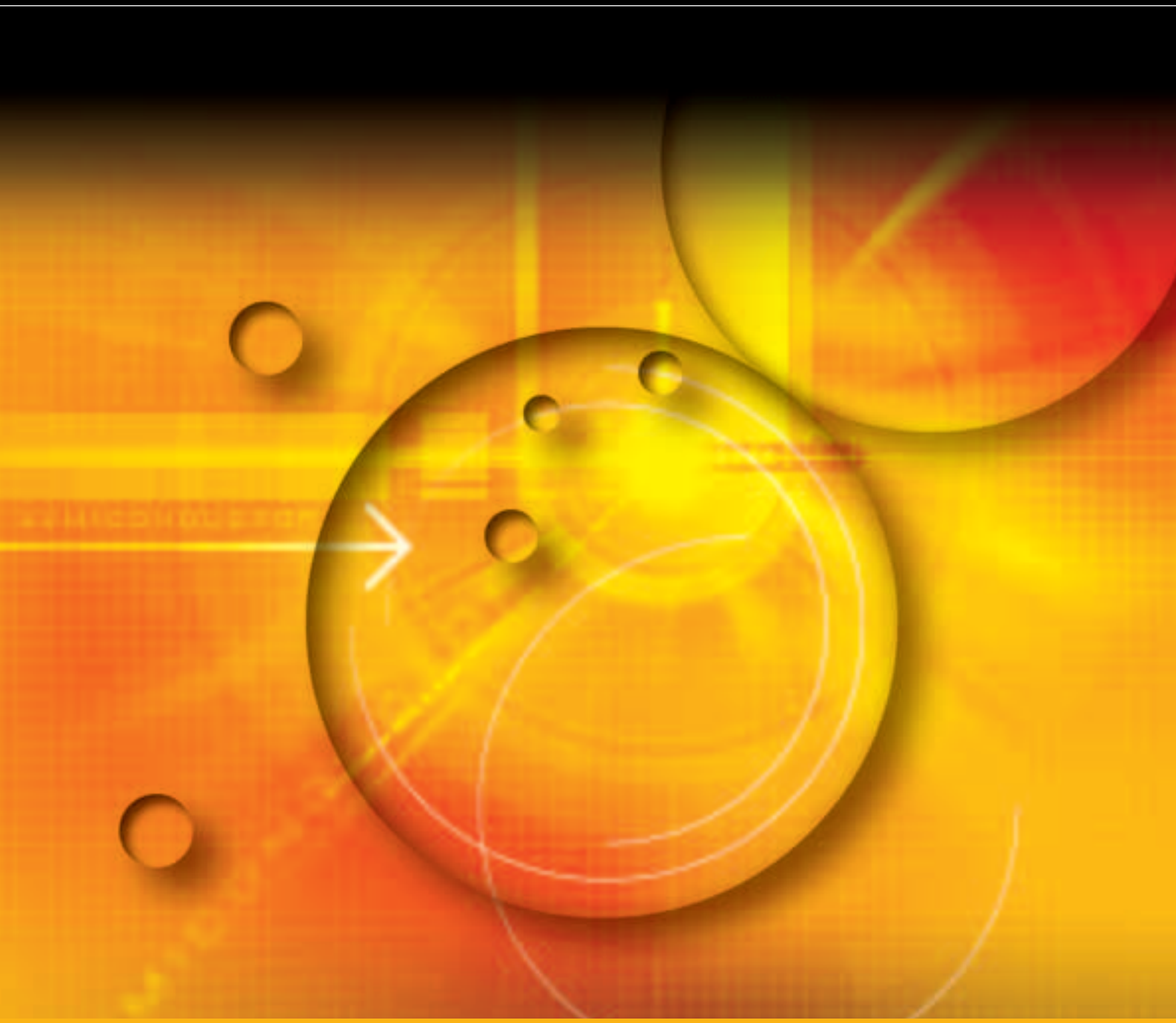
TOSHIBA

Leading Innovation

2009-3

PRODUCT GUIDE

# Discrete IGBTs



SEMICONDUCTOR

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

# IGBT: Insulated Gate Bipolar Transistor

IGBTs combine the MOSFET advantage of high input impedance with the bipolar transistor advantage of high-voltage drive.
The conductivity modulation characteristics of a bipolar transistor make it ideal for load control applications that require high breakdown voltage and high current.
Toshiba offers a family of fast switching IGBTs, which are low in carrier injection and recombination in carrier.

## Features of the Toshiba Discrete IGBTs

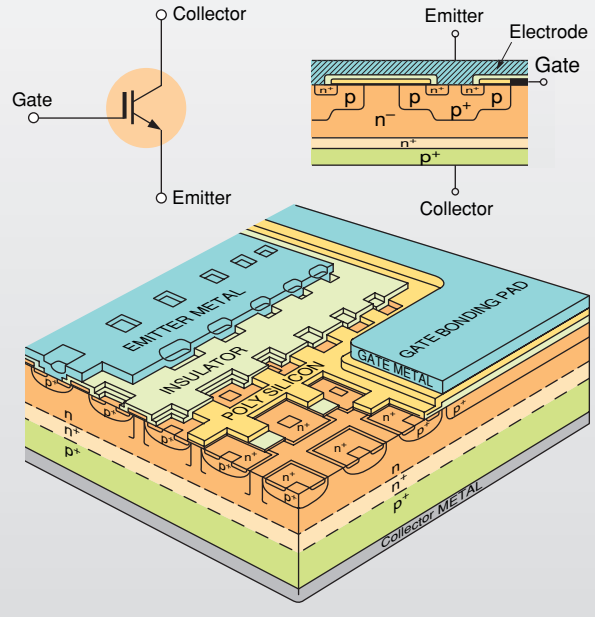
The Toshiba discrete IGBTs are available in high-voltage and high-current ratings. They are used in inverter and power conversion circuits for such diverse applications as motor drivers, uninterruptible power supply (UPS) systems, IH cookers, plasma display panels (PDPs), strobe flashes and so on.

(1) IGBTs also featuring fast switching
(2) Low collector-emitter saturation voltage even in the large current area
(3) IGBTs featuring a built-in diode with optimal characteristics tailored to specific applications
(4) High input impedance allows voltage drives
(5) Available in a variety of packages

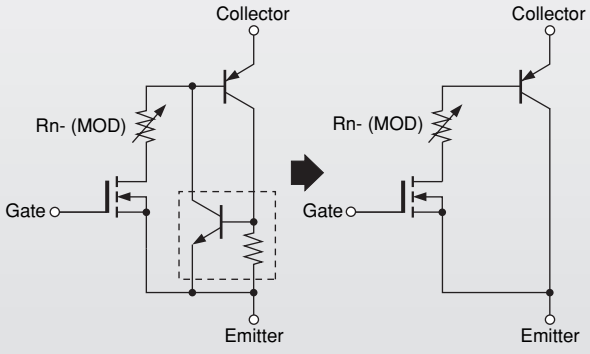
## Construction

The basic structure of the planar IGBT consists of four layers (pnpn), as shown in the following figure. Low saturation voltage is achieved by using a pnp transistor to allow conductivity modulation during conduction. Unlike MOSFETs, the IGBT does not have an integral reverse diode, since the collector contact is made on the $p^+$ layer.

### Planar Structure



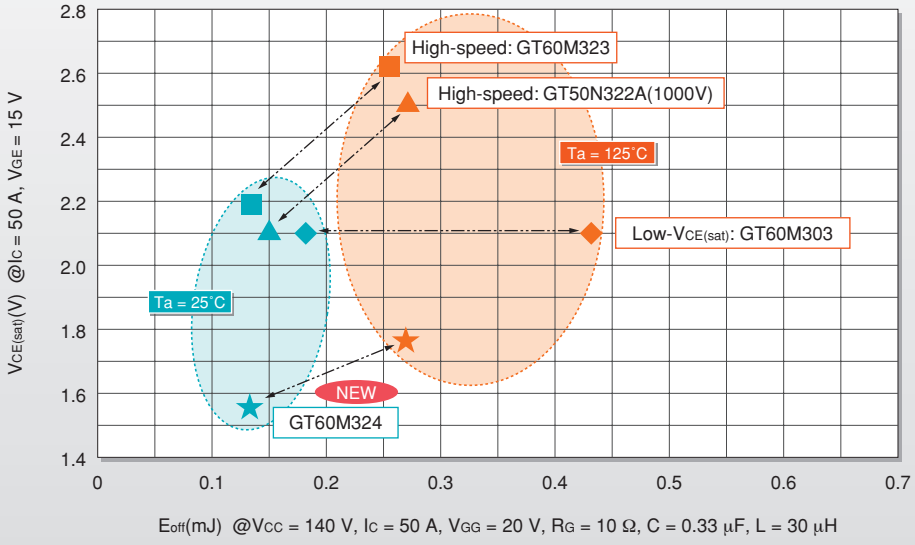

### Equivalent Circuit



# 2 IGBT Technical Overview

Prior to the development of IGBTs, power MOSFETs were used for power amplifier applications which require high input impedance and fast switching. However, at high voltages, the on-state resistance rapidly increases as the breakdown voltage increases. It is thus difficult to improve the conduction loss of power MOSFETs.
On the other hand, the IGBT structure consists of a PNP bipolar transistor and a collector contact made on the $p^+$ layer. The IGBT has a low on-state voltage drop due to conductivity modulation.
The following figure shows the VCE(sat) curve of a soft-switching 900-V IGBT. Toshiba has offered IGBTs featuring fast switching by using carrier lifetime control techniques. Now, Toshiba offers even faster IGBTs with optimized carrier injection into the collector Player.
In the future, Toshiba will launch IGBTs with varied characteristics optimized for high-current-conduction and high-frequency-switching applications. The improvements in IGBTs will be spurred by optimized wafers, smaller pattern geometries and improved carrier lifetime control techniques.

## ▶ 900-V IGBT for Soft-Switching




## Discrete IGBT Development Trends

| | | |
|---|---|---|
| 1200 V | (1) High ruggedness (3rd gen): Low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and thinner wafers | (3) High ruggedness (next gen): Thinner wafers and finer process geometries |
| | (2) Soft switching (5th gen): Low $V_{CE(sat)}$ due to trench gate structure | (4) Soft switching (next gen): Thinner wafers and finer process geometries |
| 900 to 1500 V | (1) Soft switching (4th gen): Low $V_{CE(sat)}$ due to trench gate structure | |
| | (2) Soft switching (5th gen): Low $V_{CE(sat)}$ due to optimized carrier injection and trench gate structure | (3) Soft switching (6th gen): Thinner wafers and finer process geometries |
| 600 V | (1) High ruggedness (3rd gen): Low $V_{CE(sat)}$ and high ruggedness due to optimized carrier injection and thinner wafers | (4) High ruggedness (next gen): Thinner wafers and finer process geometries |
| | (2) Fast switching (4th gen): High speedy tf due to optimized carrier injection | (5) Fast switching (next gen): Thinner wafers and finer process geometries |
| | (3) Soft switching (4th gen): Low $V_{CE(sat)}$ due to trench gate structure | (6) Soft switching (5th gen): Thinner wafers and finer process geometries |
| 400 V | (1) Strobe flashes (5th gen): Low $V_{CE(sat)}$ due to trench gate structure | |
| | (2) Strobe flashes (6th gen): High current due to trench gate structure and optimized wafers | (3) Strobe flashes (7th gen): High current due to optimized wafers and finer process geometries |
| 300 to 400 V | (1) Plasma displays (4th gen): Low $V_{CE(sat)}$ due to trench gate structure and high IC due to life time control | |
| | (2) Plasma displays (4th gen): Improved transient performance due to Cu connector | (3) Plasma displays (next gen): Low turn-on loss due to thinner wafers and finer process geometries |
| Year | 2006 | 2008 → 2010 |

# 3 Discrete IGBT Product List

| Applications and Features | Breakdown Voltage $V_{CES}$ (V) @Ta = 25°C | IGBT Current Rating Ic (A) @Ta = 25°C DC | Pulsed | TSON-8 | TSSOP-8 | SOP-8 | TO-220NIS | TO-220SIS | TO-220FL | TO-220SM | TO-220AB | TO-3P(N) | TO-3P(N)IS | TO-3P(LH) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| General-purpose motors<br>General-purpose inverters<br>Hard switching<br>fc: up to 20 kHz<br><br>High ruggedness Series | 600 | 5 | 10 | | | | GT5J301 | | | GT5J311 | | | | |
| | | 10 | 20 | | | | GT10J303 | | | GT10J312 | | GT10J301 | | |
| | | 15 | 30 | | | | GT15J301 | | | GT15J311 | | | | |
| | | 20 | 40 | | | | | | | | | GT20J301<br>GT20J101 | | |
| | | 30 | 60 | | | | | | | | | GT30J301<br>GT30J101 | | |
| | | 50 | 100 | | | | | | | | | | | GT50J301<br>GT50J102 |
| | 1200 | 10 | 20 | | | | | | | | | GT10Q301<br>GT10Q101 | | |
| | | 15 | 30 | | | | | | | | | GT15Q301<br>GT15Q102 | | |
| | | 25 | 50 | | | | | | | | | | | GT25Q301<br>GT25Q102 |
| General-purpose inverters<br>Fast switching<br>Hard switching<br>fc: up to 50 kHz<br><br>FS series | 600 | 10 | 20 | | | | GT10J321 | | | | | | | |
| | | 15 | 30 | | | | GT15J321 | | | | | | | |
| | | 20 | 40 | | | | GT20J321 | | | | | | | |
| | | 30 | 60 | | | | | | | | | GT30J324<br>GT30J121 | GT30J126 | |
| | | 50 | 100 | | | | | | | | | | | GT50J325<br>GT50J121 |
| General-purpose inverters<br>Low-$V_{CE(sat)}$ IGBT | 600 | 15 | 30 | | | | | | | GT15J331 | | | | |
| Resonant switching<br>Soft switching<br><br>Soft-Switching Series | 400 | 40 | 100 | | | | | | | | GT40G121 | | | |
| | | 50 | 100 | | | | | | | | | | | GT50G321 |
| | 600 | 30 | 100 | | | | | | | | | | GT30J322 | |
| | | 37 | 100 | | | | | | | | | | GT35J321 | |
| | | 40 | 100 | | | | | | | | | GT40J321<br>GT40J322<br>GT40J323 | | |
| | | 50 | 100 | | | | | | | | | GT50J327<br>GT50J328 | | GT50J322<br>GT50J322H |
| | | | 120 | | | | | | | | | GT50J122 | | |
| | | 60 | 120 | | | | | | | | | | | GT60J321<br>GT60J323<br>GT60J323H |
| | | 80 | 160 | | | | | | | | | | | GT80J101B |
| | 900 | 15 | 30 | | | | | | | | | | GT15M321 | |
| | | 50 | 120 | | | | | | | | | GT50M322 | | |
| | | 60 | 120 | | | | | | | | | | | GT60M303<br>GT60M323<br>GT60M324 |
| | 1000 | 50 | 120 | | | | | | | | | GT50N322A<br>GT50N324 | | |
| | | 57 | 120 | | | | | | | | | | | GT60N322 |
| | | 60 | 120 | | | | | | | | | | | GT60N321 |
| | 1200 | 42 | 80 | | | | | | | | | GT40Q321 | | |
| | 1500 | 40 | 80 | | | | | | | | | | | GT40T302 |
| PFC | 600 | 30 | 100 | | | | | | | | | | GT30J122 | |
| Strobe flashes | 400 | | 130 | GT5G133 | | | | | | | | | | |
| | | | 150 | | GT8G133<br>GT8G134<br>GT8G136 | GT8G132 | | | | | | | | |
| | | | 200 | | GT10G131 | | | | | | | | | |
| Plasma display panels | 300 | | 120 | | | | | GF30F122 | | | | | | |
| | | | 200 | | | | | GF30F123<br>GT45F122<br>GT45F123<br>GT45F124<br>GT45F125<br>GT45F127 | | | | | | |
| | 400 | | 120 | | | | | GT30G122 | | | | | | |
| | | | 200 | | | | | GT45G122<br>GT45G123<br>GT45G124<br>GT45G125 | | | | | | |
| | 430 | | 200 | | | | | GT30G123<br>GT45G127 | | | | | | |
| | 600 | | 200 | | | | | GT30J124 | | | | | | |

: Under development

# 4 Part Numbering Scheme

Example **GT 60 M 3 03 A**

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

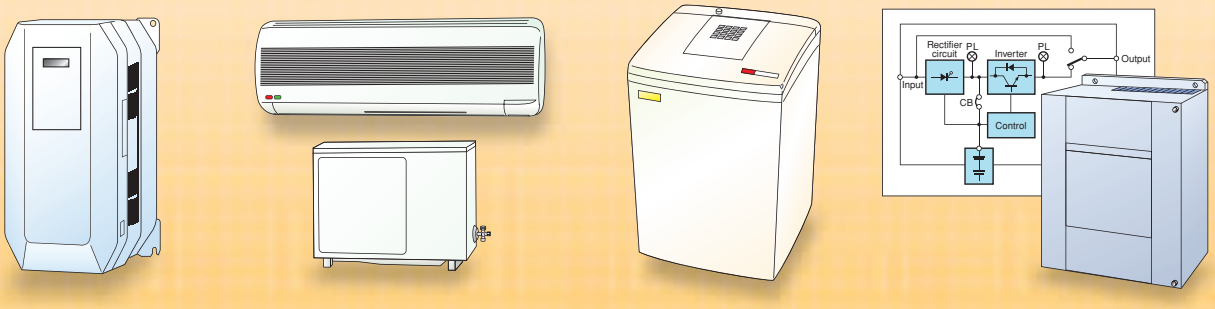
Table 1

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

# 5-1 General-Purpose Inverter

The fast-switching (FS) series, a new addition to our third-generation IGBTs, features high ruggedness which helps to improve the energy efficiency of electronic equipment.

General-Purpose Inverters | Inverter Air Conditioners | Inverter Washing Machines | UPS



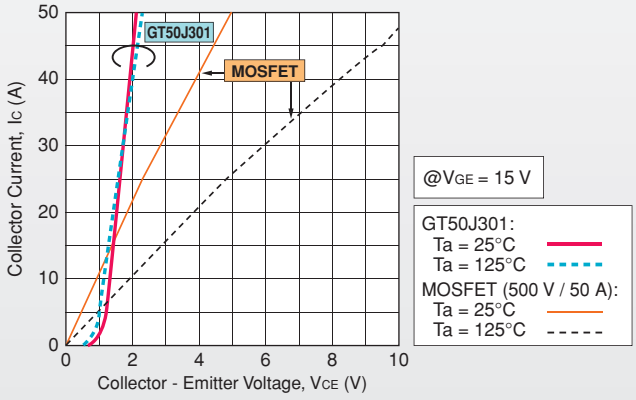

## Discrete IGBT Trend

▶ For general-purpose inverters

Our 3rd generation low-loss and low-noise IGBTs are ideal for inverter applications to reduce switching loss and thus improve energy efficiency. The following graphs compare the thermal and turn-on characteristics of our 3rd generation IGBTs and 500-V MOSFETs

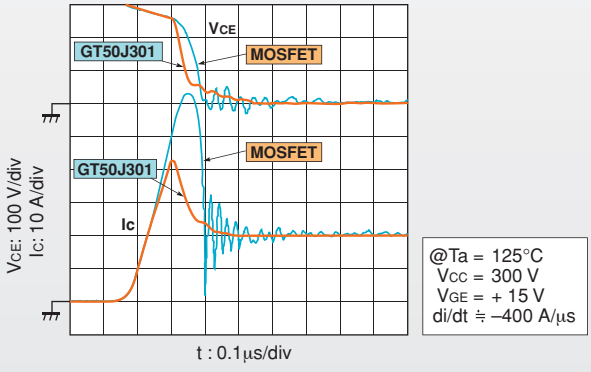
### ▶ IC - VCE Temperature Characteristics

Low saturation voltage with minimal temperature dependence



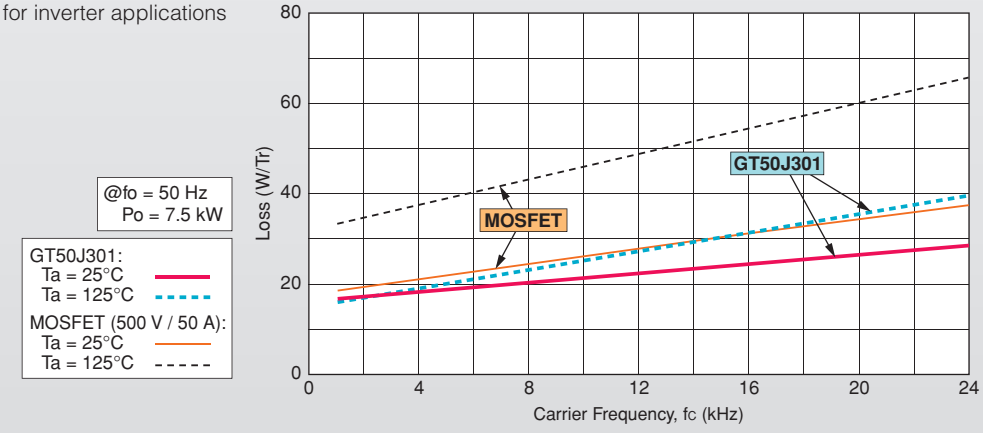

### ▶ Turn-On Waveform

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




### ▶ Power Loss vs. Carrier Frequency Characteristics

Simulation data for inverter applications



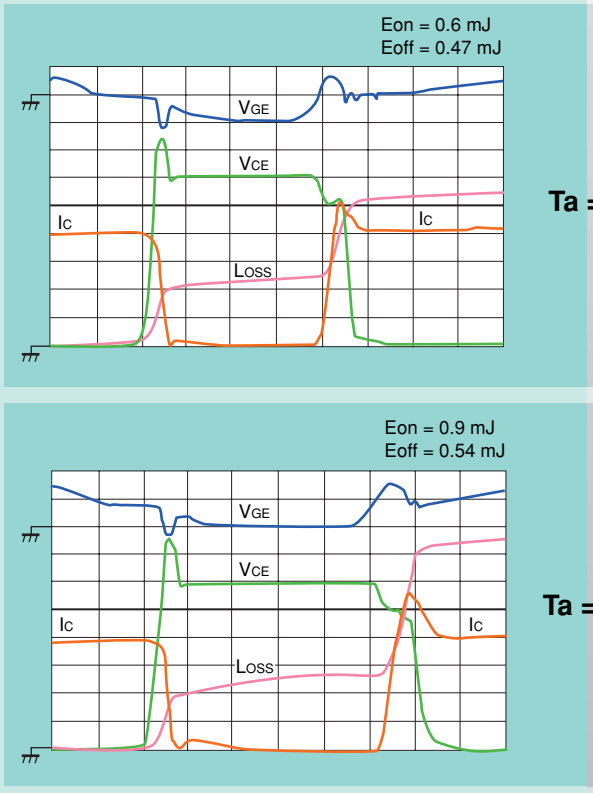
## For general-purpose inverters

▶ Fast-Switching (FS) Series

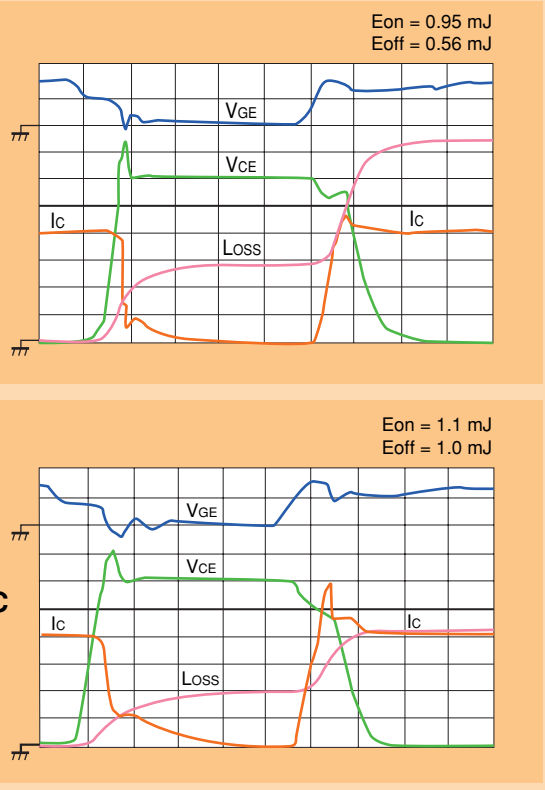
Compared to the third-generation highly rugged series, the FS series is optimized for switching speed, reducing the total switching loss (Eon + Eoff) by 30% (according to Toshiba's comparative test).

### ▶ Typical Waveforms

**GT20J321(4th generation, FS Series)**




**GT20J301(3rd generation)**




Ta = 25˚C

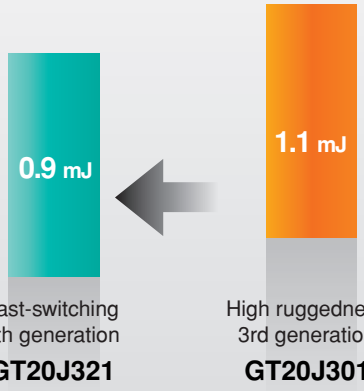
Ta = 125˚C

(Loss: 0.5 mJ/div)

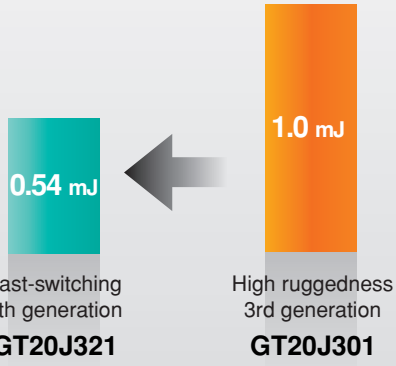
(VCE: 50 V/div, IC: 5 A/div, VGE: 10 V/div, Loss: 0.2 mJ/div, t: 0.2 μs/div)

Reduced switching loss of fast-switching IGBTs in comparison with high ruggedness IGBTs
Test condition: IC = 20 A, VGE = 15 V, RG = 33 Ω, Ta = 125˚C, with inductive load, VCC = 300 V

### ▶ Turn-On Loss



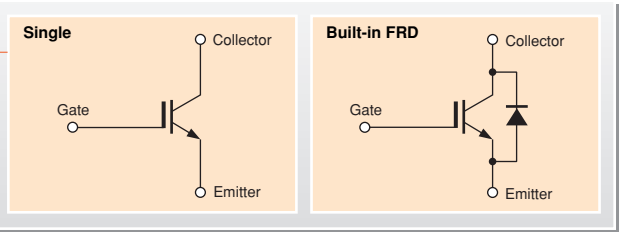

### ▶ Turn-Off Loss



## Product List

▶ For general-purpose inverters

### ▶ Circuit Configurations




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

| 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) | $I_C$ Pulsed (A) | $P_C$ $T_C$ = 25°C (W) | | Type | | (V) | @$I_C$ (A) | @$V_{GE}$ (V) | (μs) | Load (*2) | |
| Motor driving (UPS/PFC) | High $V_{CES}$ (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 $V_{CES}$ (600V) | **GT5J301** | 600 | 5 | 10 | 28 | TO-220NIS | – | Built-in FRD | 2.1 | 5 | 15 | 0.15 | L | |
| | | **GT5J311** | 600 | 5 | 10 | 45 | TO-220SM | SMD | Built-in FRD | 2.1 | 5 | 15 | 0.15 | L | |
| | | **GT10J301** | 600 | 10 | 20 | 90 | TO-3P(N) | – | Built-in FRD | 2.1 | 10 | 15 | 0.15 | L | |
| | | **GT10J303** | 600 | 10 | 20 | 30 | TO-220NIS | – | Built-in FRD | 2.1 | 10 | 15 | 0.15 | L | |
| | | **GT10J312** | 600 | 10 | 20 | 60 | TO-220SM | SMD | Built-in FRD | 2.1 | 10 | 15 | 0.15 | L | |
| | | **GT15J301** | 600 | 15 | 30 | 35 | TO-220NIS | – | Built-in FRD | 2.1 | 15 | 15 | 0.15 | L | |
| | | **GT15J311** | 600 | 15 | 30 | 70 | TO-220FL | – | Built-in FRD | 2.1 | 15 | 15 | 0.15 | L | |
| | | **GT15J311** | 600 | 15 | 30 | 70 | TO-220SM | SMD | Built-in FRD | 2.1 | 15 | 15 | 0.15 | L | |
| | | **GT20J101** | 600 | 20 | 40 | 130 | TO-3P(N) | – | ◆ | 2.1 | 20 | 15 | 0.15 | L | |
| | | **GT20J301** | 600 | 20 | 40 | 130 | TO-3P(N) | – | Built-in FRD | 2.1 | 20 | 15 | 0.15 | L | |
| | | **GT30J101** | 600 | 30 | 60 | 155 | TO-3P(N) | – | ◆ | 2.1 | 30 | 15 | 0.15 | L | |
| | | **GT30J301** | 600 | 30 | 60 | 155 | TO-3P(N) | – | Built-in FRD | 2.1 | 30 | 15 | 0.15 | L | |
| | | **GT50J102** | 600 | 50 | 100 | 200 | TO-3P(LH) | – | ◆ | 2.1 | 50 | 15 | 0.15 | L | |
| | | **GT50J301** | 600 | 50 | 100 | 200 | TO-3P(LH) | – | Built-in FRD | 2.1 | 50 | 15 | 0.15 | L | |
| Power factor correction | Low-frequency switching | **GT30J122** | 600 | 30 | 100 | 75 | TO-3P(N)IS | – | ◆ | 2.1 | 50 | 15 | 0.25 | R | Partial Switching Converter |

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

(FS: Fast Switching)

| Main Applications | Features | Part Number | $V_{CES}$ (V) | $I_C$ DC (A) | $I_C$ Pulsed (A) | $P_C$ $T_C$ = 25°C (W) | Package | Type | Circuit Configuration (*1) | $V_{CE(sat)}$ Typ. (V) | @$I_C$ (A) | @$V_{GE}$ (V) | $t_f$ Typ. (μs) | Load (*2) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | |
| | | **GT30J126** | 600 | 30 | 60 | 90 | TO-3P(N)IS | – | ◆ | 1.95 | 30 | 15 | 0.05 | L | Isolation Package |
| | | **GT30J324** | 600 | 30 | 60 | 170 | TO-3P(N) | – | Built-in FRD | 2.0 | 30 | 15 | 0.05 | L | |
| | | **GT50J121** | 600 | 50 | 100 | 240 | TO-3P(LH) | – | ◆ | 2.0 | 50 | 15 | 0.05 | L | |
| | | **GT50J325** | 600 | 50 | 100 | 240 | TO-3P(LH) | – | Built-in FRD | 2.0 | 50 | 15 | 0.05 | L | |

*1 ◆ : Single
FRD: Fast Recovery Diode
*2 R : Resistive load
L : Inductive load

# 5-2 Soft-Switching Applications

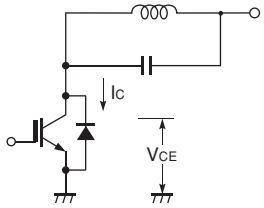
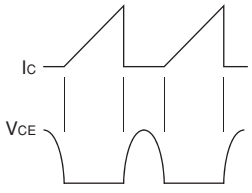
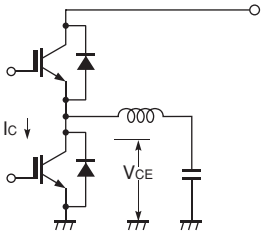
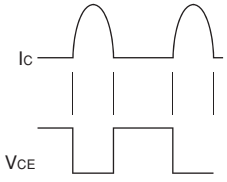
Static inverters in IH cooktops, IH rice cookers and microwave ovens utilize a soft-switching technique which exhibits low switching loss. Toshiba offers IGBTs suitable for soft-switching applications.

## Microwave Ovens

## IH Rice Cookers

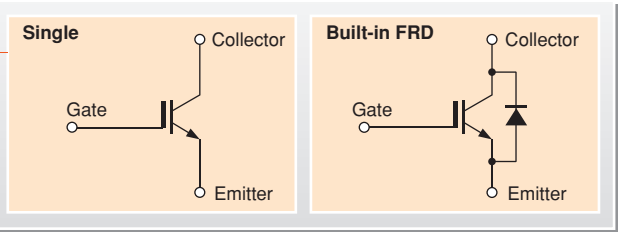

## IH Cookers

## MFPs

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

IH: Induction heating
MFP: Multifunction Printer

## ▶ Circuit Configurations




## IGBTs for Soft-Switching Applications

| Main Applications | | Features | Part Number | Absolute Maximum Ratings | | | | Package | Circuit Configuration (*1) | $V_{CE(sat)}$ Typ. | | | $t_f$ Typ. | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CES}$ (V) | $I_C$ DC (A) | $I_C$ Pulsed (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 | | |
| | | | **GT40J321** | | 40 | 100 | 110 | TO-3P(N) | | 2.1 | 40 | 15 | 0.15 | | Fast switching |
| | | | **GT40J322** | | 40 | 100 | 110 | | | 2.0 | 40 | 15 | 0.24 | | |
| | | | **GT40J323** | | 40 | 80 | 120 | TO-3P(LH) | | 2.0 | 40 | 15 | 0.06 | | 5th generation |
| | | | **GT50J322** | | 50 | 100 | 130 | | | 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 | | |
| | | | **GT50J328** | | 50 | 120 | 140 | | | 2.0 | 50 | 15 | 0.10 | | Fast switching |
| | | | **GT60J321** | | 60 | 120 | 200 | TO-3P(LH) | | 1.55 | 60 | 15 | 0.30 | R | |
| | | | **GT60J323** | | 60 | 120 | 170 | | | 1.9 | 60 | 15 | 0.16 | | |
| | | | **GT60J323H** | | 60 | 120 | 170 | | | 2.1 | 60 | 15 | 0.12 | | 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 | | |
| | | | **GT50M322** | | 50 | 120 | 156 | TO-3P(N) | | 2.1 | 60 | 15 | 0.25 | | |
| | | | **GT60M303** | | 60 | 120 | 170 | TO-3P(LH) | | 2.1 | 60 | 15 | 0.25 | | |
| | | | **GT60M323** | | 60 | 120 | 200 | | | 2.3 | 60 | 15 | 0.09 | | Fast switching |
| | | | **GT60M324** | | 60 | 120 | 150 | | | 1.65 | 60 | 15 | 0.11 | | 6th generation |
| | | | **GT50N321** | | 50 | 120 | 156 | TO-3P(N) | | 2.5 | 60 | 15 | 0.25 | | |
| | | | **GT50N322A** | | 50 | 120 | 156 | | | 2.2 | 60 | 15 | 0.10 | | Fast switching |
| | | | **GT50N324** | 1000 | 50 | 120 | 150 | | | 1.9 | 60 | 15 | 0.12 | | 6th generation |
| | | | **GT60N321** | | 60 | 120 | 170 | TO-3P(LH) | | 2.3 | 60 | 15 | 0.25 | | |
| | | | **GT60N322** | | 57 | 120 | 200 | | | 2.4 | 40 | 15 | 0.11 | | Fast switching |
| | AC 200 V | | **GT40Q321** | 1200 | 40 | 80 | 170 | TO-3P(N) | | 2.8 | 60 | 15 | 0.41 | | |
| | | | **GT40T302** | 1500 | 40 | 80 | 200 | TO-3P(LH) | | 3.7 | 40 | 15 | 0.23 | | High $V_{CES}$ |

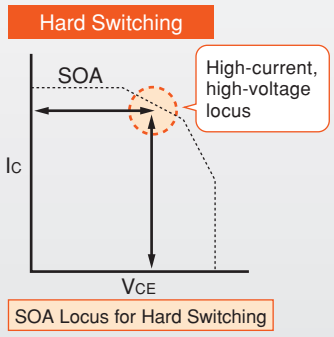
*1 ◆ : Single
FRD: Fast Recovery Diode
FWD: Free Wheeling Diode

*2 R : Resistive load
L : Inductive load

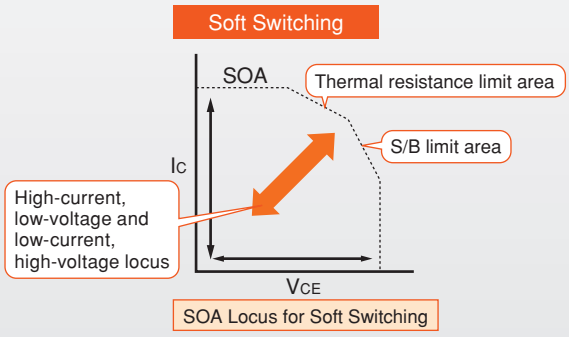
: Under development

# 5-2 Soft-Switching Applications

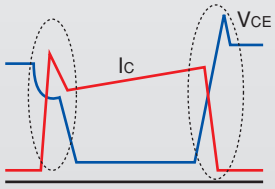
## Comparisons Between Hard and Soft Switching (diagrams shown only as a guide)



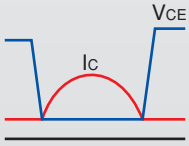

SOA Locus for Hard Switching



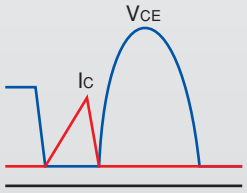

SOA Locus for Soft Switching




Switching Characteristics (Example)




Current Resonance (Example)



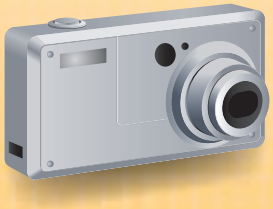

Voltage Resonance (Example)

# 5-3 Strobe Flash Applications

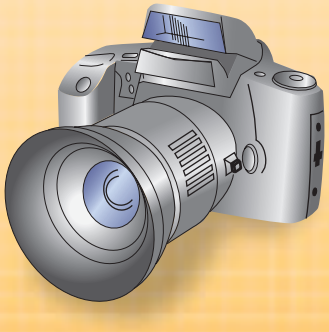
Strobe flash control is now prevalent in digital still cameras. Package sizes are getting smaller, and logic levels are increasingly used to represent the gate drive voltage. Toshiba offers compact IGBTs featuring low gate drive voltage.

- As a voltage-controlled device, the IGBT requires only a few components for drive circuit.
- IGBTs require fewer components for the strobe flash circuit (compared to SCRs).
- Strobe flash IGBTs are capable of switching large currents.

DSC, Compact Camera



Single-Lens Reflex Camera



# 5-3 Strobe Flash Applications

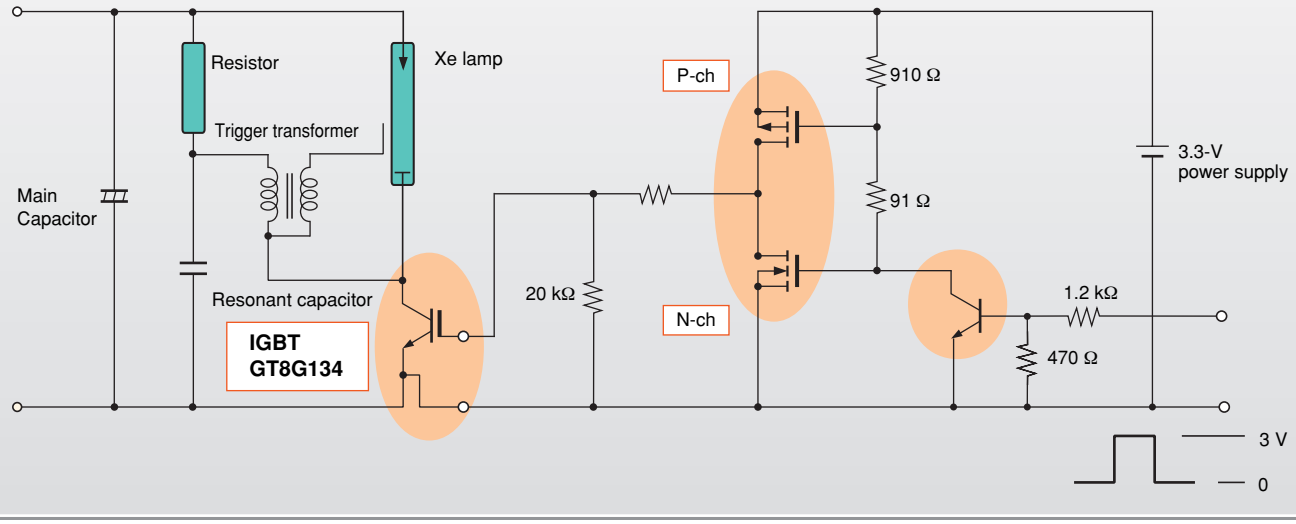
## Product List

▶ For strobe flashes

### 2.5-V to 4.0-V Gate Drive Series

The IGBT can operate with a gate drive voltage of 2.5 V to 4.0 V. The common 3.3-V or 5-V internal power supply in a camera can be used as a gate drive power supply to simplify the power supply circuitry. A zener diode is included between the gate and emitter to provide ESD surge protection.

▶ Example of an IGBT Gate Drive Circuit (3.3-V Power Supply)




### 3.3-V Power Supply

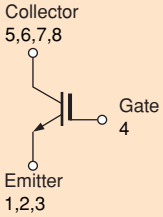
| Part Number | $V_{CES}$ / $I_C$ | $V_{CE}$(sat) (V) (V) | $V_{CE}$(sat) (V) $V_{GE}$ / $I_C$ | $P_C$ (W) @Ta = 25°C | Package | Remarks |
|---|---|---|---|---|---|---|
| **GT5G133** | 400 V / 130 A | 3.4 | 2.5 V / 130 A | 0.9 | **TSON-8***1 | 7th generation |
| **GT8G136** | 400 V / 150 A | 3.5 | 3 V / 150 A | 1.1 | **TSSOP-8***2 | 5th generation |
| **GT8G134** | 400 V / 150 A | 3.4 | 2.5 V / 150 A | 1.1 | **TSSOP-8***2 | 6th generation |

: Under development

### 5-V Power Supply

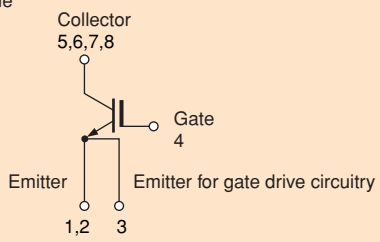
| Part Number | $V_{CES}$ / $I_C$ | $V_{CE}$(sat) (V) (V) | $V_{CE}$(sat) (V) $V_{GE}$ / $I_C$ | $P_C$ (W) @Ta = 25°C | Package | Remarks |
|---|---|---|---|---|---|---|
| **GT8G132** | 400 V / 150 A | 2.3 | 4.0 V / 150 A | 1.1 | **SOP-8***1 | 5th generation |
| **GT8G133** | 400 V / 150 A | 2.9 | 4.0 V / 150 A | 1.1 | **TSSOP-8***1 | 5th generation |
| **GT10G131** | 400 V / 200 A | 2.3 | 4.0 V / 200 A | 1.9 | **SOP-8***1 | 5th generation |

*1: Board connection example




All the emitter terminals should be connected together.

*2: Board connection example

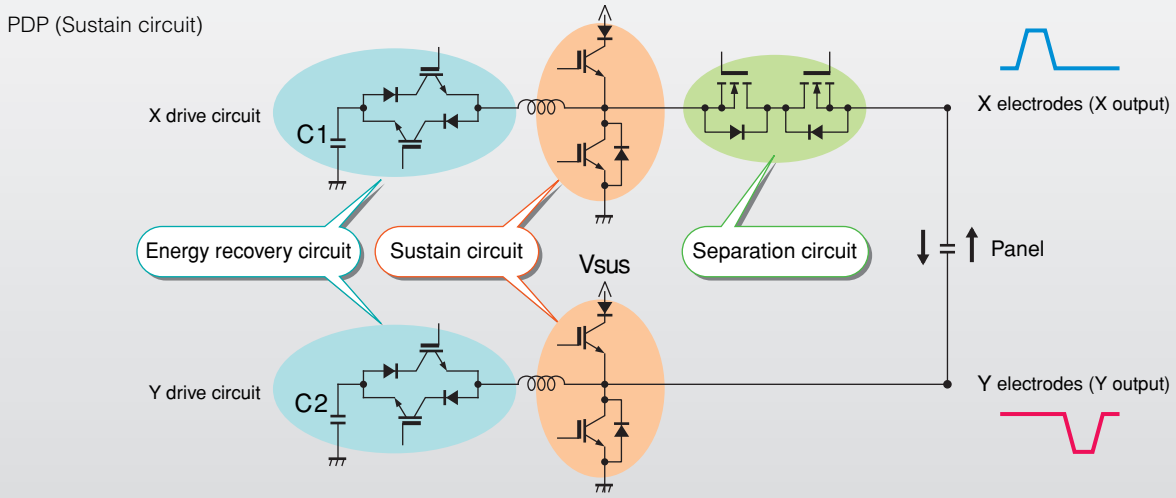


# 5-4 Plasma Display Panel Applications

## Plasma Displays

Parallel MOSFETs have been used for the drive circuitry of plasma display panels (PDPs). Recently, however, IGBTs are commonly used in large current applications due to their superior current conduction capability.

### Example of a Plasma Display Panel Drive Circuit




## Product List

▶ For plasma display panels

### 300-V IGBTs

| Part Number | $V_{CES}$ / Icp @3 μs | $V_{CE(sat)}$ (V) Max | $P_C$ (W) @Tc = 25°C | Package | Remarks |
|---|---|---|---|---|---|
| **GT30F122** | 300 V / 120 A* | 2.9 (@120 A) | 25 | **TO-220SIS** | 5th generation |
| **GT30F123** | 300 V / 200 A | 2.1 (@120 A) | 25 | **TO-220SIS** | 6th generation |
| **GT45F122** | 300 V / 200 A | 2.7 (@120 A) | 25 | **TO-220SIS** | 5th generation |
| **GT45F123** | 300 V / 200 A | 2.4 (@120 A) | 26 | **TO-220SIS** | 5th generation |
| **GT45F124** | 300 V / 200 A | 2.1 (@120 A) | 29 | **TO-220SIS** | 5th generation |
| **GT45F125** | 300 V / 200 A | 1.45 (@120 A) | 29 | **TO-220SIS** | 5th generation |
| **GT45F127** | 300 V / 200 A | 1.6 (@120 A) | 26 | **TO-220SIS** | 6th generation |
| **GT45F131** | 300 V / 200 A | 2.1 (@120 A) | 160 | **TO-220SM** | 5th generation |

*: @100 μs

### 400-V IGBTs

| Part Number | $V_{CES}$ / Icp @3 μs | $V_{CE(sat)}$ (V) Max | $P_C$ (W) @Tc = 25°C | Package | Remarks |
|---|---|---|---|---|---|
| **GT30G122** | 400 V / 120 A* | 2.6 (@120 A) | 25 | **TO-220SIS** | 5th generation |
| **GT30G123** | 430 V / 200 A | 2.2 (@120 A) | 25 | **TO-220SIS** | 6th generation |
| **GT45G122** | 400 V / 200 A | 2.9 (@120 A) | 25 | **TO-220SIS** | 5th generation |
| **GT45G123** | 400 V / 200 A | 2.6 (@120 A) | 26 | **TO-220SIS** | 5th generation |
| **GT45G124** | 400 V / 200 A | 2.3 (@120 A) | 29 | **TO-220SIS** | 5th generation |
| **GT45G125** | 400 V / 200 A | 1.6 (@120 A) | 29 | **TO-220SIS** | 5th generation |
| **GT45G127** | 430 V / 200 A | 1.7 (@120 A) | 26 | **TO-220SIS** | 6th generation |
| **GT45G131** | 400 V / 200 A | 2.3 (@120 A) | 160 | **TO-220SM** | 5th generation |

*: @100 μs

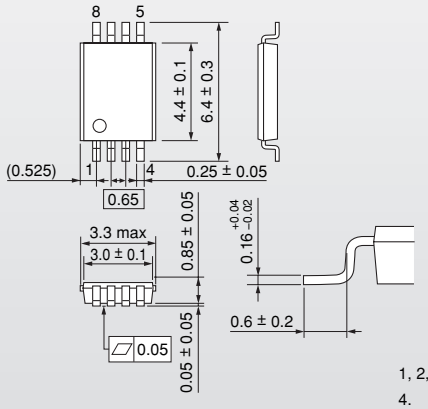
### 600-V IGBTs

| Part Number | $V_{CES}$ / Icp @3 μs | $V_{CE(sat)}$ (V) Max | $P_C$ (W) @Ta = 25°C | Package | Remarks |
|---|---|---|---|---|---|
| **GT30J124** | 600 V / 200 A | 2.4 (@120 A) | 26 | **TO-220SIS** | 5th generation |

# 6 Package Dimensions

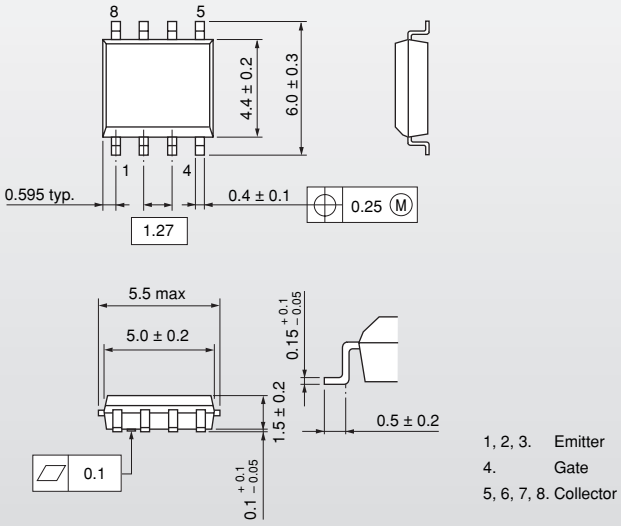
Unit: mm

## TSSOP-8



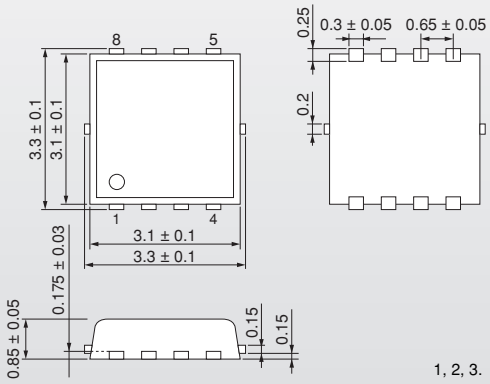

1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

## SOP-8



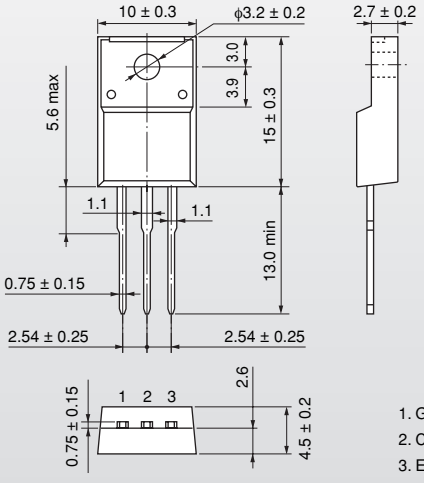

1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

## TSON-8



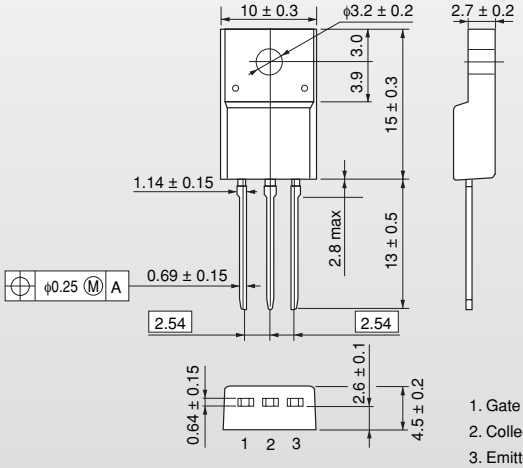

1, 2, 3. Emitter
4. Gate
5, 6, 7, 8. Collector

## TO-220NIS




1. Gate
2. Collector
3. Emitter

## TO-220SIS

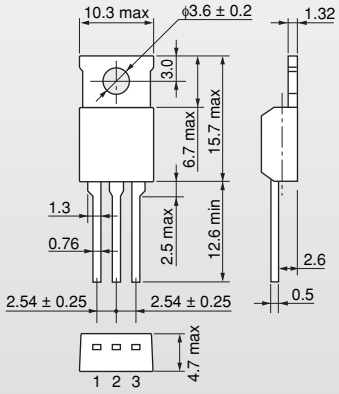



1. Gate
2. Collector
3. Emitter

# 6 Package Dimensions

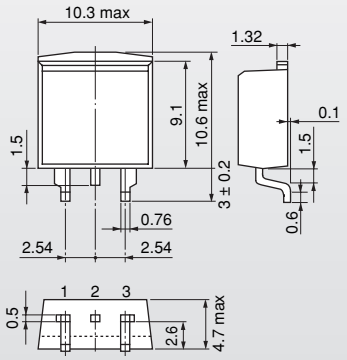
Unit: mm

## TO-220AB



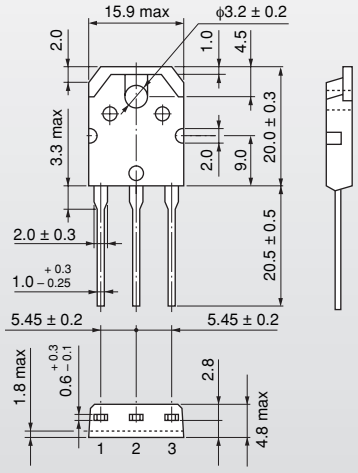

1. Gate
2. Collector
3. Emitter

## TO-220SM



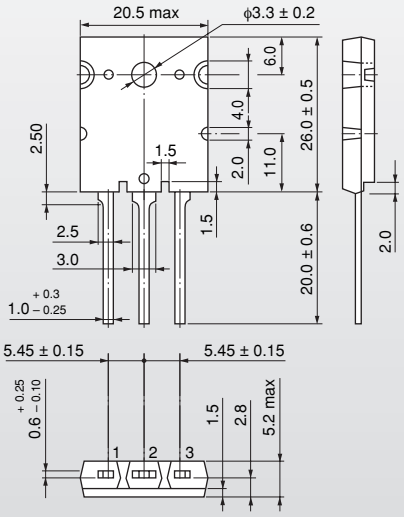

1. Gate
2. Collector
3. Emitter

## TO-3P(N)



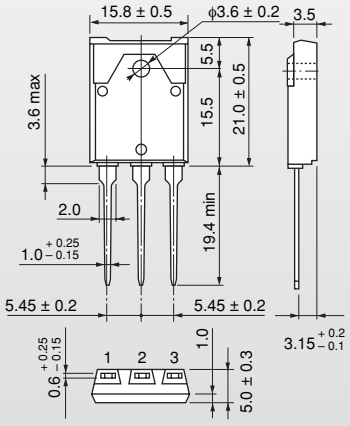

1. Gate
2. Collector
3. Emitter

## TO-3P(LH)




1. Gate
2. Collector
3. Emitter

## TO-3P(N)IS




1. Gate
2. Collector
3. Emitter

# 7 Final-Phase and Obsolete Products

The following products are in stock but are being phased out of production. The recommended replacements that continue to be available are listed in the right-hand column. However, the characteristics of the recommended replacements may not be exactly the same as those of the final-phase and obsolete products. Before using a recommended replacement, be sure to check that it is suitable for use under the intended operating conditions.

| Audio amps | Final-Phase or Obsolete Product | Absolute Maximum Ratings | | Package | Recommended Obsolete Replacements | Absolute Maximum Ratings | | Package |
|---|---|---|---|---|---|---|---|---|
| | | $V_{CES}$ (V) | $I_C$ (A) DC | | | $V_{CES}$ (V) | $I_C$ (A) DC | |
| Soft switching<br>Resonant switching | **MG30T1AL1** | 1500 | 30 | **IH** | – | – | – | – |
| | **MG60M1AL1** | 900 | 60 | **IH** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT40M101** | 900 | 40 | **TO-3P(N)IS** | – | – | – | – |
| | **GT40M301** | 900 | 40 | **TO-3P(LH)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT40Q322** | 1200 | 39 | **TO-3P(N)** | **GT40Q321** | 1200 | 42 | **TO-3P(N)** |
| | **GT40Q323** | 1200 | 39 | **TO-3P(N)** | **GT40Q321** | 1200 | 42 | **TO-3P(N)** |
| | **GT40T101** | 1500 | 40 | **TO-3P(LH)** | – | – | – | – |
| | **GT40T301** | 1500 | 40 | **TO-3P(LH)** | **GT40T302** | 1500 | 40 | **TO-3P(LH)** |
| | **GT50L101** | 800 | 50 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT50M101** | 900 | 50 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT50Q101** | 1200 | 50 | **IH** | – | – | – | – |
| | **GT50S101** | 1400 | 50 | **IH** | – | – | – | – |
| | **GT50T101** | 1500 | 50 | **IH** | – | – | – | – |
| | **GT60J101** | 600 | 60 | **TO-3P(L)** | **GT80J101B** | 600 | 60 | **TO-3P(LH)** |
| | **GT60J322** | 600 | 60 | **TO-3P(LH)** | **GT60J321** | 600 | 60 | **TO-3P(LH)** |
| | **GT60M101** | 900 | 60 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M102** | 900 | 60 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M103** | 900 | 60 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M104** | 900 | 60 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M105** | 900 | 60 | **TO-3P(L)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M301** | 900 | 60 | **TO-3P(LH)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M302** | 900 | 60 | **TO-3P(LH)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M305** | 900 | 60 | **TO-3P(LH)** | **GT60M303** | 900 | 60 | **TO-3P(LH)** |
| | **GT60M322** | 950 | 60 | **TO-3P(LH)** | **GT60N321** | 1000 | 60 | **TO-3P(LH)** |
| | **GT60N323** | 1050 | 60 | **TO-3P(LH)** | **GT60N322** | 1000 | 57 | **TO-3P(LH)** |
| | **GT80J101** | 600 | 80 | **TO-3P(L)** | **GT80J101B** | 600 | 80 | **TO-3P(LH)** |
| | **GT80J101A** | 600 | 80 | **TO-3P(LH)** | **GT80J101B** | 600 | 80 | **TO-3P(LH)** |
| General-purpose motors<br>General-purpose inverters | **GT8J101** | 600 | 8 | **TO-220NIS** | **GT10J303** | 600 | 10 | **TO-220NIS** |
| | **GT8J102** | 600 | 8 | **TO-220SM** | **GT10J312** | 600 | 10 | **TO-220SM** |
| | **GT8N101** | 1000 | 8 | **TO-3P(N)** | **GT10Q101** | 1200 | 10 | **TO-3P(N)** |
| | **GT8Q101** | 1200 | 8 | **TO-3P(N)** | **GT10Q101** | 1200 | 10 | **TO-3P(N)** |
| | **GT8Q102** | 1200 | 8 | **TO-220SM** | – | – | – | – |
| | **GT10Q311** | 1200 | 10 | **TO-3P(SM)** | – | – | – | – |
| | **GT15J101** | 600 | 15 | **TO-3P(N)** | **GT20J101** | 600 | 20 | **TO-3P(N)** |
| | **GT15J102** | 600 | 15 | **TO-220NIS** | **GT15J301** | 600 | 15 | **TO-220NIS** |
| | **GT15J103** | 600 | 15 | **TO-220SM** | **GT15J311** | 600 | 15 | **TO-220SM** |
| | **GT15N101** | 1000 | 15 | **TO-3P(N)** | **GT15Q102** | 1200 | 15 | **TO-3P(N)** |
| | **GT15Q101** | 1200 | 15 | **TO-3P(N)** | **GT15Q102** | 1200 | 15 | **TO-3P(N)** |
| | **GT15Q311** | 1200 | 15 | **TO-3P(SM)** | – | – | – | – |
| | **GT20J311** | 600 | 20 | **TO-3P(SM)** | – | – | – | – |
| | **GT25H101** | 500 | 25 | **TO-3P(N)** | **GT30J121** | 600 | 30 | **TO-3P(N)** |
| | **GT25J101** | 600 | 25 | **TO-3P(N)** | **GT30J121** | 600 | 30 | **TO-3P(N)** |
| | **GT25J102** | 600 | 25 | **TO-3P(N)IS** | **GT30J126** | 600 | 30 | **TO-3P(N)** |
| | **GT25Q101** | 1200 | 25 | **TO-3P(LH)** | **GT25Q102** | 1200 | 25 | **TO-3P(LH)** |
| | **GT30J311** | 600 | 30 | **TO-3P(SM)** | – | – | – | – |
| | **GT50J101** | 600 | 50 | **TO-3P(L)** | **GT50J121** | 600 | 50 | **TO-3P(LH)** |
| Strobe flashes | **GT5G101** | 400 | 130 (pulsed) | **NPM** | – | – | – | – |
| | **GT5G102** | 400 | 130 (pulsed) | **DP** | – | – | – | – |
| | **GT5G103** | 400 | 130 (pulsed) | **DP** | – | – | – | – |
| | **GT8G101** | 400 | 130 (pulsed) | **NPM** | – | – | – | – |
| | **GT8G102** | 400 | 150 (pulsed) | **NPM** | – | – | – | – |
| | **GT8G103** | 400 | 150 (pulsed) | **DP** | – | – | – | – |
| | **GT10G101** | 400 | 130 (pulsed) | **TO-220NIS** | – | – | – | – |
| | **GT10G102** | 400 | 130 (pulsed) | **TO-220NIS** | – | – | – | – |
| | **GT15G101** | 400 | 170 (pulsed) | **TO-220NIS** | – | – | – | – |
| | **GT20G101** | 400 | 130 (pulsed) | **TO-220FL** | – | – | – | – |
| | **GT20G102** | 400 | 130 (pulsed) | **TO-220FL** | – | – | – | – |
| | **GT25G101** | 400 | 170 (pulsed) | **TO-220FL** | – | – | – | – |
| | **GT25G102** | 400 | 150 (pulsed) | **TO-220FL** | – | – | – | – |
| | **GT50G101** | 400 | 100 (pulsed) | **TO-3P(N)** | – | – | – | – |
| | **GT50G102** | 400 | 100 (pulsed) | **TO-3P(N)** | – | – | – | – |
| | **GT75G101** | 400 | 150 (pulsed) | **TO-3P(N)** | – | – | – | – |
| Audio amps | **GT20D101** | 250 | 20 | **TO-3P(L)** | – | – | – | – |
| | **GT20D201** | –250 | –20 | **TO-3P(L)** | – | – | – | – |

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