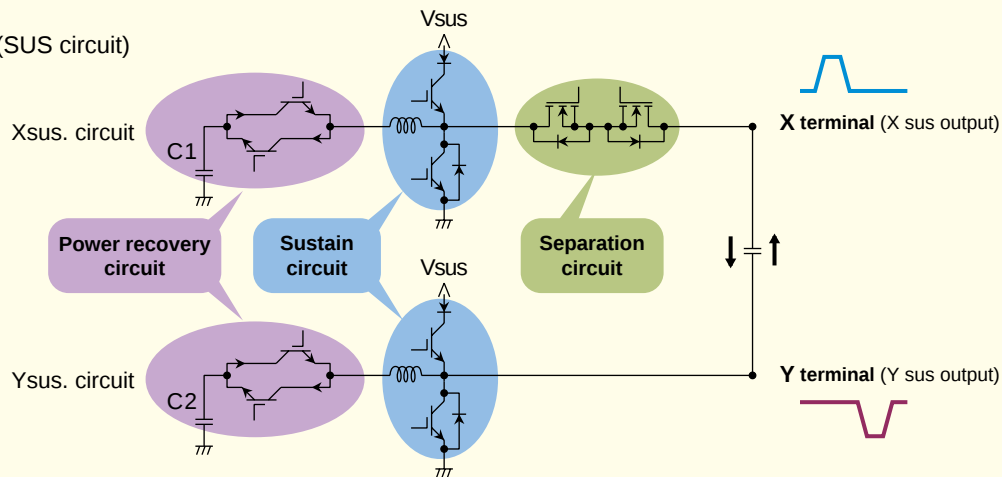
Plasma Display

Many MOSFETs have been used for the power supplies of plasma display panels (PDPs). Recently IGBTs, which have low $V_{CE(sat)}$ characteristics in a large current area, are being used in PDPs.



Example of a plasma display panel power supply

• PDP (SUS circuit)



Lineup for Plasma Display Panel Applications

■ 300 V Series

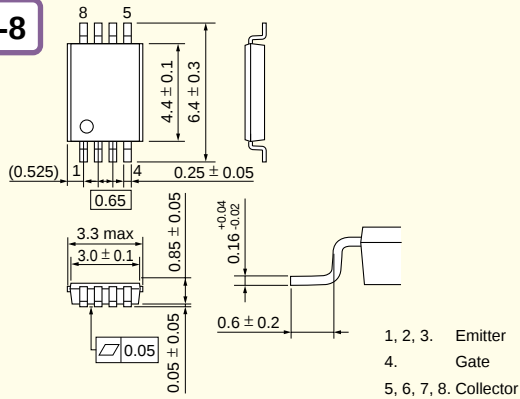
Part No.	V_{CES} / I_{cp}	$V_{CE(sat)}$ (V) max	P_c (W) @ $T_a = 25^\circ\text{C}$	Package	Remarks
GT35F131	300 V / 140 A	3.4 (@140 A)	60	TO-220AB	
GT30F121	300 V / 120 A	2.9 (@120 A)	35	TO-220SIS	
GT45F121	300 V / 180 A	2.5 (@180 A)	45	TO-220SIS	

■ 400 V Series

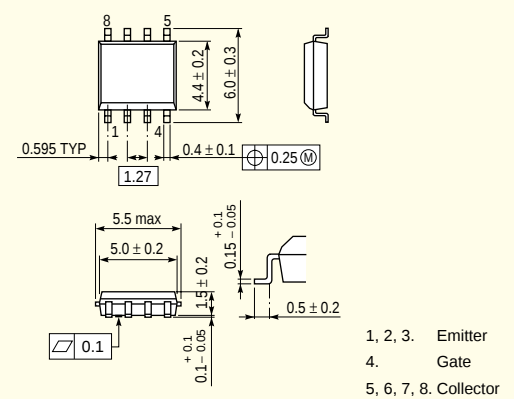
Part No.	V_{CES} / I_{cp}	$V_{CE(sat)}$ (V) max	P_c (W) @ $T_a = 25^\circ\text{C}$	Package	Remarks
GT30G131	400 V / 120 A	3.2 (@120 A)	60	TO-220AB	
GT30G121	400 V / 120 A	2.9 (@120 A)	35	TO-220SIS	
GT45G121	400 V / 180 A	2.6 (@180 A)	45	TO-220SIS	

6 Package Dimensions

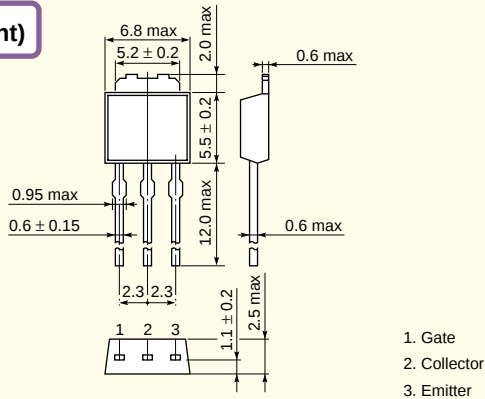
TSSOP-8



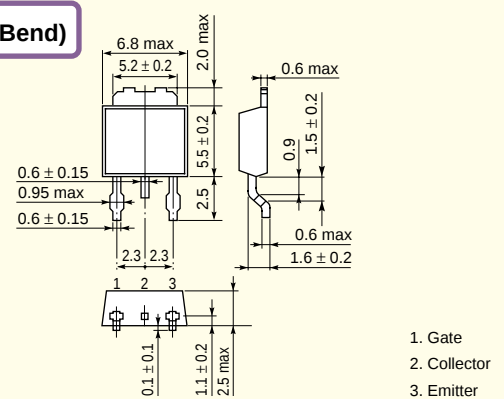
SOP-8



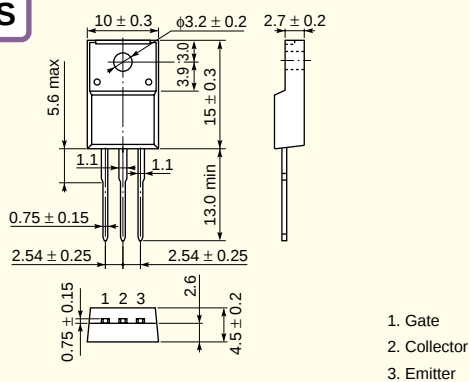
DP (straight)



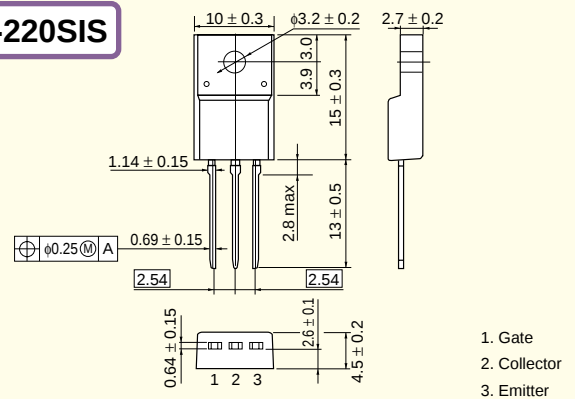
DP (Lead Bend)



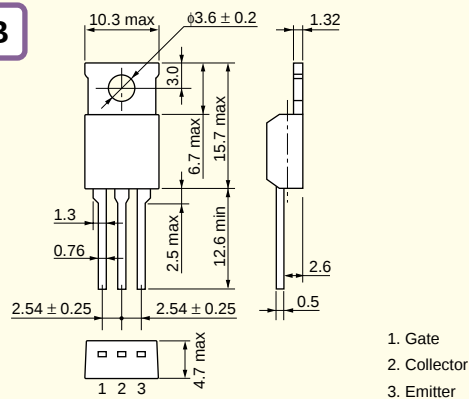
TO-220NIS



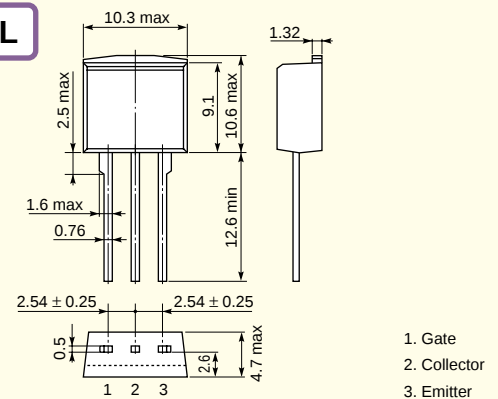
TO-220SIS



TO-220AB



TO-220FL



7 Final-Phase and Discontinued Products

The following products are in stock but are being phased out of production. Equivalent products recommended for use 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 or discontinued product. Before using a recommended equivalent product, please check that it is suitable for use under the intended operating conditions.

Application	Final-Phase 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	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)	GT50J102	600	50	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)	GT60M322A	950	60	TO-3P(LH)
	GT60M305	900	60	TO-3P(LH)	GT60M303	900	60	TO-3P(LH)
	GT80J101	600	80	TO-3P(L)	GT80J101B	600	80	TO-3P(LH)
Hard-switching applications	GT80J101A	600	80	TO-3P(LH)	GT60J321	600	60	TO-3P(LH)
	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(N)IS	GT30J121	600	30	TO-3P(N)
	GT25Q101	1200	25	TO-3P(LH)	GT25Q102	1200	25	TO-3P(LH)
Strobe applications	GT50J101	600	50	TO-3P(L)	GT50J121	600	50	TO-3P(LH)
	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	GT8G121	400	150 (pulse)	DP
	GT10G102	400	130 (pulse)	TO-220NIS	GT25G101	400	170 (pulse)	TO-220FL
	GT15G101	400	170 (pulse)	TO-220NIS	GT25G102	400	150 (pulse)	TO-220FL
	GT20G101	400	130 (pulse)	TO-220FL	GT25G101	400	170 (pulse)	TO-220FL
	GT20G102	400	130 (pulse)	TO-220FL	GT25G101	400	170 (pulse)	TO-220FL
	GT25G102	400	150 (pulse)	TO-220FL	GT8G103	400	150 (pulse)	DP
	GT50G101	400	100 (pulse)	TO-3P(N)	GT8G103	400	150 (pulse)	DP
Audio amp applications	GT50G102	400	100 (pulse)	TO-3P(N)	GT25G101	400	170 (pulse)	TO-220FL
	GT75G101	400	150 (pulse)	TO-3P(N)	GT8G103	400	150 (pulse)	DP
	GT20D101	250	20	TO-3P(L)	GT25G101	400	170 (pulse)	TO-220FL
	GT20D201	-250	-20	TO-3P(L)	—	—	—	—

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