2005-3

TOSHIBA

PRODUCT GUIDE

Discrete IGBTs

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.
- 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:

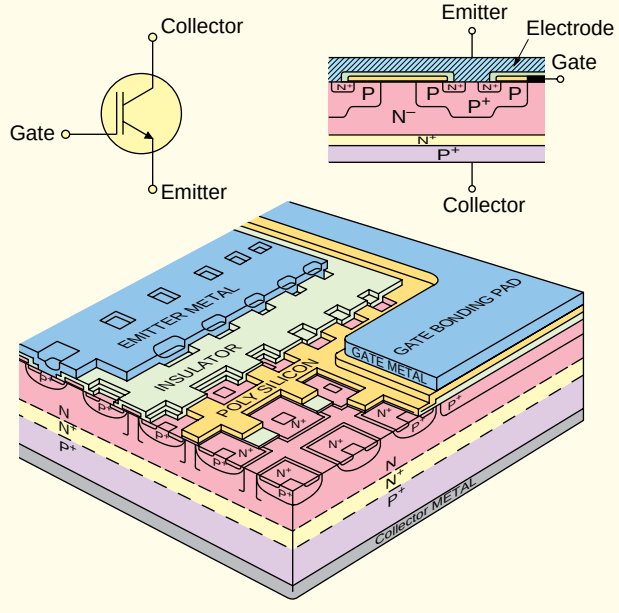
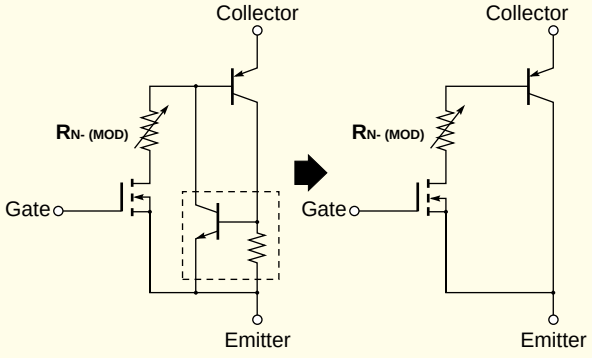
(1) High switching speed
(2) Low-saturation voltage
(3) Built-in diode with optimal characteristics
(4) High input impedance characteristics enabling voltage drive
(5) Availability in a variety of package types

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.

Structure	Equivalent Circuit
	

2 IGBT Engineering Advances

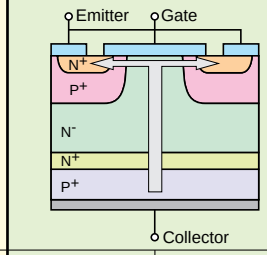
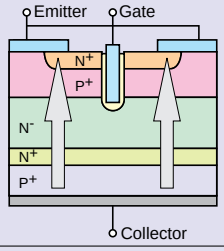
Power MOSFETs have long provided both high-input impedance and high speed. However, various disadvantages, such as increased resistance with increased breakdown voltage as well as difficulties handling high breakdown voltages and high currents, are also associated with MOSFETs.

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.

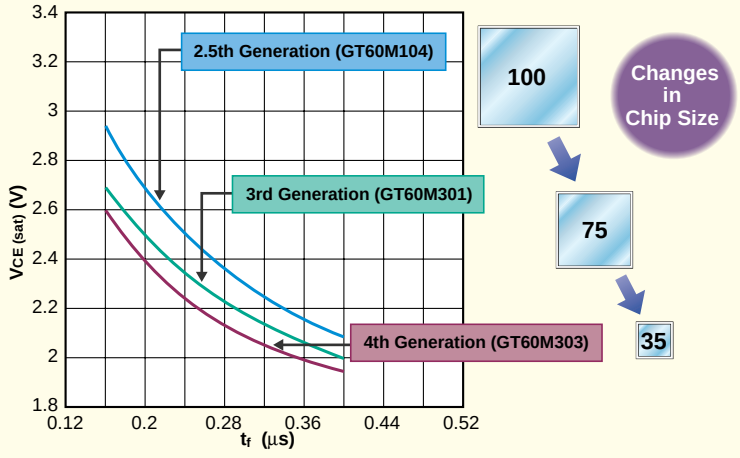
Toshiba have miniaturized unit cells and optimized wafers to decrease $V_{CE(sat)}$ switching loss. The following data demonstrates the progress made thus far:

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	0.06
	1200 V	1.00	0.75	–

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 tf due to adoption of trench gate

900 V
- (1) Soft switching (4th generation): improved tradeoff between $V_{CE(sat)}$ and tf 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 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) : 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) @Tc = 25°C	IGBT Current Rating Ic(A) @Tc = 25°C DC	Pulse	TSSOP-8	SOP-8	DP straight leads	DP formed leads	TO-220NIS	TO-220SIS	TO-220FL	TO-220SM	TO-220AB	TO-3P(N)	TO-3P(N)IS	TO-3P(SM)	TO-3P(LH)
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 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-$V_{CE(sat)}$ products	600	15	30								GT15J331					
Soft switching series	400	40	100									GT40G121				
		50	100													GT50G321
	600	30	100											GT30J322		
		50	100													GT50J322
			120										GT50J122			
		60	120													GT60J321 GT60J323
		80	160													GT80J101B
	900	15	30											GT15M321		
		60	120													GT60M303 GT60M323
	950	60	120													GT60M322
	1000	50	120										GT50N321			
		57	120													GT60N322
		60	120													GT60N321
	1200	39	80										GT40Q323			
		42	80										GT40Q321			
	1500	40	80													GT40T301
PFCs	600	30	100											GT30J122		
Strobe flash	400		130		GT5G131	GT5G103										
			150	GT8G133	GT8G131 GT8G132	GT8G103 GT8G121										
			170							GT25G101	GT25G101					
Plasma display panels	300		120						GT30F121							
			140									GT35F131				
	400		120						GT30G121			GT30G131				

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

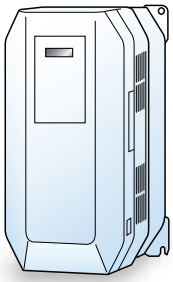
Table 1

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

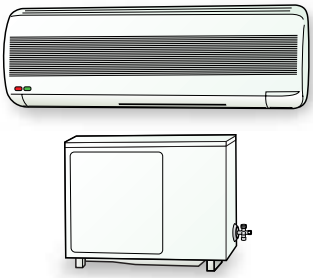
5-1 Hard-Switching Applications

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.

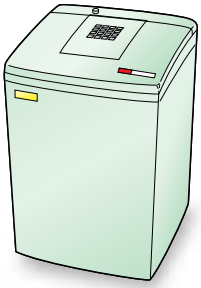
General-Purpose Inverters



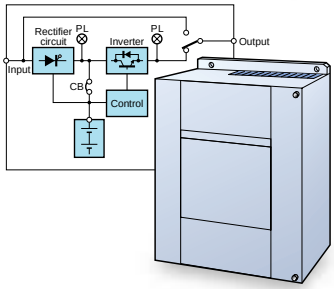
Inverter Air Conditioners



Inverter Washing Machines



UPS

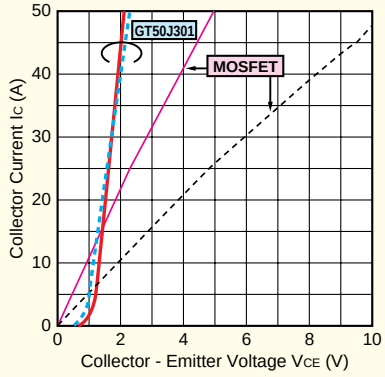


Hard-switching series — Highly Rugged Products

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).

■ I_C - V_{CE} Temperature Characteristics

▶ Low-saturation voltage with minimal temperature dependence

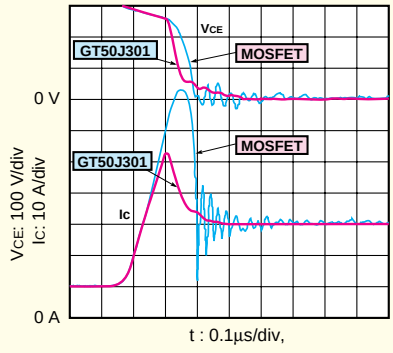


@V_{GE} = 15 V

GT50J301:
T_j = 25°C
T_j = 125°C
MOSFET (500 V / 50 A):
T_{ch} = 25°C
T_{ch} = 125°C

■ Turn-On Waveform

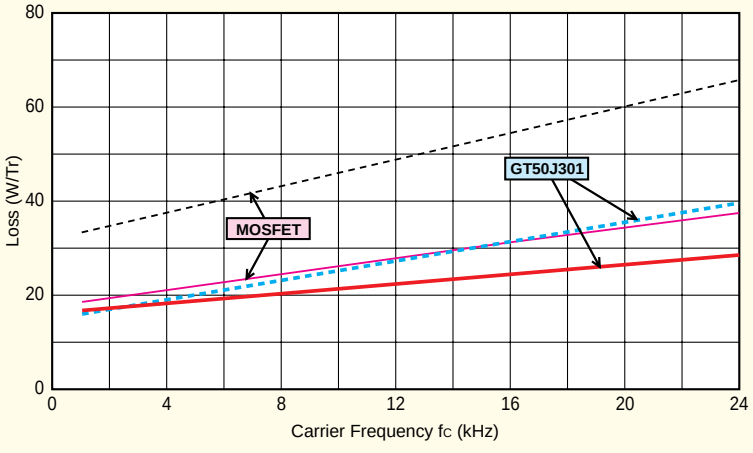
▶ Superior reverse-recovery characteristics due to built-in diode with optimal characteristics



@ T_j = 125°C
V_{CC} = 300 V
V_{GE} = + 15 V
– 5 V
di/dt ≒ 400 A/µs

■ Power Loss vs. Frequency Characteristics

▶ Simulation data of inverter application



@fo = 50 Hz
Po = 7.5 kW

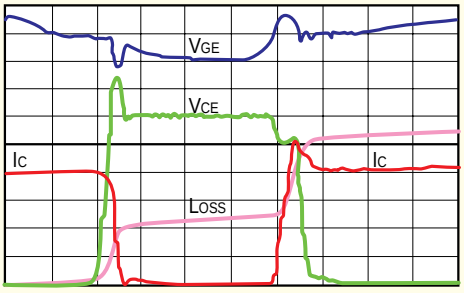
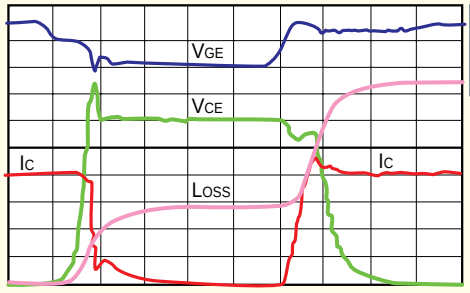
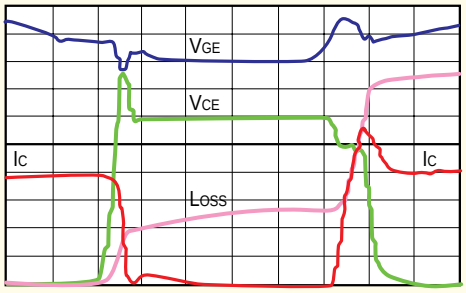
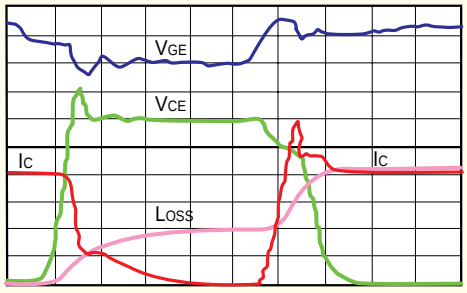
GT50J301:
T_j = 25°C
T_j = 125°C
MOSFET (500 V / 50 A):
T_{ch} = 25°C
T_{ch} = 125°C

Hard-switching series

Fast-Switching (FS) Series

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

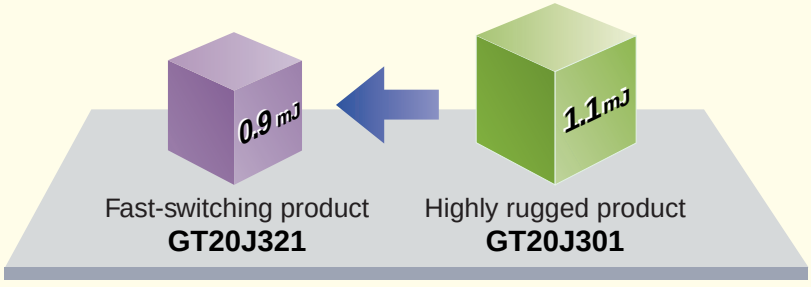
Typical Waveforms

	GT20J321(FS)	GT20J301(3rd generation)
Tc = 25°C	 Eon = 0.6 mJ Eoff = 0.47 mJ	 Eon = 0.95 mJ Eoff = 0.56 mJ
Tc = 125°C	 Eon = 0.9 mJ Eoff = 0.54 mJ	 Eon = 1.1 mJ Eoff = 1.0 mJ (Loss: 0.5 mJ/div)

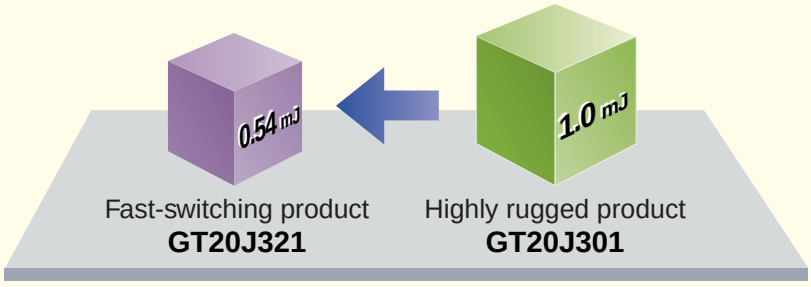
(VCE: 50 V/div, IC: 5 A/div, VGE: 10 V/div, Loss: 0.2 mJ/div, t: 0.2 µs/div)

Reduced switching loss of fast-switching products in comparison with highly rugged products
Test condition: IC = 20 A, VGE = 15 V, RG = 33 Ω, TC = 125°C with inductive load VCC = 300 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

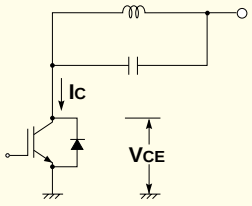
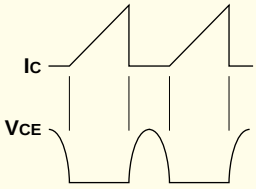
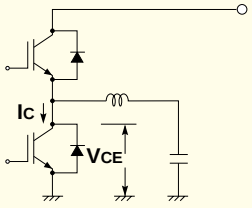
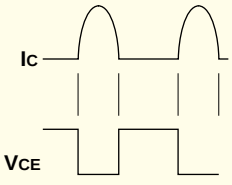
Package	Part No.	V_{CES} (V)	I_C (A) DC	P_C (W)	$V_{CE(sat)}$ (V) typ.	t_r (µs) typ.	t_f (µs) typ.	Remarks
TO-3P(N)	GT30J121	600	30	170	2.0	0.07	0.05	
TO-3P(LH)	GT50J121		50	240	2.0	0.07	0.05	

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 to120 V	Voltage Resonance 	Waveform 	V_{CES} = 900 V to 1000 V I_C = 15 A to 60 A
200 V to 240 V			V_{CES} = 1200 V to 1500 V I_C = 40 A
100 V to 240 V	Current Resonance 	Waveform 	V_{CES} = 400 V I_C = 40 A to 50 A
			V_{CES} = 600 V I_C = 30 A to 80 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	tr (µs) max	$V_{CE(sat)}$ (V) max	V_{GE} / I_C	Package	Remarks
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	tr (µs) max	$V_{CE(sat)}$ (V) max	V_{GE} / I_C	Package	Remarks
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**	

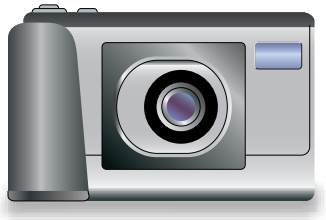
○: Included

5-3 Strobe Applications

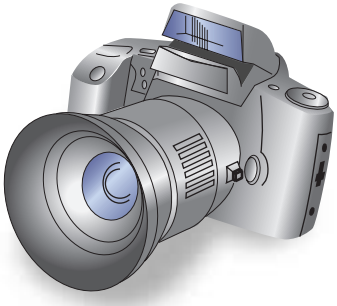
Thyristors previously used in strobe control circuits are today increasingly being replaced by IGBTs, which have the following advantages.

- 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.

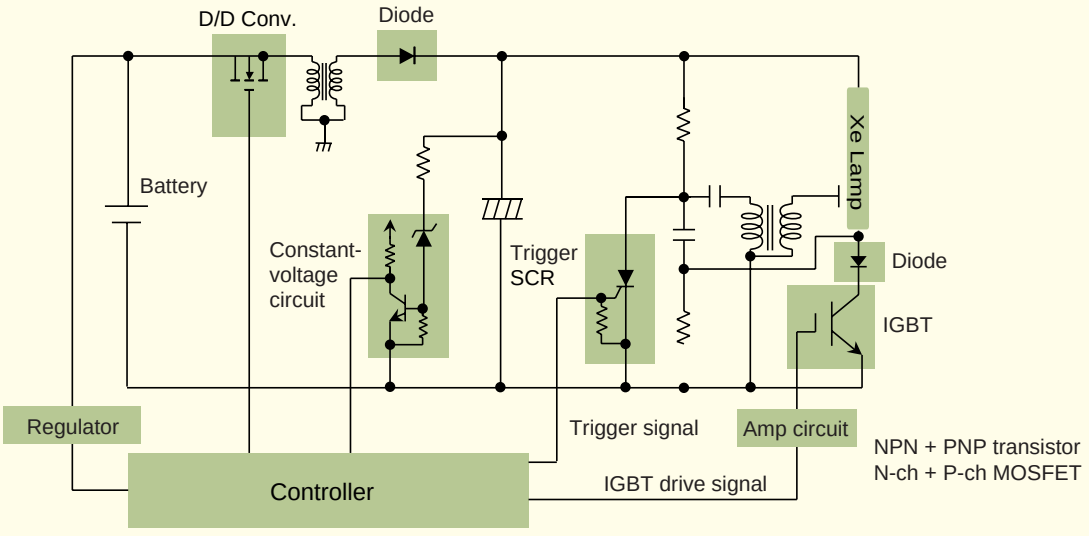
DSC, Compact Camera



Single-Lens Reflex Camera



Example of a strobe-flash circuit



Lineup for Strobe Applications

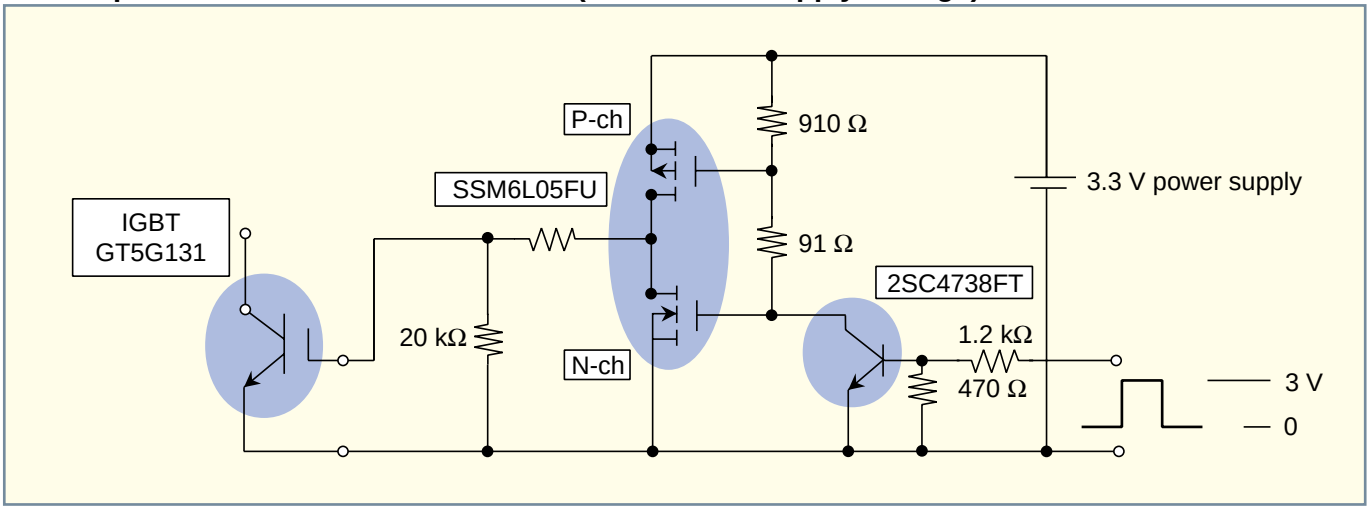
3 V to 4.5 V Gate Drive Series

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) max	$V_{CE(sat)}$ (V) V_{GE} / I_C	P_C (W) @Ta = 25°C	Package	Remarks
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) max	$V_{CE(sat)}$ (V) 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
GT8G133	400 V / 150 A	7	4.0 V / 150 A	1.1	**TSSOP-8**	

20 V Gate Drive Series

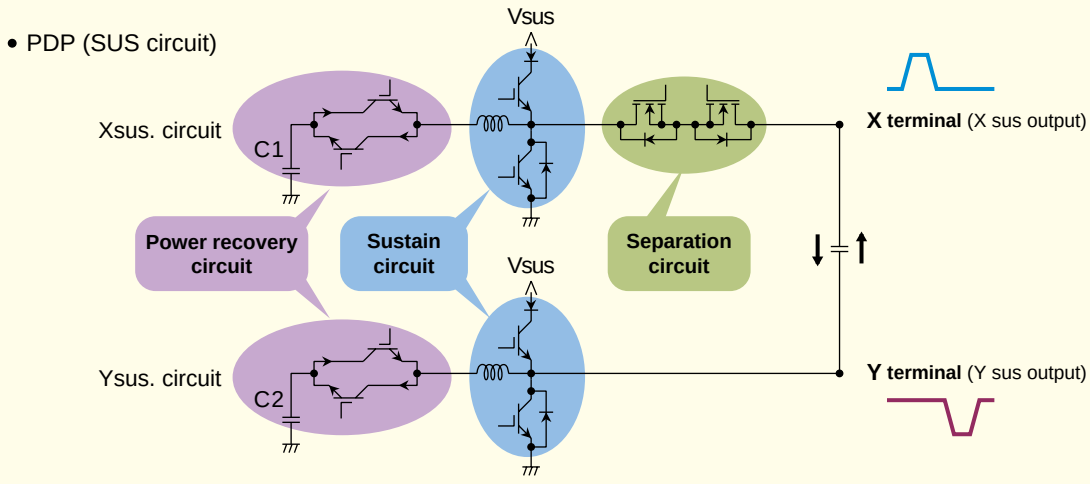
Part No.	V_{CES} / I_C	$V_{CE(sat)}$ (V) max	$V_{CE(sat)}$ (V) V_{GE} / I_C	P_C (W) @Ta = 25°C	Package	Remarks
GT25G101	400V / 170 A	8	20 V / 170 A	1.3	**TO-220FL**	

5-4 Plasma Display Panel Applications

Plasma Display

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



Lineup for Plasma Display Panel Applications

300 V Series

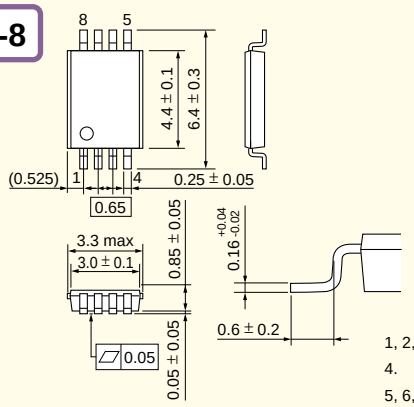
Part No.	V_{CES} / Icp	$V_{CE(sat)}$ (V) max	P_C (W) @Ta = 25°C	Package	Remarks
GT35F131	300 V / 140 A	3.4 (@140 A)	60	**TO-220AB**	
GT30F121	300 V / 120 A	2.9 (@120 A)	35	**TO-220SIS**	
GT45F121	300 V / 180 A	2.5 (@180 A)	45	**TO-220SIS**	

400 V Series

Part No.	V_{CES} / Icp	$V_{CE(sat)}$ (V) max	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**	
GT45G121	400 V / 180 A	2.6 (@180 A)	45	**TO-220SIS**	

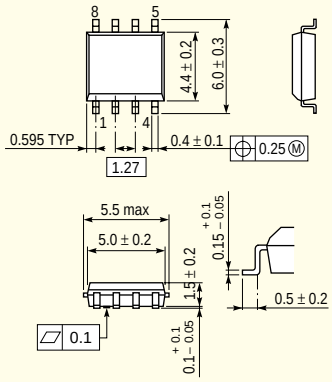
6 Package Dimensions

TSSOP-8



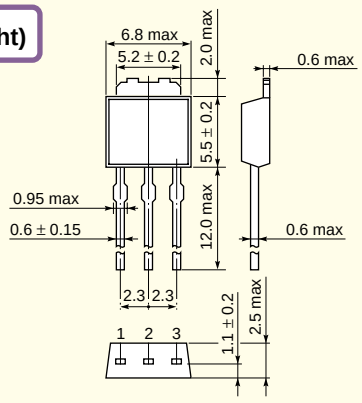
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

SOP-8



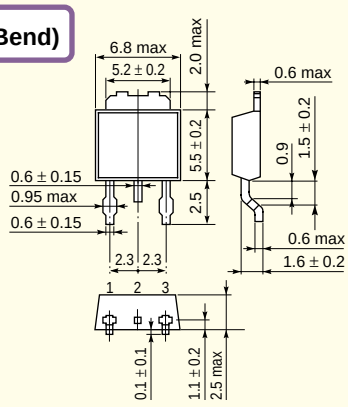
1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

DP (straight)



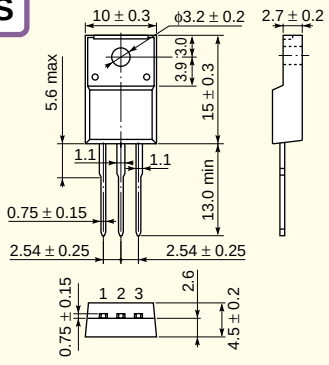
1. Gate
2. Collector
3. Emitter

DP (Lead Bend)



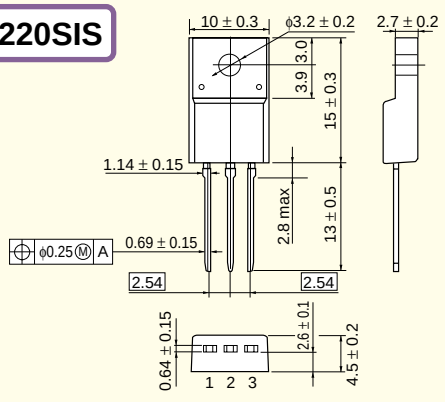
1. Gate
2. Collector
3. Emitter

TO-220NIS



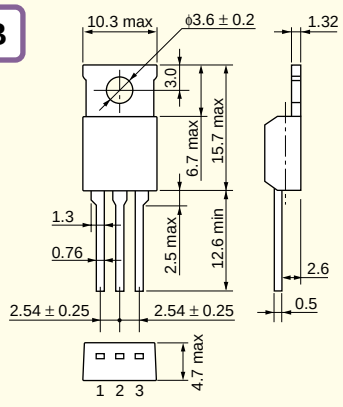
1. Gate
2. Collector
3. Emitter

TO-220SIS



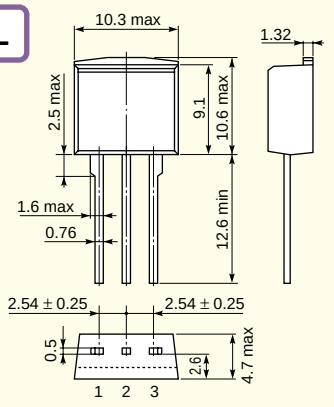
1. Gate
2. Collector
3. Emitter

TO-220AB



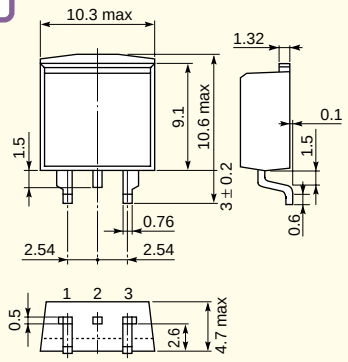
1. Gate
2. Collector
3. Emitter

TO-220FL



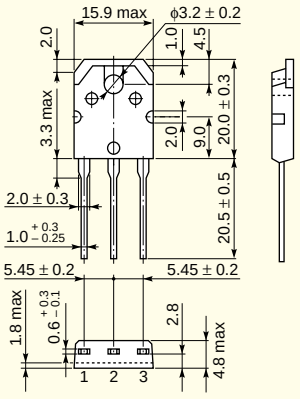
1. Gate
2. Collector
3. Emitter

TO-220SM



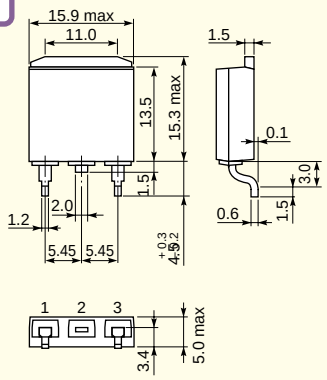
1. Gate
2. Collector
3. Emitter

TO-3P(N)



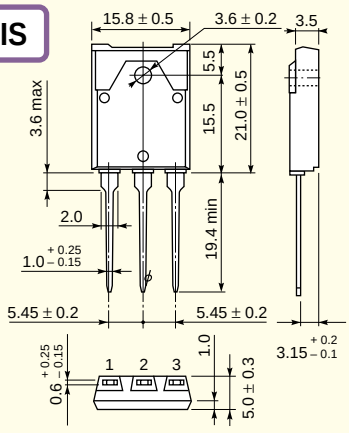
1. Gate
2. Collector
3. Emitter

TO-3P(SM)



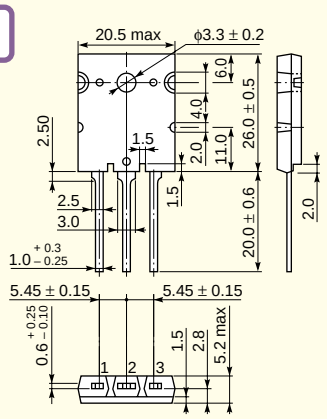
1. Gate
2. Collector
3. Emitter

TO-3P(N)IS



1. Gate
2. Collector
3. Emitter

TO-3P(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. 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)**
					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**	**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)**
	GT50J101	600	50	**TO-3P(L)**	**GT50J121**	600	50	**TO-3P(LH)**
Strobe 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**
					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**	**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)**	—	—	—	—

OVERSEAS SUBSIDIARIES AND AFFILIATES

(As of February 16, 2005)

Toshiba America Electronic Components, Inc.

Headquarters-Irvine, CA
19900 MacArthur Boulevard,
Suite 400, Irvine, CA 92612, U.S.A.
Tel: (949)623-2900 Fax: (949)474-1330

Boulder, CO (Denver)
3100 Araphahoe #500,
Boulder, CO 80303, U.S.A.
Tel: (303)442-3801 Fax: (303)442-7216

Buffalo Grove (Chicago)
2150 E. Lake Cook Road, Suite 310,
Buffalo Grove, IL 60089, U.S.A.
Tel: (847)484-2400 Fax: (847)541-7287

Duluth, GA (Atlanta)
3700 Crestwood Pkwy, #160,
Duluth, GA 30096, U.S.A.
Tel: (770)931-3363 Fax: (770)931-7602

Beaverton/Portland, OR
8323 SW Cirrus Drive, Beaverton,
OR 97008, U.S.A.
Tel: (503)466-3721 Fax: (503)629-0827

Raleigh, NC
3120 Highwoods Blvd., #108, Raleigh,
NC 27604, U.S.A.
Tel: (919)859-2800 Fax: (919)859-2898

Richardson, TX (Dallas)
777 East Campbell Rd., #650, Richardson,
TX 75081, U.S.A.
Tel: (972)480-0470 Fax: (972)235-4114

San Jose Engineering Center, CA
1060 Rincon Circle, San Jose, CA 95131, U.S.A.
Tel: (408)526-2400 Fax:(408)526-8910

Wakefield, MA (Boston)
401 Edgewater Place, #360, Wakefield,
MA 01880-6229, U.S.A.
Tel: (781)224-0074 Fax: (781)224-1095

Wixom (Detroit)
48679 Alpha Drive, Suite 100, Wixom,
MI 48393 U.S.A.
Tel: (248)449-6165 Fax: (248)449-8430

Toshiba Electronics do Brasil Ltda.

Rua Afonso Celso, 552-8 andar, CJ. 81
Vila Mariana Cep 04119-002 São Paulo SP, Brasil
Tel: (011)5576-6619 Fax: (011)5576-6607

Toshiba India Private Ltd.

6F DR. Gopal Das Bhawan 28,
Barakhamba Road, New Delhi, 110001, India
Tel: (011)2371-4601 Fax: (011)2371-4603

Toshiba Electronics Europe GmbH

Düsseldorf Head Office
Hansaallee 181, D-40549 Düsseldorf,
Germany
Tel: (0211)5296-0 Fax: (0211)5296-400

München Office
Büro München Hofmannstrasse 52,
D-81379, München, Germany
Tel: (089)748595-0 Fax: (089)748595-42

France Branch
Les Jardins du Golf 6 rue de Rome 93561,
Rosny-Sous-Bois, Cedex, France
Tel: (1)48-12-48-12 Fax: (1)48-94-51-15

Italy Branch
Centro Direzionale Colleoni,
Palazzo Perseo 3,
I-20041 Agrate Brianza, (Milan), Italy
Tel: (039)68701 Fax: (039)6870205

Spain Branch
Parque Empresarial, San Fernando, Edificio Europa,
1ª Planta, E-28831 Madrid, Spain
Tel: (91)660-6798 Fax:(91)660-6799

U.K. Branch
Riverside Way, Camberley Surrey,
GU15 3YA, U.K.
Tel: (01276)69-4600 Fax: (01276)69-4800

Sweden Branch
Gustavslundsvägen 18, 5th Floor,
S-167 15 Bromma, Sweden
Tel: (08)704-0900 Fax: (08)80-8459

Toshiba Electronics Asia (Singapore) Pte. Ltd.

Singapore Head Office
438B Alexandra Road, #06-08/12 Alexandra
Technopark, Singapore 119968
Tel: (6278)5252 Fax: (6271)5155

Toshiba Electronics Service (Thailand) Co., Ltd.

135 Moo 5, Bangkadi Industrial Park, Tivanon Road,
Pathumthani, 12000, Thailand
Tel: (02)501-1635 Fax: (02)501-1638

Toshiba Electronics Trading (Malaysia)Sdn. Bhd.

Kuala Lumpur Head Office
Suite W1203, Wisma Consplant, No.2,
Jalan SS 16/4, Subang Jaya, 47500 Petaling Jaya,
Selangor Darul Ehsan, Malaysia
Tel: (03)5631-6311 Fax: (03)5631-6307

Penang Office
Suite 13-1, 13th Floor, Menara Penang Garden,
42-A, Jalan Sultan Ahmad Shah,
10050 Penang, Malaysia
Tel: (04)226-8523 Fax: (04)226-8515

Toshiba Electronics Philippines, Inc.

26th Floor, Citibank Tower, Valero Street, Makati,
Manila, Philippines
Tel: (02)750-5510 Fax: (02)750-5511

Toshiba Electronics Asia, Ltd.

Hong Kong Head Office
Level 11, Tower 2, Grand Century
Place, No.193, Prince Edward Road West,
Mongkok, Kowloon, Hong Kong
Tel: 2375-6111 Fax: 2375-0969

Beijing Office
Room 714, Beijing Fortune Building,
No.5 Dong San Huan Bei-Lu, Chao Yang District,
Beijing, 100004, China
Tel: (010)6590-8796 Fax: (010)6590-8791

Chengdu Office
Suite 403A, Holiday Inn Crown Plaza 31, Zongfu Street,
Chengdu, 610016, Sichuan, China
Tel: (028)8675-1773 Fax: (028)8675-1065

Qingdao Office
Room 4(D-E), 24F, International Financial Center,
59 Xiang Gang Zhong Road, Qingdao,
Shandong, China
Tel: (0532)579-3328 Fax: (0532)579-3329

Toshiba Electronics Shenzhen Co., Ltd.

Room 2601-2609, 2616, Office Tower Shun Hing Square,
Di Wang Commercial Center, 5002 Shennan Road East,
Shenzhen, 518008, China
Tel: (0755)2583-0827 Fax: (0755)8246-1581

Toshiba Electronics Korea Corporation

Seoul Head Office
891, Sejong Securities Bldg. 20F, Daechi-dong,
Gangnam-gu, Seoul, 135-738, Korea
Tel: (02)3484-4334 Fax: (02)3484-4302

Gumi Office
6F, Goodmorning Securities Building,
56 Songjung-dong, Gumi-shi,
Kyeongbuk, 730-090, Korea
Tel: (054)456-7613 Fax: (054)456-7617

Toshiba Electronics (Shanghai) Co., Ltd.

11F, HSBC Tower, 101
Yin Cheng East Road, Pudong New Area, Shanghai,
200120, China
Tel: (021)6841-0666 Fax: (021)6841-5002

Hangzhou Office
502 JiaHua International Business Center,
No.28 HangDa Road, Hangzhou, 310007, China
Tel: (0571)8717-5004 Fax: (0571)8717-5013

Tsurong Xiamen Xiangyu Trading Co., Ltd.

14G, International Bank BLDG., No.8 Lujiang Road,
Xiamen, 361001, China
Tel: (0592)226-1398 Fax: (0592)226-1399

Toshiba Electronics Taiwan Corporation

Taipei Head Office
17F, Union Enterprise Plaza Building, 109
Min Sheng East Road, Section 3, Taipei, 10544, Taiwan
Tel: (02)2514-9988 Fax: (02)2514-7892

Kaohsiung Office
16F-A, Chung-Cheng Building, 2, Chung-Cheng 3Road,
Kaohsiung, 80027, Taiwan
Tel: (07)237-0826 Fax: (07)236-0046

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