

TOSHIBA

Thyristors and Triacs

PRODUCT GUIDE



1 Overview

Features

Thyristors

General-Purpose Thyristors

A variety of non-insulated and insulated thyristors is available. Non-insulated thyristors range from 0.3 A to 10 A and insulated thyristors range from 3 A to 25 A. These can be applied to tape packing, lead forming and other applications. In the insulated thyristors, there is no exposed metal on the resin surface. The standard products have an isolation voltage of 1500 V and a high-isolation voltage of 2500 V.

Special-Purpose Thyristor

Thyristor for high-speed, stroboscopic, TV and discharge lamp applications

Triacs



General-Purpose Triacs

A variety of non-insulated and insulated triacs is available.

Non-insulated thyristors range from 0.8 A to 16 A and insulated thyristors range from 2 A to 25 A. In the insulated thyristors, there is no exposed metal on the resin surface. The standard products have an isolation voltage of 1,500 V and a high-isolation voltage of 2,500 V.



Special-Purpose Triacs

We have triacs for high-rush-current loads, too, with greatly improved ability to withstand repetitive rush currents.



1 Overview

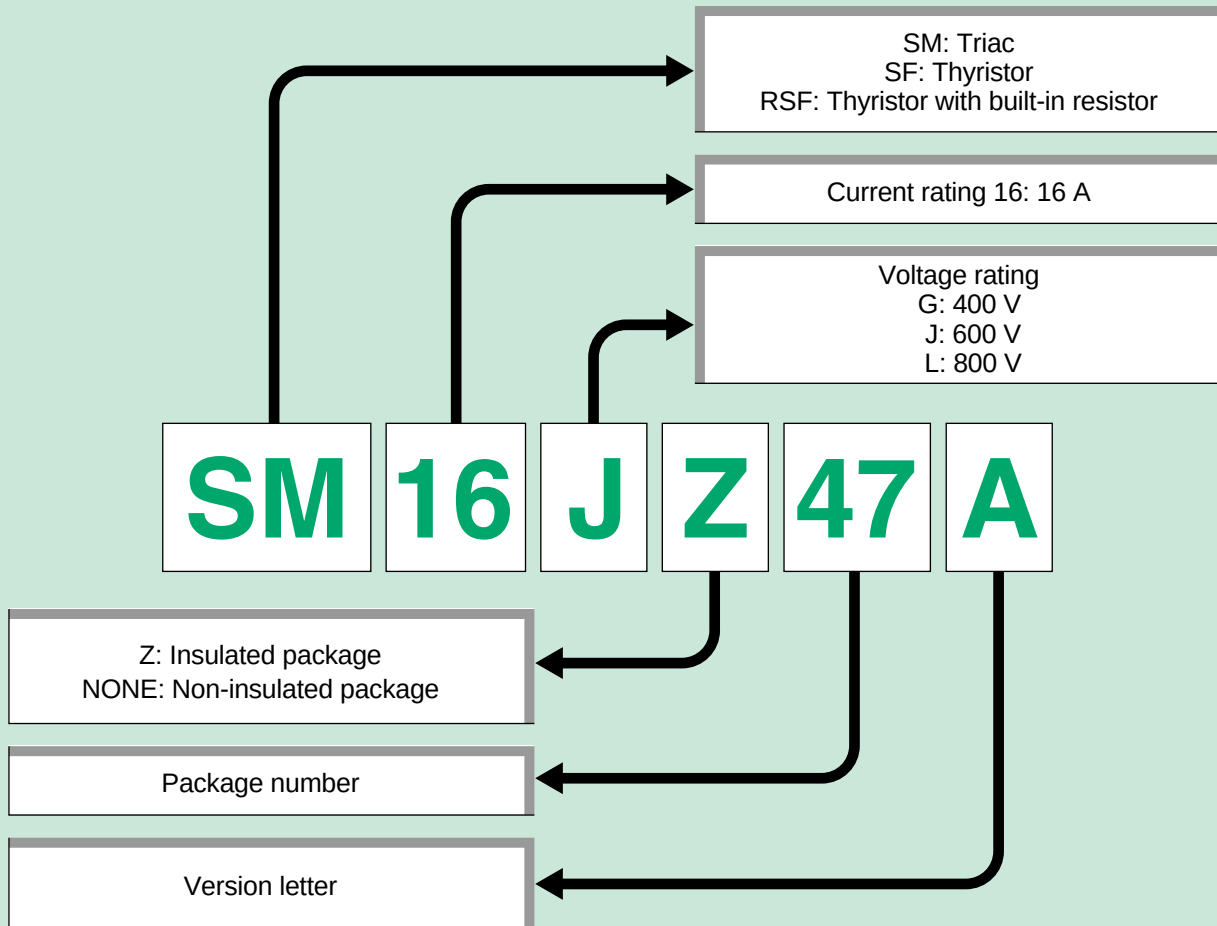
Symbols and Terms

Symbols	Usage	Definition
V_{RRM}	Repetitive peak reverse voltage	Maximum allowable instantaneous value of reverse voltage repeatedly applicable between anode and cathode
V_{DRM}	Repetitive peak OFF-state voltage	Maximum allowable instantaneous value of OFF-state voltage repeatedly applicable between anode and cathode (between T1 and T2 for triacs)
$I_{T(AV)}$	Average ON-state current	Average value of continuously conductible ON-state current (applied to thyristors and stipulated by a half sine wave of commercial frequency)
$I_{T(RMS)}$	RMS ON-state current	RMS value of continuously conductible ON-state current (applied to triacs and stipulated by whole sine waves of commercial frequency)
di/dt	Critical rate of rise of ON-state current	Maximum rate of rise of ON-state current allowable when a device is turned on
I_{TSM}	Peak one-cycle surge ON-state current	Peak one-cycle ON-state current allowable for non-repetitive conduction
I_{TRM}	Repetitive peak surge ON-state current	Peak ON-state current allowable for repetitive conduction
V_{FGM} (V_{GM})	Peak forward gate voltage (peak gate voltage)	Maximum allowable instantaneous value of forward gate voltage repeatedly applicable between gate and cathode (between gate and T1 for triacs)
V_{RGM}	Peak reverse gate voltage	Maximum allowable instantaneous value of reverse gate voltage repeatedly applicable between gate and cathode
I_{GM}	Peak forward gate current	Maximum allowable instantaneous value of forward gate current repeatedly applicable between gate and cathode (between gate and T1 for triacs)
P_{GM}	Peak gate power dissipation	Maximum allowable instantaneous value of gate power dissipation
$P_{G(AV)}$	Average gate power dissipation	Allowable average value of gate power dissipation
I_{RRM}	Repetitive peak reverse current	Leakage current flowing at the time of reverse voltage application between anode and cathode
I_{DRM}	Repetitive peak OFF-state current	Leakage current flowing at the time of OFF-state voltage application between anode and cathode (between T1 and T2 for triacs)
V_{TM}	Peak ON-state voltage	Peak ON-state voltage value between anode and cathode (between T1 and T2 for triacs) when the device is in ON-state.
V_{GT}	Gate trigger voltage	Minimum gate voltage necessary to turn on devices
I_{GT}	Gate trigger current	Minimum gate current necessary to turn on devices
t_{gt}	Turn-ON time	Duration from gate current conduction to ON state of devices
t_q	Turn-OFF time	Duration to device's recovery of its forward current blocking ability after ON-state current decreases and becomes zero
dv/dt	Critical rate of rise of OFF-state voltage	Maximum rate of rise of OFF-state voltage which can be applied without switching to ON-state
$(dv/dt)_c$	Critical rate of rise of OFF-state voltage at the time of commutation	Maximum rate of rise of OFF-state voltage not allowing a device to switch ON state even when reverse voltage is applied immediately after the ON-state current decreases and becomes zero
$R_{th(j-a)}$, $R_{th(j-c)}$	Thermal resistance	Temperature difference per watt between two points (between junction and surrounding space and between junction and case) when a device is thermally balanced
V_{ISOL}	Isolation voltage	Voltage applicable between lead and case when the device has an insulated package (usually AC, and indicated by its r.m.s.)

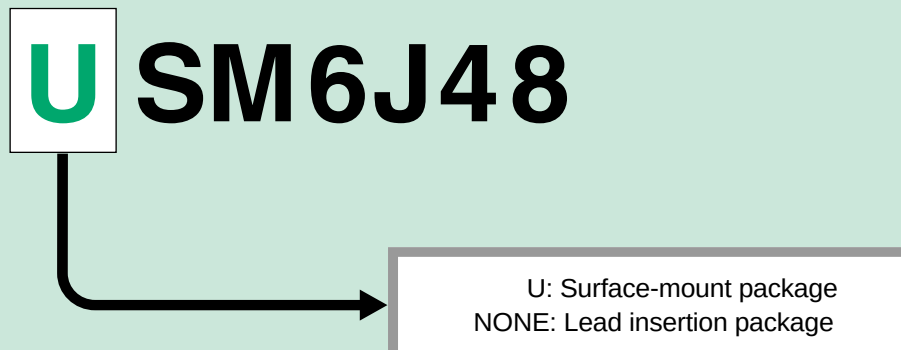
* Every item is specified under particular conditions which are stated in the technical data sheet for each product. For the conditions, please refer to each.

Identification

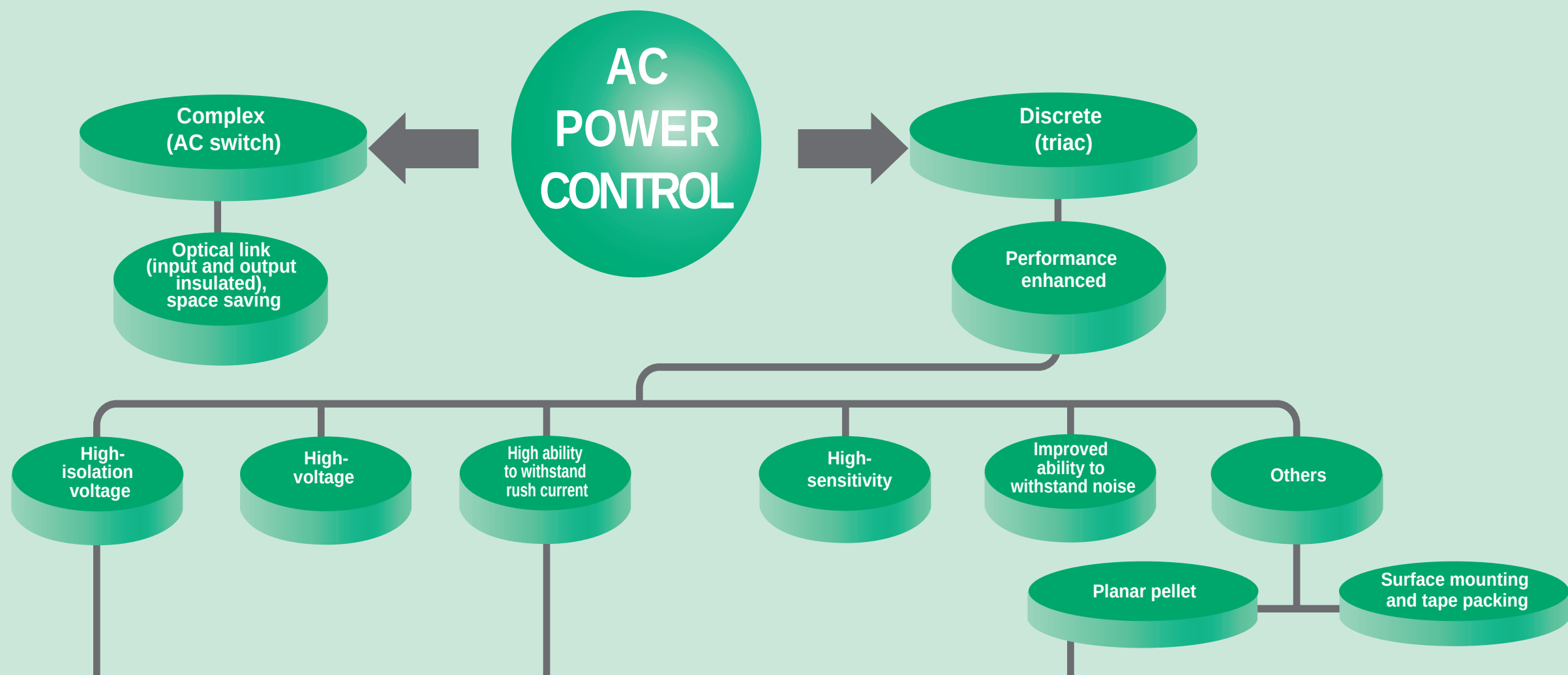
Example 1. SM16JZ47A (Insulated 16A Triac)



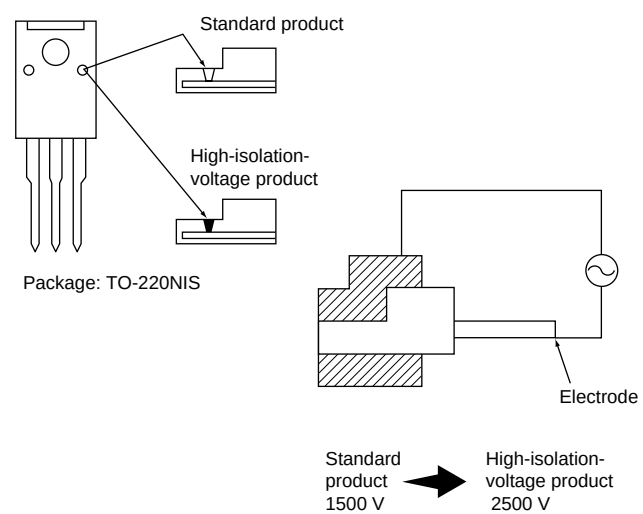
Example 2. USM6J48 (Surface-Mounting 6A Triac)



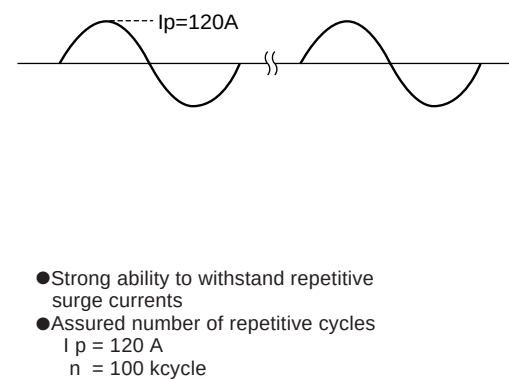
2 Development Trends



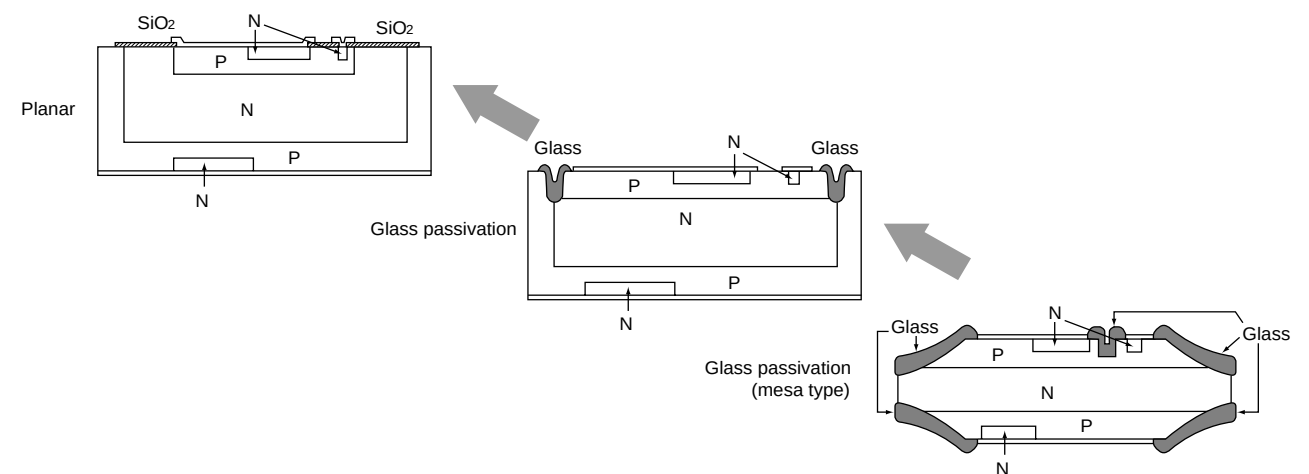
Improved isolation voltage performance (resin potting)



High-rush-current-withstanding triac



Pellet evolution (illustration)





3 New Product Information

High-Sensitivity Triac SM2GZ47A Series for 1 A Loads

High-Sensitivity with Insulated Package

Overview

Toshiba has developed a high-sensitivity triac capable of controlling 1 A RMS; without a heat sink. It is most suitable for controlling apparatus such as heaters rated less than 100W.

Features

- High-sensitivity: $I_{GT} = 5 \text{ mA max (SM2GZ47A)}$
- Capable of controlling 1 A RMS; without a heat sink.
 $I_{T(RMS)} = 1 \text{ A @ } T_a = 65^\circ\text{C; without a heat sink.}$
- Insulated package: model TO-220NIS

Package Appearance

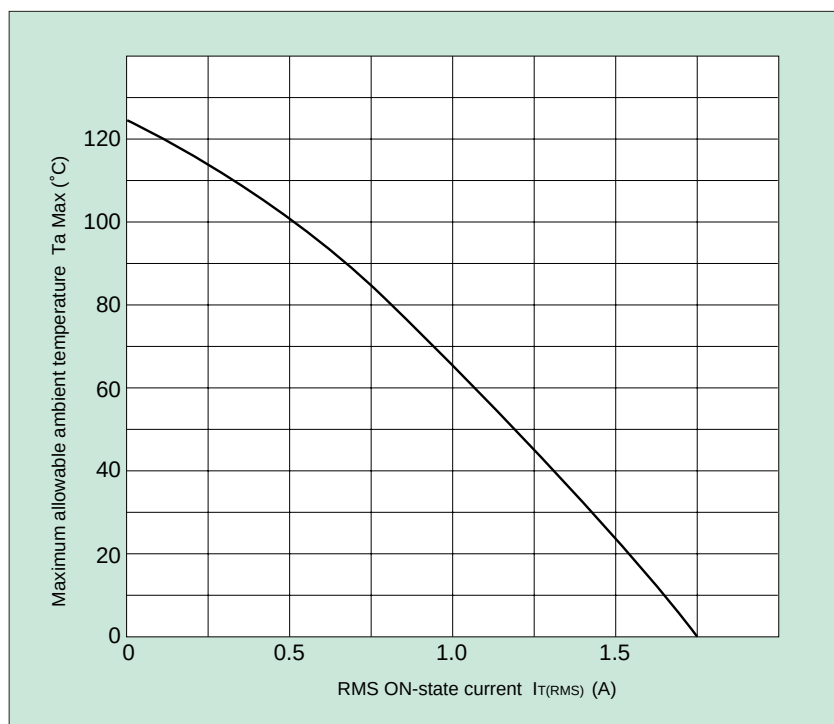


TO-220NIS

Main Ratings and Characteristics

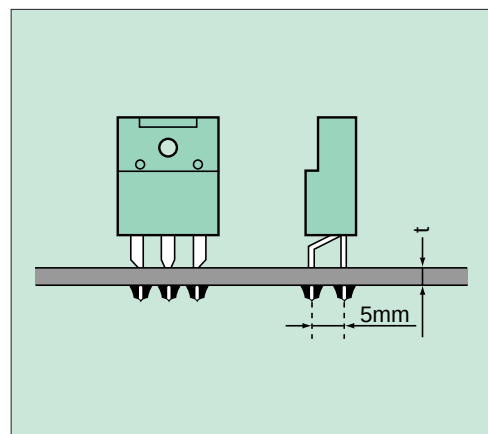
Item	Symbol	Rating and Characteristics	Condition
RMS ON-state current	$I_{T(RMS)}$	1 A	$T_a = 65^\circ\text{C; without a heat sink}$
Gate trigger current	I_{GT}	8 mA max	$V_D = 12 \text{ V, I, II, III quadrants}$
		5 mA max	
Repetitive peak OFF-state voltage	V_{DRM}	400 V/600 V	—
Peak one-cycle surge ON-state current	I_{TSM}	8 A	$f = 50 \text{ Hz}$

$T_a \text{ Max} - I_{T(RMS)}$ without a heat sink



Conditions

- ✱ No heat sink; device itself radiates heat
- ✱ Leadforming: LB107
- ✱ Paper Epoxy board used
- ✱ $t = 1.6 \text{ mm}$
- ✱ Soldering land: $2 \text{ mm}\varnothing$



High-Voltage (800 V) Triac 1A~10A Series

High-Voltage: $V_{\text{DRM}} = 800 \text{ V}$

Overview

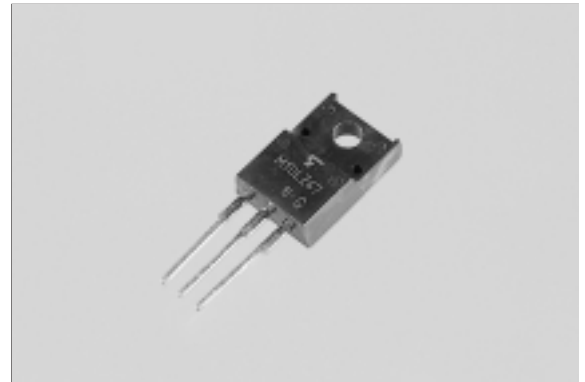
Toshiba has developed a high-voltage triac with 800V-OFF-state-voltage rating, which is most suitable for high-voltage applications, including reversible rotation motor in 200V-line-voltage.

Features

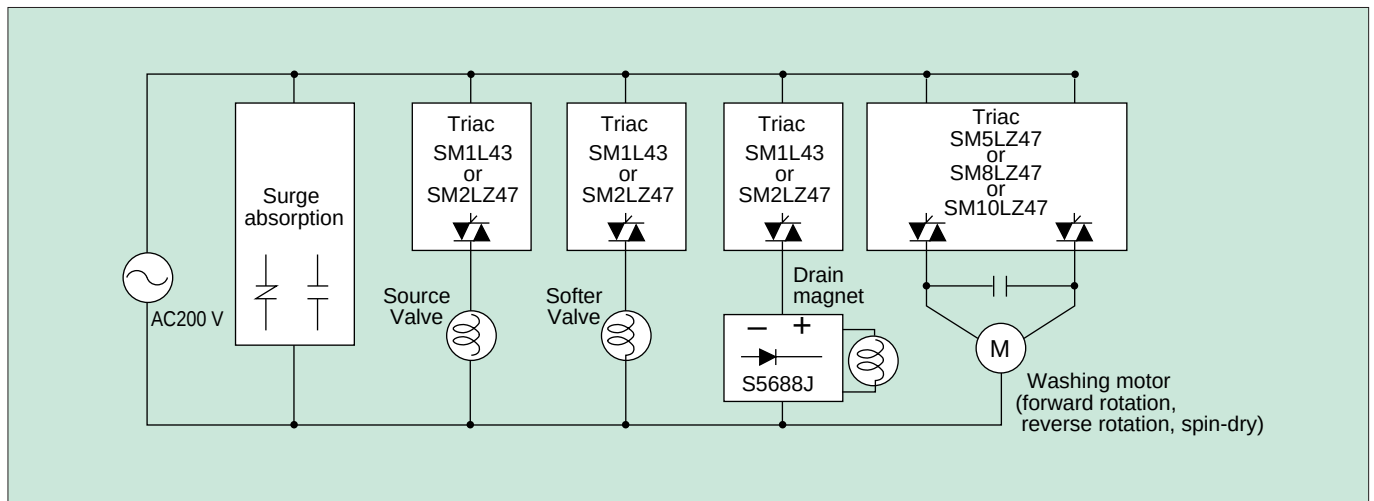
- High-voltage: $V_{\text{DRM}} = 800 \text{ V}$
- Insulated package: TO-220NIS type (2A, *5A, 8A, 10A)
 $V_{\text{ISOL}} = 1500 \text{ V (AC, } t = 60 \text{ s)}$
- Compact package: TO-92 type (1A)

*Under development

Package Appearance



Example Application (washing machine)



Main Ratings and Characteristics: SM10LZ47

Item	Symbol	Rating and Characteristics	Condition
Repetitive peak OFF-state voltage	V_{DRM}	800 V	
RMS ON-state current	$I_{\text{T(RMS)}}$	10 A	
Peak one-cycle surge ON-state current	I_{TSM}	100 A	$f = 50 \text{ Hz}$, non-repetitive
Gate trigger current	I_{GT}	30 mA (max)	$V_{\text{D}} = 12 \text{ V}$, $R_{\text{L}} = 20 \Omega$
Peak ON-state voltage	V_{TM}	1.5 V (max)	$I_{\text{TM}} = 15 \text{ A}$
Repetitive peak OFF-state current	I_{DRM}	20 μA (max)	$V_{\text{DRM}} = 800 \text{ V}$



3 New Product Information

High-Isolation-Voltage Version TO-220NIS (E) Series

TO-220NIS package with improved insulation performance

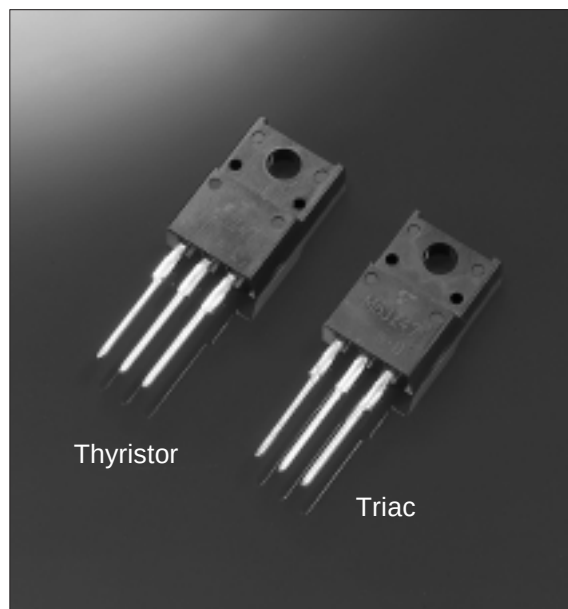
Overview

Toshiba has developed a high-isolation-voltage version of the TO-220NIS insulated package. This is known as the (E) Series package. The new package boasts insulation performance far superior to that of the standard package, yet is the same size.

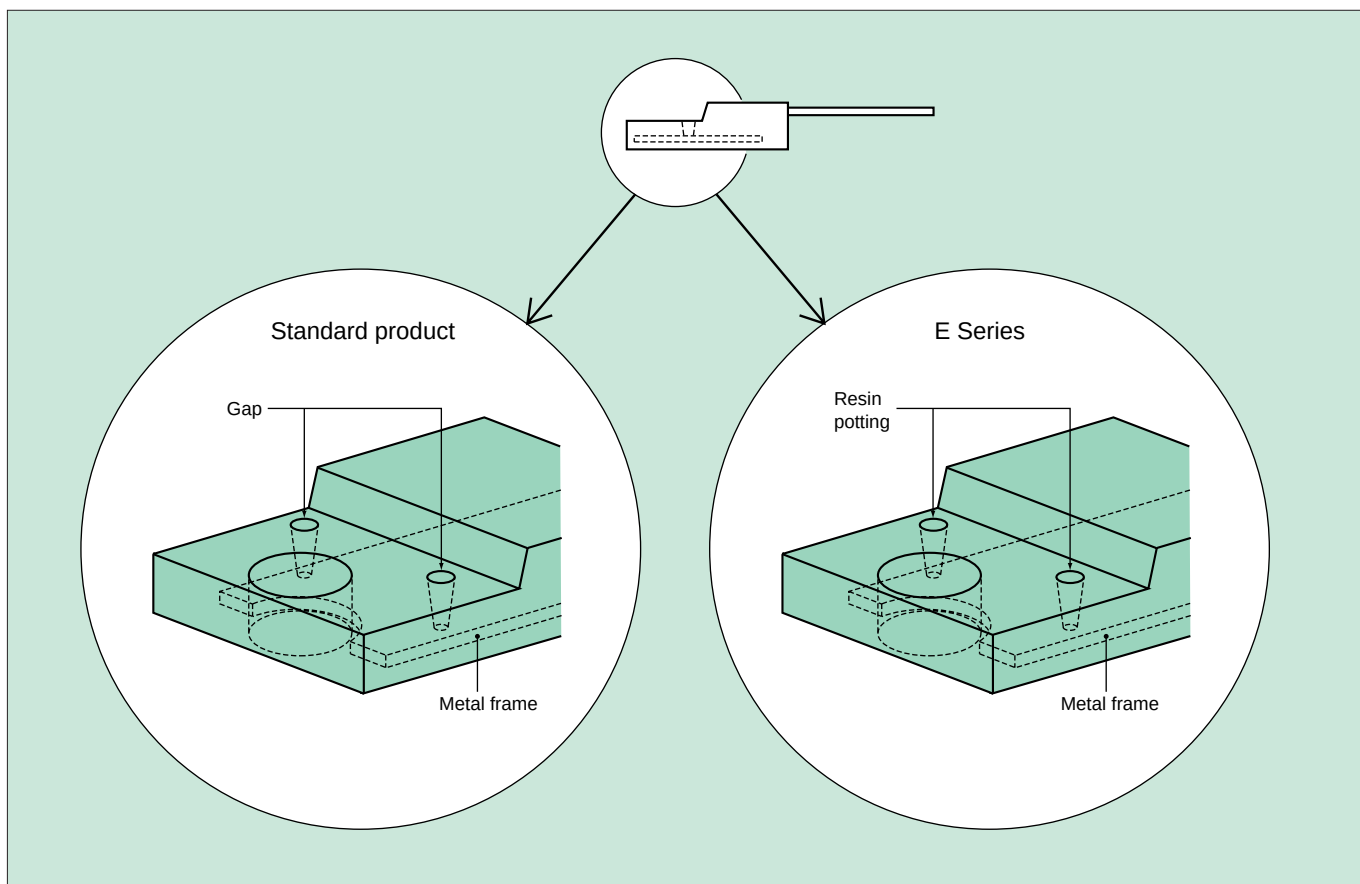
Features

- High-isolation-voltage is assured
Isolation voltage: $V_{ISOL} = 2500 \text{ V RMS (AC, } t = 60 \text{ s)}$
Lightning surge: $1.2 \times 50 \mu\text{s } V_p = 6 \text{ kV}$
- Corresponds to all TO-220NIS Model basically
For example, SM16JZ47 (E)

Package Appearance



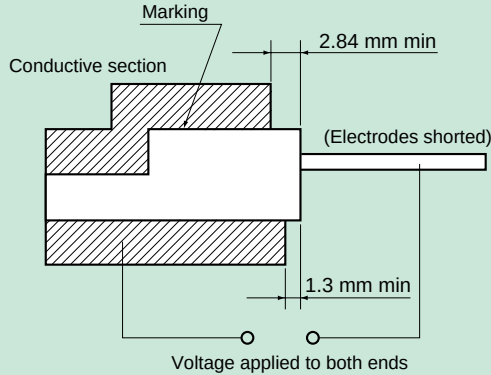
Structural Comparison



Insulation Performance Test

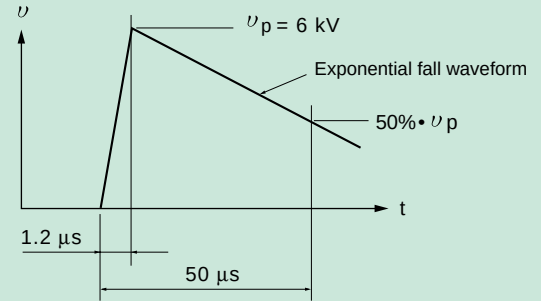
AC insulation test

- $T_a = 25^\circ\text{C}$
- $RH \leq 60\%$
- AC 2500 VRMS applied, $t = 60\text{ s}$



Lightning surge test

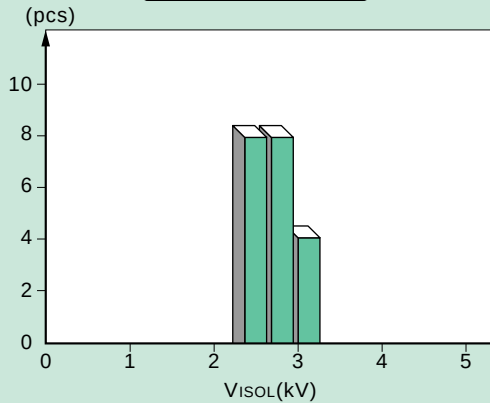
- $T_a = 25^\circ\text{C}$
- $RH \leq 60\%$
- One cycle applied as shown below



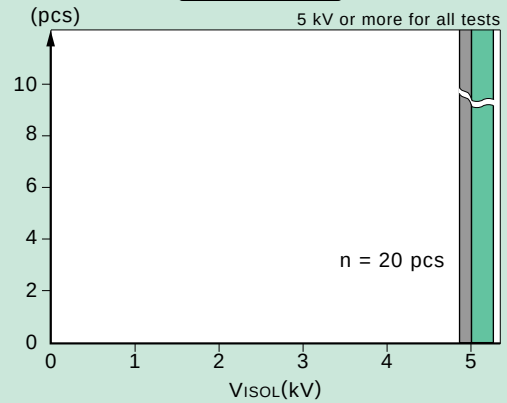
Test Data 1 (reference)

AC Insulation Test

Standard product

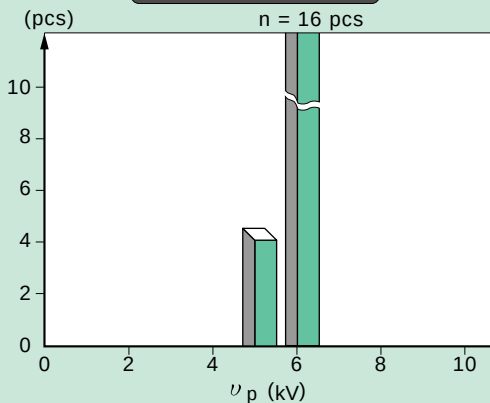


E Series

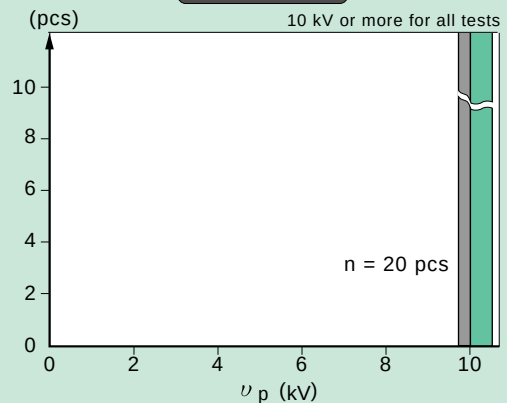


Lightning Surge Test

Standard product



E Series



(Note: Test results may differ depending upon the surrounding environment, measuring jigs, etc.
Standard products are tested during installation with M3 screws; there is no metal plate on the mark surface.)



3 New Product Information

High-Rush-Current-Withstanding Triac S6903G Series

Enhanced ability to withstand repetitive rush currents

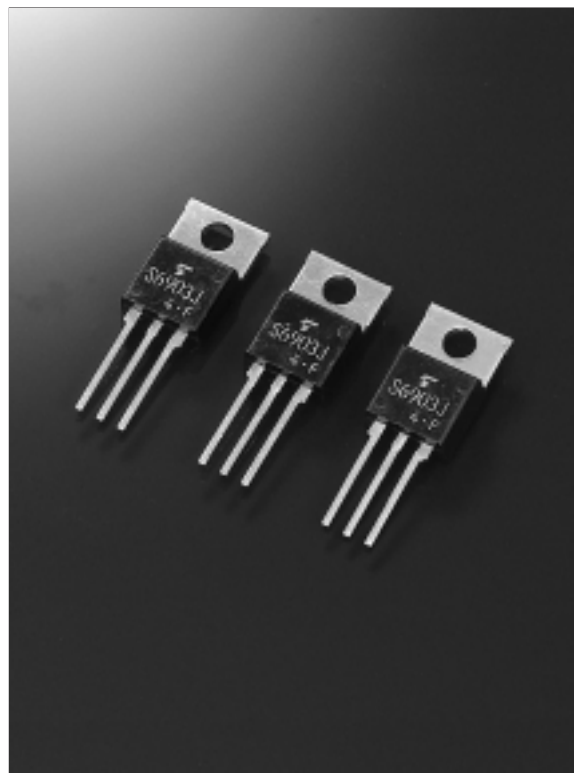
Overview

Toshiba has developed a high-rush-current-withstanding triac with greatly enhanced repetitive rush-current-withstanding ability. It is now possible to provide assurances (previously difficult) as to the level of repetitive surge current and the number of repetitive cycles. This triac is most suitable for controlling actuators that generates high-rush current.

Features

- Strong ability to withstand repetitive surge current
- Assurance of the number of repetitive cycles is available

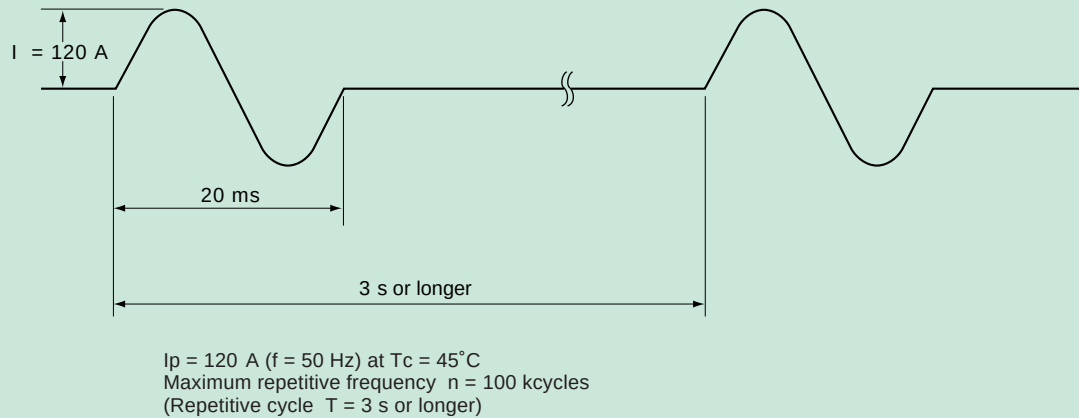
Package Appearance



Main Ratings and Characteristics

Item	Symbol	Rating and Characteristics	Condition
Repetitive surge ON-state current (Figure 1)	I_{TRM}	120 A	$n = 100$ kcycle, $T_c = 45^\circ\text{C}$
Non-repetitive surge On-state current	I_{TSM}	200 A	$f = 60$ Hz, $T_c = 125^\circ\text{C}$
RMS ON-state current	$I_{T(RMS)}$	20 A	Whole sine waves $T_c = 100^\circ\text{C}$
Gate trigger current	I_{GT}	30 mA max	$V_D = 12$ V, $R_L = 20\ \Omega$
Thermal resistance (between junction and case)	$R_{th(j-c)}$	1°C/W max	Alternating current

Figure 1. Repetitive Surge ON-State Current



Handling Precautions

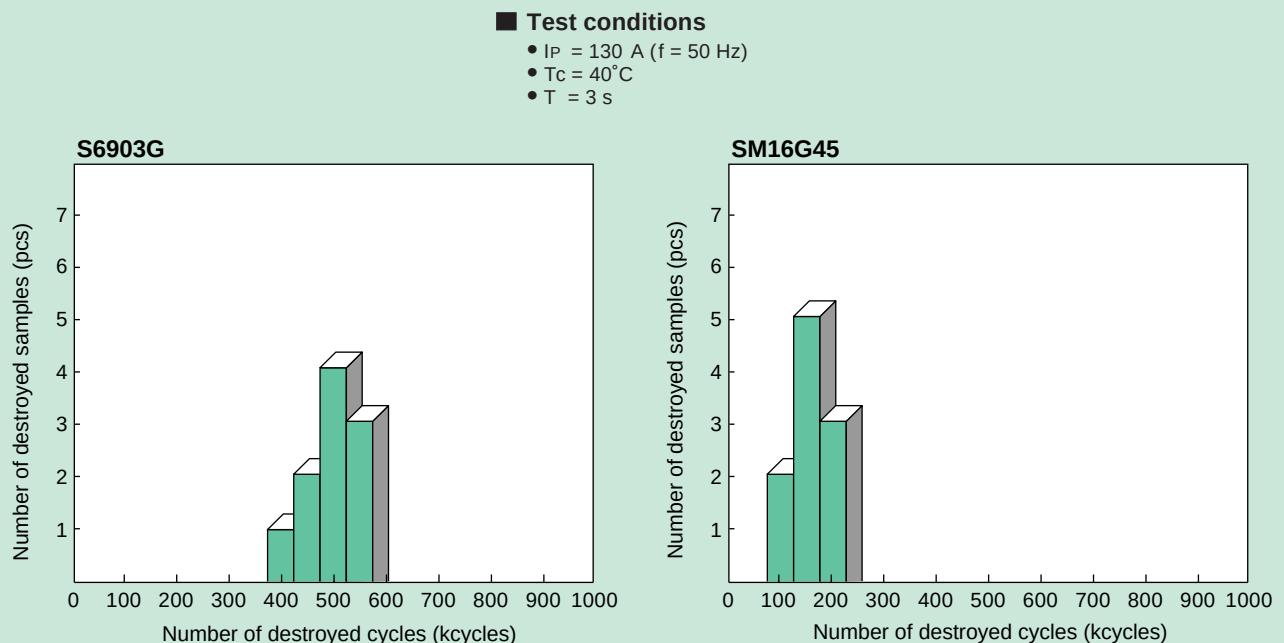
When used under conditions other than those recommended, devices may be damaged.

They may even ignite. Please use devices within their recommended conditions.

If they must be used under other conditions, add protective circuits (such as phase controls to lessen starting stresses) and provide a warranty when shipping.

Please note that if the devices are used under conditions that are not recommended, loss of human life, bodily injury or damage to property to third parties must be settled between you and the third party.

Repetitive Surge Current Test Data (reference)





4 Selection Chart

General-Purpose Thyristors

→ Repetitive peak OFF-state voltage and repetitive peak reverse voltage

I_T (AV) (A)	V_{DRM} and V_{DRM} (V)		I_{GT} (mA)	Package Dimensions	Page
	400	600			
0.3	SF0R3G42	—	0.2	①	18
0.5	SF0R5G43	SF0R5J43	0.2	①	18
	(Note 1) RSF05G1-1P/3P/5P	—	1/0.4/0.25	①	18
	USF05G49	—	0.2	②	19
	(Note 1) URSF05G49-1P/3P/5P	—	1/0.4/0.25	②	19
3	SF3G48	SF3J48	10	⑤	18
	USF3G48	USF3J48	10	⑥	19
5	SF5G42	SF5J42	0.2	③	18
	SF5G41A	SF5J41A	15	③	18
	SF5G48	SF5J48	10	⑤	18
	SF5G49	SF5J49	0.07	⑧	18
	USF5G48	USF5J48	10	⑥	19
	USF5G49	USF5J49	0.07	⑨	19
8	SF8G41A	SF8G41A	15	③	18
	SF8G48	SF8J48	10	⑤	18
	USF8G48	USF8J48	10	⑥	19
10	SF10G41A	SF10J41A	15	③	18
	SF10G48	SF10J48	10	⑤	18
	USF10G48	USF10J48	10	⑥	19

(Note 1) Resistance (R_{GK}) built-in Thyristor
 -1P : $R_{GK} = 1 \text{ k}\Omega$
 -3P : $R_{GK} = 2.7 \text{ k}\Omega$
 -5P : $R_{GK} = 5.1 \text{ k}\Omega$

Insulated Thyristors

→ Repetitive peak OFF-state voltage and repetitive peak reverse voltage

I_T (AV) (A)	V_{DRM} and V_{DRM} (V)		I_{GT} (mA)	Package Dimensions	Page
	400	600			
3	SF3GZ47	SF3JZ47	10	④	19
5	SF5GZ47	SF5JZ47	10	④	19
8	SF8GZ47	SF8JZ47	10	④	19
10	SF10GZ47	SF10JZ47	10	④	19
16	SF16GZ51	SF16JZ51	15	⑦	19
25	SF25GZ51	SF25JZ51	20	⑦	19

Special-Purpose Thyristors

Usage		I _{T(AV)} (A)	V _{DRM} and V _{DRM} (V)			Main Features	Packeage Dimensions	Page
			200	400	800			
High speed		0.3	SH0R3D42	—	—	t _q ≤ 6 μs	①	24
Strobe	Trigger	0.3	—	S6370	—	t _{gt} ≤ 1.5 μs	①	24
	Chopper	8	—	SH8G41	—	I _{TRM} = 350 A	③	24
	Bypass	8	—	S6744	—	I _{TRM} = 1300 A	⑤	24
		—	—	S6A35	—	I _{TRM} = 900 A	⑨	24
TV		3	—	S6785G	—	t _q ≤ 3.5 μs	④	24
Discharge Lamp		—	—	—	S6992	I _P = 500 A, di/dt = 750 A/μs	⑤	24
		—	—	—	S6A13	I _P = 500 A, di/dt = 750 A/μs Diode included between cathode and anode		24

Triacs

—▶ Repetitive peak OFF-state voltage

	I_T (RMS) (A)	V_{DRM} and V_{DRM} (V)			I_{GT} (mA)	Package Dimensions	Page
		400	600	800			
↓ RMS ON-state current	0.8	SM08G43	—	—	3	①	20
	1	SM1G43	SM1J43	SM1L43	*5 (400 V, 600 V) 10 (800 V)	①	20
	3	SM3G45	SM3J45	—	20	③	20
		SM3G48	SM3J48	—	20	⑤	21
		USM3G48	USM3J48	—	20	⑥	23
	6	SM6G45/A	SM6J45/A	—	30/20	③	20
		SM6G48/A	SM6J48/A	—	30/20	⑤	21
		USM6G45/A	USM6J45/A	—	30/20	⑥	23
	8	SM8G45/A	SM8J45/A	—	30/20	③	20
		SM8G48/A	SM8J48/A	—	30/20	⑤	21
		USM8G45/A	USM8J45/A	—	30/20	⑥	23
	12	SM12G45/A	SM12J45/A	—	30/20	③	20
		SM12G48/A	SM12J48/A	—	30/20	⑤	21
		USM12G45/A	USM12J45/A	—	30/20	⑥	23
	16	SM16G45/A	SM16J45/A	—	30/20	③	20
		SM16G48/A	SM16J48/A	—	30/20	⑤	21
		USM16G45/A	USM16J45/A	—	30/20	⑥	23

* I_{GT} = 3 mA, 7 mA models are also available.

Insulation Triac

—▶ Repetitive peak OFF-state voltage

	I_T (RMS) (A)	V_{DRM} and V_{DRM} (V)			I_{GT} (mA)	Package Dimensions	Page
		400	600	800			
↓ RMS ON-state current	2	SM2GZ47/A	SM2JZ47/A	SM2LZ47	8/5 (400 V, 600 V) 10 (800 V)	④	22
	3	SM3GZ47	SM3JZ47	—	20	④	22
	5	—	—	SM5LZ47 *	30	④	22
	6	SM6GZ47/A	SM6JZ47/A	—	30/20	④	22
	8	SM8GZ47/A	SM8JZ47/A	SM8LZ47	30/20 (400 V, 600 V) 30 (800 V)	④	22
	10	—	—	SM10LZ47	30	④	22
	12	SM12GZ47/A	SM12JZ47/A	—	30/20	④	22
	16	SM16GZ47/A	SM16JZ47/A	—	30/20	④	22
		SM16GZ51	SM16JZ51	—	30	⑦	22
	25	SM25GZ51	SM25JZ51	—	30	⑦	22

* Under development

Special-Purpose Triacs

Usage	I_T (RMS) (A)	V_{DRM} and V_{DRM} (V)		Main Features	Package Dimensions	Page
		200	400			
High speed	20	S6903G	S6903J	I_{TRM} = 120 A	③	31



5 Product Lines

5.1 General-Purpose Thyristors (Non-insulated)

I _{T(AV)} (A)	Maximum Ratings					Electrical Characteristics (Ta=25°C)								Package Dimensions	Package Number	Package Appearance
	V _{DRM} , V _{RRM} (V)		I _{TSM} (A)		T _j (°C)	I _{DRM} , I _{RRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM} (V)	I _{TM} (A)	dv/dt (V/ms)	TC (°C)				
	400	600	50 Hz	60 Hz												
0.3	SF0R3G42	—	9	9.9	-40 to 125	Note 1 0.1	0.2	0.8	2.0	2	—	—	①	13-5A1A	 TO-92	
0.5	SF0R5G43	SF0R5J43	7	8	-40 to 125	Note 1 0.05	0.2	0.8	1.5	1	—	—	①	13-5A1D		
	Note 2 RSF05G1-1P	—	9	10	-40 to 125	0.01	1	0.8	1.5	1	200 (typ.)	25	①	13-5A1A		
	Note 3 RSF05G1-3P	—	9	10	-40 to 125	0.01	0.4	0.8	1.5	1	70 (typ.)	25	①	13-5A1A		
	Note 4 RSF05G1-5P	—	9	10	-40 to 125	0.01	0.25	0.8	1.5	1	40 (typ.)	25	①	13-5A1A		
5	SF5G42	SF5J42	80	88	-40 to 125	Note 1 2	0.2	0.8	1.6	15	50 (typ.)	75	③	13-10G1B	 TO-220AB	
	SF5G41A	SF5J41A	80	88	-40 to 125	0.01	15	1.0	1.6	15	100	125	③	13-10G1B		
8	SF8G41A	SF8J41A	120	132	-40 to 125	0.01	15	1.0	1.6	25	100	125	③	13-10G1B		
10	SF10G41A	SF10J41A	160	176	-40 to 125	0.01	15	1.0	1.6	30	100	125	③	13-10G1B		
3	SF3G48	SF3J48	50	55	-40 to 125	0.01	10	1.0	1.5	12	50 (typ.)	125	⑤	13-10J1B	 TO-220FL	
5	SF5G48	SF5J48	80	88	-40 to 125	0.01	10	1.0	1.5	15	50 (typ.)	125	⑤	13-10J1B		
8	SF8G48	SF8J48	120	132	-40 to 125	0.01	10	1.0	1.5	25	50 (typ.)	125	⑤	13-10J1B		
10	SF10G48	SF10J48	160	176	-40 to 125	0.01	10	1.0	1.5	30	50 (typ.)	125	⑤	13-10J1B		
5	SF5G49	SF5J49	65	—	-40 to 125	0.02	0.07	0.8	1.6	12	50 (typ.)	75	⑧	13-7F1A		 DP

Note 1: T_J = 125°C

Note 2: R_{GK} = 1 kΩ

Note 3: R_{GK} = 2.7 kΩ

Note 4: R_{GK} = 5.1 kΩ

5.1 General-Purpose Thyristors (Insulated and surface-mount)

I _{T(AV)} (A)	Maximum Ratings						Electrical Characteristics (Ta=25°C)							Package Dimensions	Package Number	UL Listing Number	Package Appearance
	V _{DRM} , V _{RRM} (V)		I _{TSM} (A)		V _{ISOL} (V)	T _J (°C)	I _{DRM} , I _{RRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM} (V)	I _{TM} (A)	dv/dt (V/ms)	TC (°C)				
	400	600	50 Hz	60 Hz													
3	SF3GZ47	SF3JZ47	50	55	1500	-40 to 125	0.01	10	1.0	1.5	12	50 (typ.)	125	④	13-10H1B	E87989	 TO-220NIS
5	SF5GZ47	SF5JZ47	80	88	1500	-40 to 125	0.01	10	1.0	1.5	15	50 (typ.)	125	④	13-10H1B	E87989	
8	SF8GZ47	SF8JZ47	120	132	1500	-40 to 125	0.01	10	1.0	1.5	25	50 (typ.)	125	④	13-10H1B	E87989	
10	SF10GZ47	SF10JZ47	160	176	1500	-40 to 125	0.01	10	1.0	1.5	30	50 (typ.)	125	④	13-10H1B	E87989	
16	SF16GZ51	SF16JZ51	250	275	1500	-40 to 125	0.02	15	1.5	1.5	50	50 (typ.)	125	⑦	13-16A1B	Under application	 TO-3P (N)IS
25	SF25GZ51	SF25JZ51	350	385	1500	-40 to 125	0.02	20	1.5	1.5	80	50 (typ.)	125	⑦	13-16A1B	Under application	
0.5	USF05G49	—	9	10	—	-40 to 125	0.01	0.2	0.8	1.5	1	200 (typ.)	25	②	13-5B1A	—	 PW-MINI
	Note 1 URSF05G49-1P	—	9	10	—	-40 to 125	0.01	1	0.8	1.5	1	200 (typ.)	25	②	13-5B1A	—	
	Note 2 URSF05G49-3P	—	9	10	—	-40 to 125	0.01	0.4	0.8	1.5	1	70 (typ.)	25	②	13-5B1A	—	
	Note 3 URSF05G49-5P	—	9	10	—	-40 to 125	0.01	0.25	0.8	1.5	1	40 (typ.)	25	②	13-5B1A	—	
3	USF3G48	USF3J48	50	55	—	-40 to 125	0.01	10	1.0	1.5	12	50 (typ.)	125	⑥	13-10J2B	—	 TO-220SM
5	USF5G48	USF5J48	80	88	—	-40 to 125	0.01	10	1.0	1.5	15	50 (typ.)	125	⑥	13-10J2B	—	
8	USF8G48	USF8J48	120	132	—	-40 to 125	0.01	10	1.0	1.5	25	50 (typ.)	125	⑥	13-10J2B	—	
10	USF10G48	USF10J48	160	176	—	-40 to 125	0.01	10	1.0	1.5	30	50 (typ.)	125	⑥	13-10J2B	—	
5	USF5G49	USF5J49	65	—	—	-40 to 125	0.02	0.07	0.8	1.6	12	50 (typ.)	75	⑨	13-7F2A	—	 DP

Note 1: R_{GK} = 1 kΩ

Note 2: R_{GK} = 2.7 kΩ

Note 3: R_{GK} = 5.1 kΩ



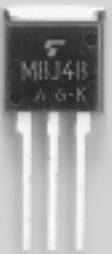
5 Product Lines

5.2 General-Purpose Triacs (Non-insulated)

I _{T(RMS)} (A)	Maximum Ratings						Electrical Characteristics (Ta=25°C)						Package Dimensions	Package Number	Package Appearance
	V _{DRM} (V)			I _{TSM} (A)		T _J (°C)	I _{DRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM}		(dv/dt) _C (V/ms)			
	400	600	800	50 Hz	60 Hz					(V)	I _{TM} (A)				
0.8	SM08G43	–	–	6	6.6	–40 to 125	0.01	Note 2 3	Note 2 1.5	1.5	1.2	–	①	13-5A1E	 TO-92
1	SM1G43	SM1J43	SM1L43	8	8.8	–40 to 125	0.01	5 (400 V, 600 V) 10 (800 V)	2	1.5	1.5	–	①	13-5A1E	
3	SM3G45	SM3J45	–	30	33	–40 to 125	0.02	20	1.5	1.5	4.5	10	③	13-10G1A	 TO-220AB
6	SM6G45	SM6J45	–	60	66	–40 to 125	Note 1 2	30	2	1.5	9	10	③	13-10G1A	
	SM6G45A	SM6J45A	–	60	66	–40 to 125	Note 1 2	20	1.5	1.5	9	4	③	13-10G1A	
8	SM8G45	SM8J45	–	80	88	–40 to 125	Note 1 2	30	2	1.5	12	10	③	13-10G1A	
	SM8G45A	SM8J45A	–	80	88	–40 to 125	Note 1 2	20	1.5	1.5	12	4	③	13-10G1A	
12	SM12G45	SM12J45	–	120	132	–40 to 125	Note 1 2	30	2	1.5	17	10	③	13-10G1A	
	SM12G45A	SM12J45A	–	120	132	–40 to 125	Note 1 2	20	1.5	1.5	17	4	③	13-10G1A	
16	SM16G45	SM16J45	–	150	165	–40 to 125	0.02	30	1.5	1.5	25	10	③	13-10G1A	
	SM16G45A	SM16J45A	–	150	165	–40 to 125	0.02	20	1.5	1.5	25	4	③	13-10G1A	

Note 1: T_J = 125°C Note 2: II, III mode only

5.2 General-Purpose Triacs (Non-insulated)

I _{T(RMS)} (A)	Maximum Ratings					Electrical Characteristics (T _a =25°C)						Package Dimensions	Package Number	Package Appearance
	V _{DRM} (V)		I _{TSM} (A)		T _J (°C)	I _{DRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM} (V)		(dv/dt) _C (V/ms)			
	400	600	50 Hz	60 Hz					I _{TM} (A)					
3	SM3G48	SM3J48	30	33	-40 to 125	0.02	20	1.5	1.5	4.5	10	⑤	13-10J1A	 TO-220FL
6	SM6G48	SM6J48	60	66	-40 to 125	0.02	30	1.5	1.5	9	10	⑤	13-10J1A	
	SM6G48A	SM6J48A	60	66	-40 to 125	0.02	20	1.5	1.5	9	4	⑤	13-10J1A	
8	SM8G48	SM8J48	80	88	-40 to 125	0.02	30	1.5	1.5	12	10	⑤	13-10J1A	
	SM8G48A	SM8J48A	80	80	-40 to 125	0.02	20	1.5	1.5	12	4	⑤	13-10J1A	
12	SM12G48	SM12J48	120	132	-40 to 125	0.02	30	1.5	1.5	17	10	⑤	13-10J1A	
	SM12G48A	SM12J48A	120	132	-40 to 125	0.02	20	1.5	1.5	17	4	⑤	13-10J1A	
16	SM16G48	SM16J48	150	165	-40 to 125	0.02	30	1.5	1.5	25	10	⑤	13-10J1A	
	SM16G48A	SM16J48A	150	165	-40 to 125	0.02	20	1.5	1.5	25	4	⑤	13-10J1A	



5 Product Lines

5.2 General-Purpose Triacs (Insulated)

I _{T(RMS)} (A)	Maximum Ratings						Electrical Characteristics (Ta = 25°C)						Package Dimensions	Package Number	UL Listing Number	Package Appearance
	V _{DRM} (V)			I _{TSM} (A)		T _j (°C)	I _{DRM} (mA)	I _{GT} (mA) I, II, III	V _{GT} (V) I, II, III	V _{TM} (V)	(dv/dt) _C (V/ms)					
	400	600	800	50 Hz	60 Hz											
2	SM2GZ47	SM2JZ47	-	8	8.8	-40 to 125	0.02	8	1.5	1.7	3	-	④	13-10H1A	-	 TO-220N1S
	SM2GZ47A	SM2JZ47A	-	8	8.8	-40 to 125	0.02	5	1.5	1.7	3	-	④	13-10H1A	-	
	-	-	SM2LZ47	8	8.8	-40 to 125	0.02	10	1.5	2.0	3	5	④	13-10H1A	-	
3	SM3GZ47	SM3JZ47	-	30	33	-40 to 125	0.02	20	1.5	1.5	4.5	10	④	13-10H1A	E87989	
5	-	-	SM5LZ47*	50	-	-40 to 125	0.02	30	1.5	1.5	8	10	④	13-10H1A	-	
6	SM6GZ47	SM6JZ47	-	60	66	-40 to 125	0.02	30	1.5	1.5	9	10	④	13-10H1A	E87989	
	SM6GZ47A	SM6JZ47A	-	60	66	-40 to 125	0.02	20	1.5	1.5	9	4	④	13-10H1A	E87989	
8	SM8GZ47	SM8JZ47	-	80	88	-40 to 125	0.02	30	1.5	1.5	12	10	④	13-10H1A	E87989	
	SM8GZ47A	SM8JZ47A	-	80	88	-40 to 125	0.02	20	1.5	1.5	12	4	④	13-10H1A	E87989	
	-	-	SM8LZ47	70	80	-40 to 125	0.02	30	1.5	1.5	12	10	④	13-10H1A	-	
10	-	-	SM10LZ47	100	110	-40 to 125	0.02	30	1.5	1.5	15	10	④	13-10H1A	-	
12	SM12GZ47	SM12JZ47	-	120	132	-40 to 125	0.02	30	1.5	1.5	17	10	④	13-10H1A	E87989	
	SM12GZ47A	SM12JZ47A	-	120	132	-40 to 125	0.02	20	1.5	1.5	17	4	④	13-10H1A	E87989	
16	SM16GZ47	SM16JZ47	-	150	165	-40 to 125	0.02	30	1.5	1.5	25	10	④	13-10H1A	E87989	
	SM16GZ47A	SM16JZ47A	-	150	165	-40 to 125	0.02	20	1.5	1.5	25	4	④	13-10H1A	E87989	
	SM16GZ51	SM16JZ51	-	150	165	-40 to 125	0.02	30	1.5	1.5	25	10	⑦	13-16A1A	E87989	
25	SM25GZ51	SM25JZ51	-	230	253		0.02	30	1.5	1.5	40	10	⑦	13-16A1A	E87989	 TO-3P(N)IS

* Under development

5.2 General-Purpose Triacs (Surface-mount)

I _{T(RMS)} (A)	Maximum Ratings					Electrical Characteristics (Ta = 25°C)						Package Dimensions	Package Number	Package Appearance
	V _{DRM} (V)		I _{TSM} (A)		T _j (°C)	I _{DRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM} (V)	(dv/dt) _c (V/ms)				
	400	600	50 Hz	60 Hz							I _{TM} (A)			
3	USM3G48	USM3J48	30	33	-40 to 125	0.02	20	1.5	1.5	4.5	10	⑥	13-10J2A	 TO-220SM
6	USM6G48	USM6J48	60	66	-40 to 125	0.02	30	1.5	1.5	9	10	⑥	13-10J2A	
	USM6G48A	USM6J48A	60	66	-40 to 125	0.02	20	1.5	1.5	9	4	⑥	13-10J2A	
8	USM8G48	USM8J48	80	88	-40 to 125	0.02	30	1.5	1.5	12	10	⑥	13-10J2A	
	USM8G48A	USM3J48A	80	88	-40 to 125	0.02	20	1.5	1.5	12	4	⑥	13-10J2A	
12	USM12G48	USM12J48	120	132	-40 to 125	0.02	30	1.5	1.5	17	10	⑥	13-10J2A	
	USM12G48A	USM12J48A	120	132	-40 to 125	0.02	20	1.5	1.5	17	4	⑥	13-10J2A	
16	USM16G48	USM16J48	150	165	-40 to 125	0.02	30	1.5	1.5	25	10	⑥	13-10J2A	
	USM16G48A	USM16J48A	150	165	-40 to 125	0.02	20	1.5	1.5	25	4	⑥	13-10J2A	

5.3 Special-Purpose Thyristors

• High-Speed

I _{T(AV)} (A)	Maximum Ratings						Electrical Characteristics (Ta = 25°C)								Package Dimensions	Package Number	Package Appearance
	V _{DRM} , V _{RRM} (V)		V _{DSM} (V)	I _{TSM} (A)		T _j (°C)	I _{DRM} (mA)	I _{GT} (mA)	V _{GT} (V)	t _q (ms)	V _{TM} (V)	I _{TM} (A)	dv/dt (V/ms)	T _c (°C)			
	200	400		50 Hz	60 Hz												
0.3	SH0R3D42	—	250	7	7.7	-40 to 125	Note 1 0.1	1	0.9	6	1.8	2	15	110	①	13-5A1A	 TO-92

Note 1 : T_J = 125°C

• TV

I _{T(AV)} (A)	Maximum Ratings				Electrical Characteristics (Ta = 25°C)										Package Dimensions	Package Number	Package Appearance
	V _{DRM} , V _{RRM} (V)		I _{TSM} (A)		T _j (°C)	I _{DRM} , I _{RRM} (mA) (T _j =125°C)	I _{GT} (mA)	V _{GT} (V)	t _{qT} (ms)	t _q (ms)	V _{TM} (V)	I _{TM} (A)	dv/dt (V/ms)	T _C (°C)			
	400	50 Hz	60 Hz														
3	S6785G	60	66	-40 to 125	Note 1 1 2	25	1.5	3	3.5	2	20	100	125 V _G =-2.5V	④	13-10H1B	 TO-220NIS	

• High-di/dt

Note 1: upper value = I_{DRM}, lower value = I_{RRM}

	Maximum Ratings				Electrical Characteristics (Ta = 25°C)								Package Dimensions	Package Number	Package Appearance
	V _{DRM} (V)	I _{TRM} (A)	di/dt (A/ms)	T _j (°C)	I _{DRM} (mA)	I _{GT} (mA)	V _{GT} (V)	V _{TM} (V)	dv/dt (V/ms)		T _C (°C)				
	800								I _{TM} (A)	—					
	S6992	500	750	-40 to 125	0.01	20	1.0	1.5	25	—	—	⑤	13-10J1B	 TO-220FL	
	Note 1 S6A13	500	750	-40 to 125	0.01	30	1.0	1.5	25	50	125	⑤	13-10J1B		

• Strobe

Note 1: Diode included between cathode and anode

Application	Maximum Ratings						Electrical Characteristics (Ta = 25°C)						Package Dimensions	Package Number	Package Appearance
	V _{DRM} , V _{RRM} (V)	I _{TSM} (A)		I _{TRM} (A)	di/dt (A/ms)	T _J (°C)	I _{GT} (mA)	V _{GT} (V)	I _H (mA)	V _{TM} (V)	I _{TM} (A)	C _c (mF)			
	400	50 Hz	60 Hz												
Note 1 Trigger	S6730	9	9.9	—	—	-40 to 125	0.2	0.8	4 (typ.)	2	2	—	①	13-5A1A	 TO-92
Chopper	SH8G41	—	—	350 (C _M ≤ 1000 μF)	100	-40 to 125	50	1.5	150	2.3	25	2.7 (I _{TM} = 230 A)	③	13-10G1B	 TO-220AB
Bypass	S6744	200	220	1300	100	-40 to 125	20	1.0	40	1.5	25	—	⑤	13-10J1B	 TO-220FL
	S6A35	80	—	900	500	-40 to 125	8.0	1.0	10	1.7	25	—	⑨	13-7F2A	DP 

Notes 1: The following products are also suitable for use as triggers: RSF05G1-1P (P.18), USF05G49 (P.19), URSF05G49-1P (P.19)

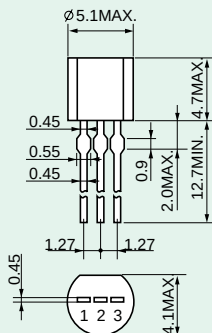
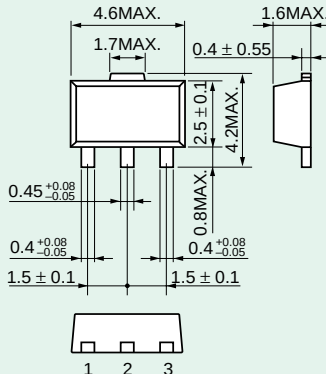
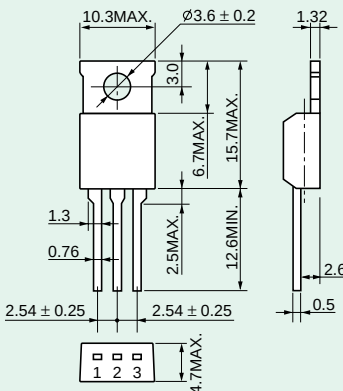
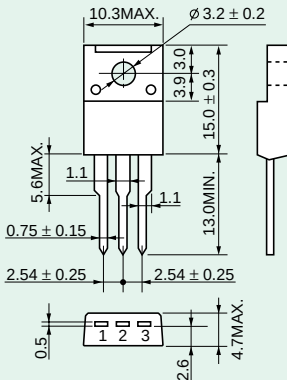
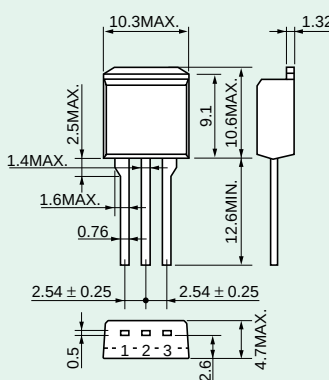
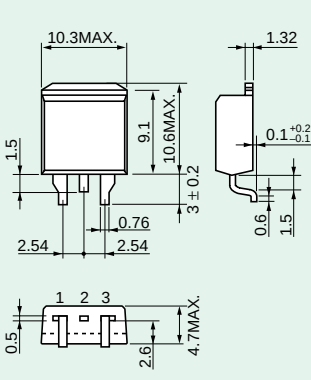
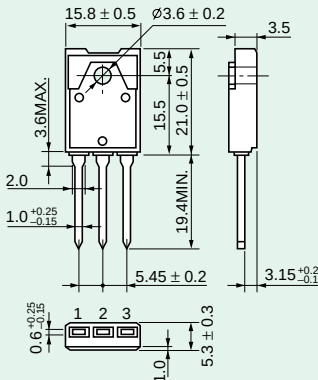
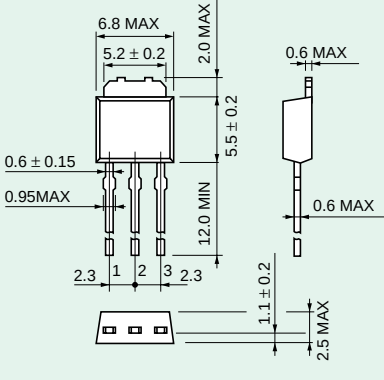
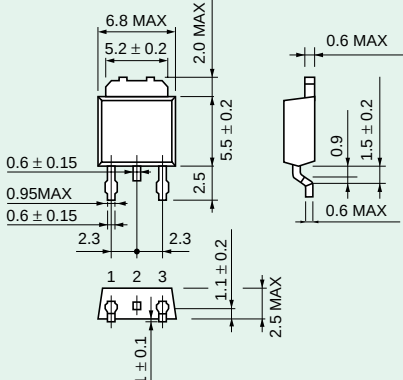
5.4 Special-Purpose Triacs

• High-Rush Current

Maximum Ratings							Electrical Characteristics (Ta = 25°C)							Package Dimensions	Package Number	Package Appearance
IT(RMS) (A)	VDRM (V)		ITRM (A)	ITSM (A)		Tj (°C)	IDRM (mA)	IGT (mA) I, II, III	VGT (V) I, II, III	tq (ms)	VTM (V)	(dv/dt)c (V/ms)				
	400	600		50 Hz	60 Hz								ITM (A)			
20	S6903G	S6903J	120	180	200	-40 to 125	0.02	30	1.5	1.6	30	10	5	③	13-10G1A	 TO-220AB

6 Package Dimensions

Unit: mm

① TO-92  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-5A1A</td><td>Gate</td><td>Anode</td><td>Cathode</td></tr><tr><td>13-5A1D</td><td>Cathode</td><td>Gate</td><td>Anode</td></tr><tr><td>13-5A1E</td><td>T1</td><td>Gate</td><td>T2</td></tr></table>	Pin Number	1	2	3	13-5A1A	Gate	Anode	Cathode	13-5A1D	Cathode	Gate	Anode	13-5A1E	T1	Gate	T2	② PW-MINI  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-5B1A</td><td>Gate</td><td>Anode</td><td>Cathode</td></tr></table>	Pin Number	1	2	3	13-5B1A	Gate	Anode	Cathode	③ TO-220AB  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-10G1B</td><td>Cathode</td><td>Anode</td><td>Gate</td></tr><tr><td>13-10G1A</td><td>T1</td><td>T2</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-10G1B	Cathode	Anode	Gate	13-10G1A	T1	T2	Gate
Pin Number	1	2	3																																			
13-5A1A	Gate	Anode	Cathode																																			
13-5A1D	Cathode	Gate	Anode																																			
13-5A1E	T1	Gate	T2																																			
Pin Number	1	2	3																																			
13-5B1A	Gate	Anode	Cathode																																			
Pin Number	1	2	3																																			
13-10G1B	Cathode	Anode	Gate																																			
13-10G1A	T1	T2	Gate																																			
④ TO-220NIS  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-10H1B</td><td>Cathode</td><td>Anode</td><td>Gate</td></tr><tr><td>13-10H1A</td><td>T1</td><td>T2</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-10H1B	Cathode	Anode	Gate	13-10H1A	T1	T2	Gate	⑤ TO-220FL  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-10J1B</td><td>Cathode</td><td>Anode</td><td>Gate</td></tr><tr><td>13-10J1A</td><td>T1</td><td>T2</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-10J1B	Cathode	Anode	Gate	13-10J1A	T1	T2	Gate	⑥ TO-220SM  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-10J2B</td><td>Cathode</td><td>Anode</td><td>Gate</td></tr><tr><td>13-10J2A</td><td>T1</td><td>T2</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-10J2B	Cathode	Anode	Gate	13-10J2A	T1	T2	Gate
Pin Number	1	2	3																																			
13-10H1B	Cathode	Anode	Gate																																			
13-10H1A	T1	T2	Gate																																			
Pin Number	1	2	3																																			
13-10J1B	Cathode	Anode	Gate																																			
13-10J1A	T1	T2	Gate																																			
Pin Number	1	2	3																																			
13-10J2B	Cathode	Anode	Gate																																			
13-10J2A	T1	T2	Gate																																			
⑦ TO-3P(N)IS  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-16A1B</td><td>Cathode</td><td>Anode</td><td>Gate</td></tr><tr><td>13-16A1A</td><td>T1</td><td>T2</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-16A1B	Cathode	Anode	Gate	13-16A1A	T1	T2	Gate	⑧ DP  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-7F1A</td><td>Cathode</td><td>Anode (heat sink)</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-7F1A	Cathode	Anode (heat sink)	Gate	⑨ DP (Surface-mount)  <table><tr><th>Pin Number</th><th>1</th><th>2</th><th>3</th></tr><tr><td>13-7F2A</td><td>Cathode</td><td>Anode (heat sink)</td><td>Gate</td></tr></table>	Pin Number	1	2	3	13-7F2A	Cathode	Anode (heat sink)	Gate								
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Pin Number	1	2	3																																			
13-7F2A	Cathode	Anode (heat sink)	Gate																																			



7 Tape Packing

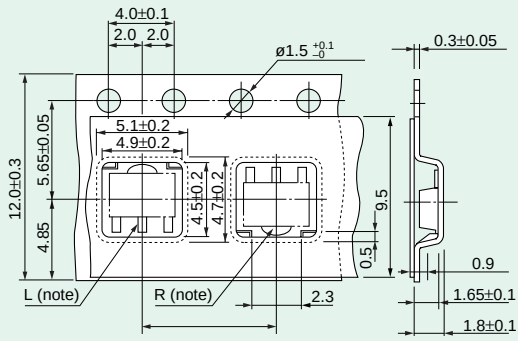
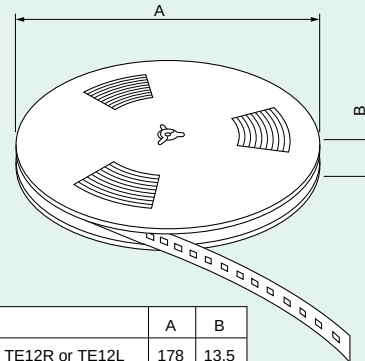
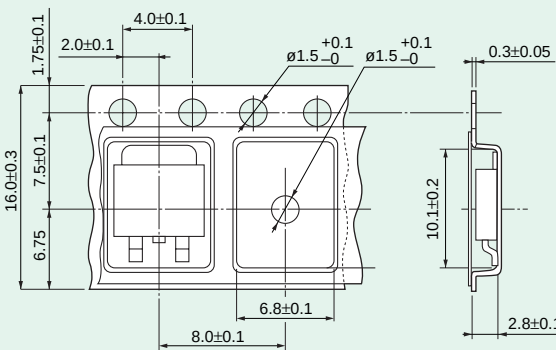
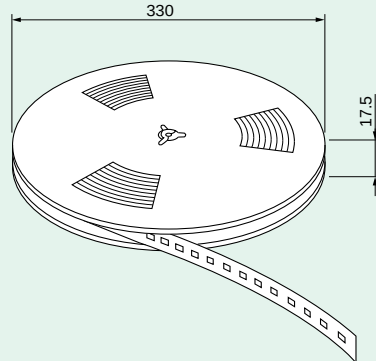
7.1 Packing of TO-92

Unit: mm

Type No.	Tape Dimensions	Packing Quantity	Packing Method
TPE1		2000 pcs/reel	Reel
TPER1		2000 pcs/reel	Reel
TPE2		3000 pcs/box	Box (Ammo Pack)
TPER2		3000 pcs/box	Box (Ammo Pack)

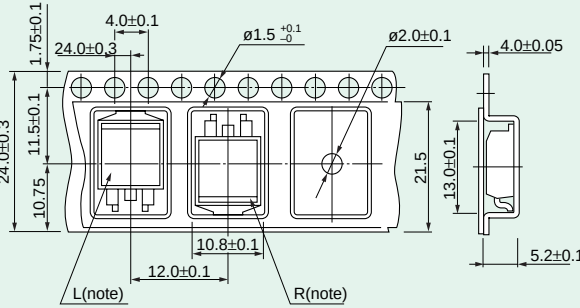
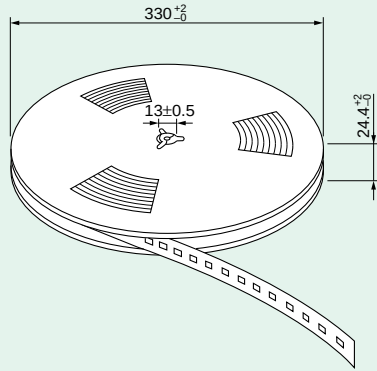
7.2 Packing of PW-MINI and DP

Unit: mm

Type No.	Tape Dimensions	Packing Quantity	Packing Method									
TE12R or TE12L	PW-MINI  Note: L = Leads to Left R = Leads to Right	1000 pcs/reel (5 reels/box)	Reel  <table border="1" data-bbox="1080 717 1334 812"><thead><tr><th></th><th>A</th><th>B</th></tr></thead><tbody><tr><td>TE12R or TE12L</td><td>178</td><td>13.5</td></tr><tr><td>TE12R1 or TE12L1</td><td>330</td><td>12.5</td></tr></tbody></table>		A	B	TE12R or TE12L	178	13.5	TE12R1 or TE12L1	330	12.5
		A	B									
TE12R or TE12L	178	13.5										
TE12R1 or TE12L1	330	12.5										
TE12R1 or TE12L1	5000 pcs/reel (1 reel/box)											
TE16R1 or TE16L1	DP  Note: L = Leads to Left R = Leads to Right	2000 pcs/reel (1 reel/box)	Reel 									

7.3 Packing of TO-220SM

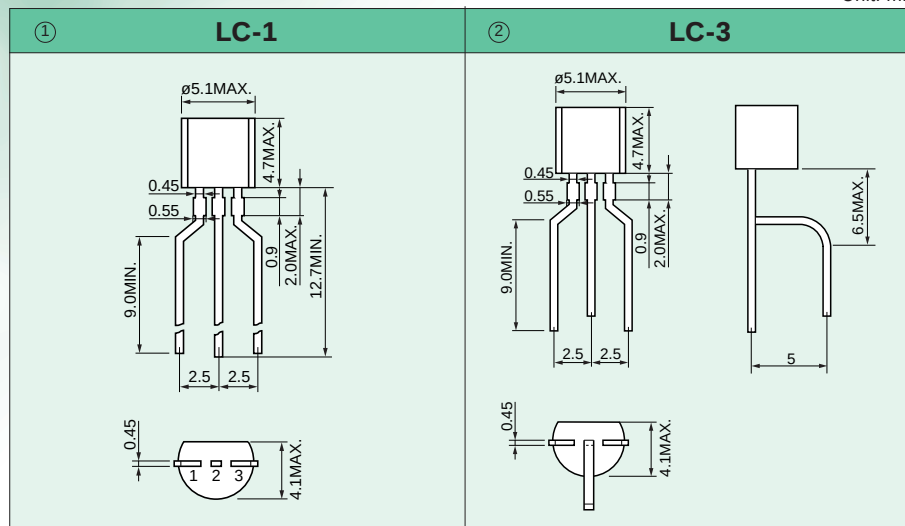
Unit: mm

Type No.	Tape Dimensions	Packing Quantity	Packing Method
TE24R or TE24L	 Note: L = Leads to Left R = Leads to Right	1000 pcs/reel (4 reels/box)	Reel 

8 Leadforming

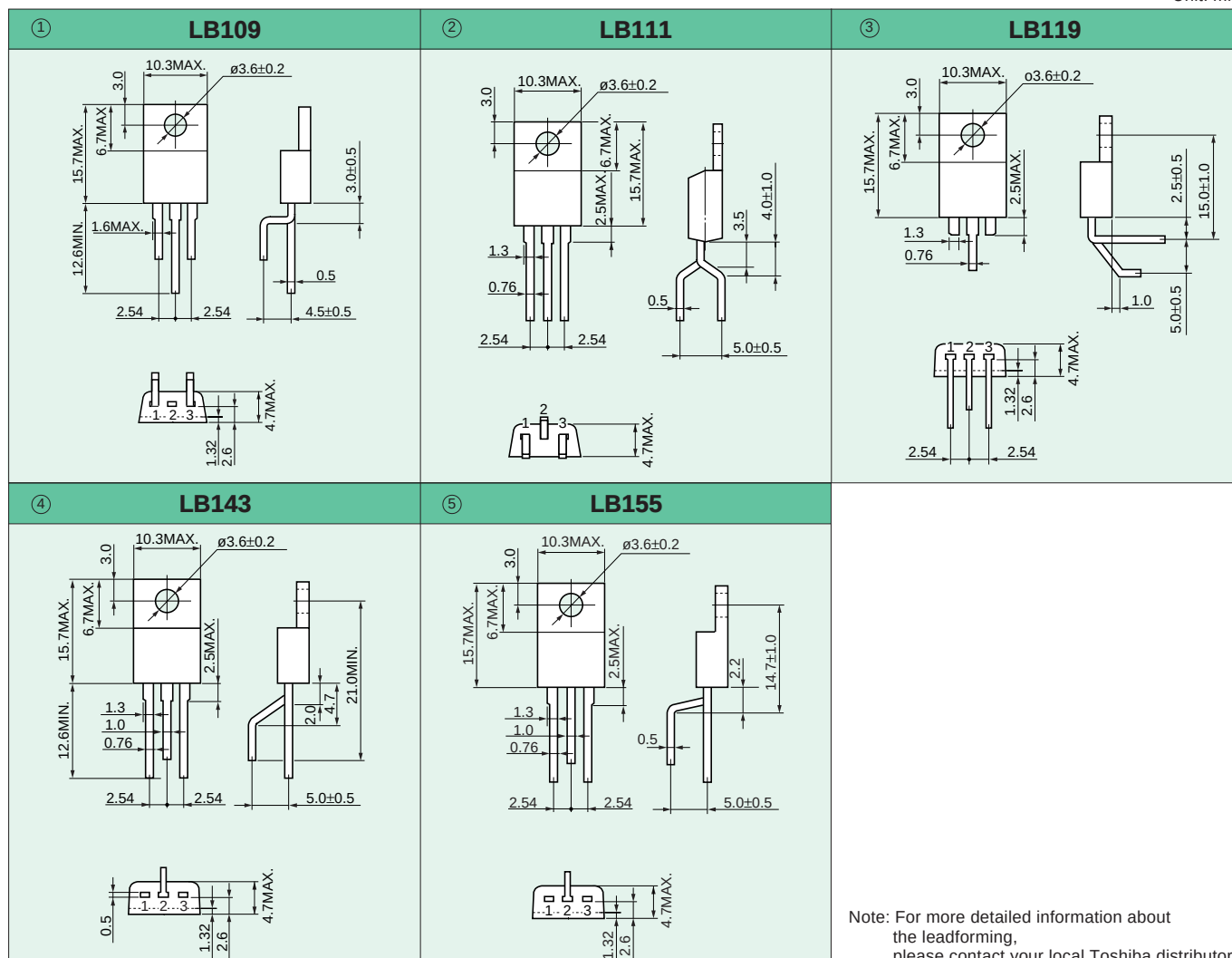
8.1 Leadforming of TO-92

Unit: mm



8.2 Leadforming of TO-220AB

Unit: mm



Note: For more detailed information about the leadforming, please contact your local Toshiba distributor.

8.3 Leadforming of TO-220NIS

Unit: mm

① LB180	② LB181	③ LB182
④ LB183	⑤ LB184	⑥ LB185
⑦ LB186	⑧ LB187	⑨ LB188

Note 1: For more detailed information about the leadforming, please contact your local Toshiba distributor.
Note 2: For more detailed information about the SM2GZ47 and SM2GZ47A, please contact your local Toshiba distributor.



9 Recommended Soldering Method

9.1 PCB Insertion Devices

9.1.1. Temperature Profile Using a Soldering Iron

Complete soldering within 10 seconds for lead temperature up to 260°C, or within three seconds for lead temperature up to 350°C.

9.1.2. Temperature Conditions for Flow Soldering

- (1) Lead temperature must be not more than 260°C, and flow time must be not more than 10 seconds.
- (2) Preheat leads at 150°C $\pm$ 10°C, for 60 $\pm$ 30 seconds.
- (3) Keep the package resin surface temperature suppressed to 210°C or lower.
- (4) The recommended thermal profile is as shown on Figure 1.
- (5) Notes on heating
Allowing device package resin to remain at high temperatures for a long time may adversely affect reliability. Solder in as short time as possible so as not to heat the resin.

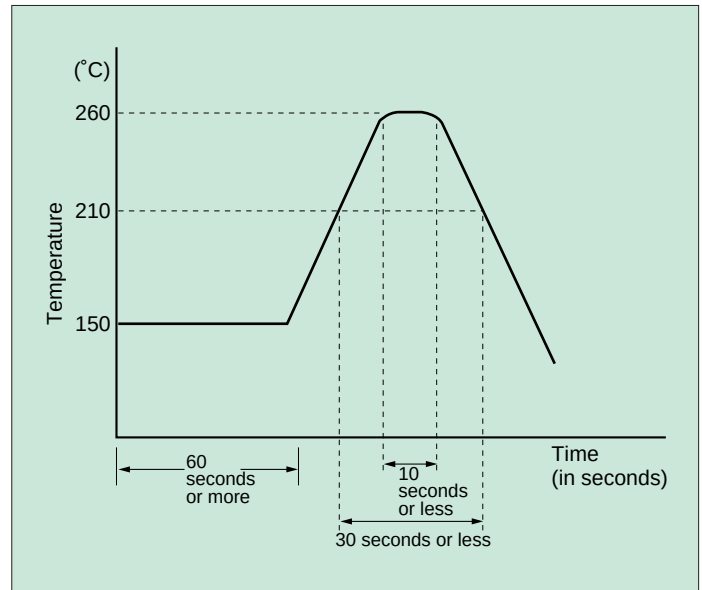


Figure 1

9.2 Surface-Mount Devices

9.2.1. Temperature Profile Using a Soldering Iron

Complete soldering within 10 seconds for lead temperature up to 260°C, or within three seconds for lead temperature up to 350°C.

9.2.2. Using Long or Medium Infrared Ray Reflow

There are three different types of infrared ray reflow, classified by wavelength. Short-wave near infrared ray reflow tends to penetrate the resin and heat up the internal device as well as the surface of resin.

The resulting heat stress may cause device degradation. Since long and medium infrared rays are of longer wavelength, they generally heat only the resin surface, causing little temperature fluctuation or heat stress in the internal device. Thus, the use of either long- or medium-infrared ray reflow is recommended for solder-mounting.

- (1) Top and bottom heating with long or medium infrared rays is recommended. (Figure 2)
- (2) Complete the infrared ray reflow process within 30 seconds at a package surface temperature between 210°C and 240°C.
- (3) Refer to Figure 3 or an example of the recommended temperature profile.
- (4) Near infrared ray reflow soldering produces thermal stress equivalent to that of dip soldering, so take care when using this method.

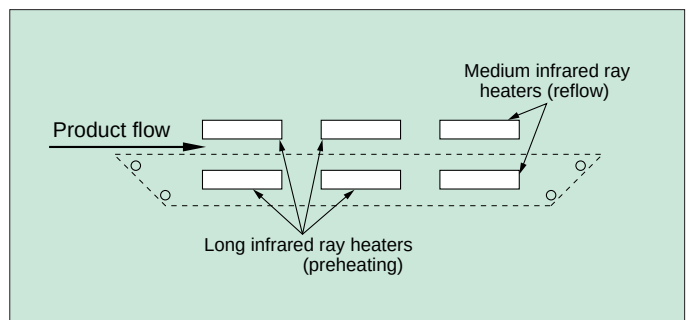


Figure 2

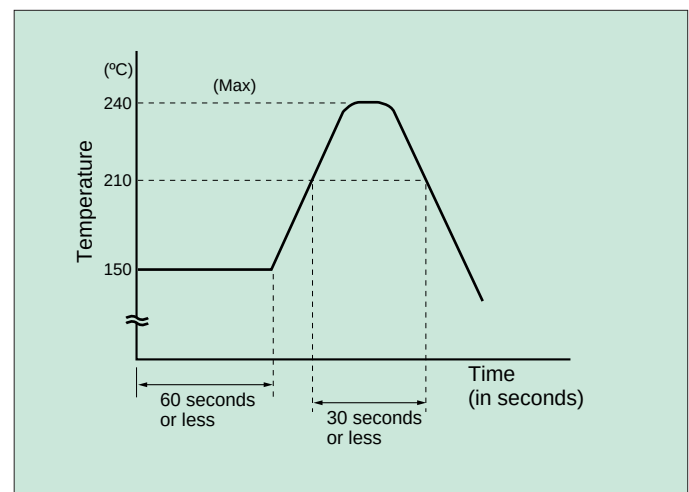


Figure 3

9.2.3. Using Hot Air Reflow

For an example of a recommended temperature profile, refer to 9.2.2. Using long or medium infrared ray reflow.

- (1) Complete hot air reflow within 30 seconds at a package surface temperature between 210°C and 240°C.

9.2.4. Using Vapor Phase Reflow

- (1) The recommended solvent is Fluorinate FC-70 or equivalent.
- (2) Complete hot air reflow within 20 seconds at an ambient atmospheric temperature of 215°C, or within 60 seconds at an ambient atmospheric temperature of 200°C.
- (3) Refer to Figure 4 for an example of a recommended temperature profile for vapor phase reflow soldering.

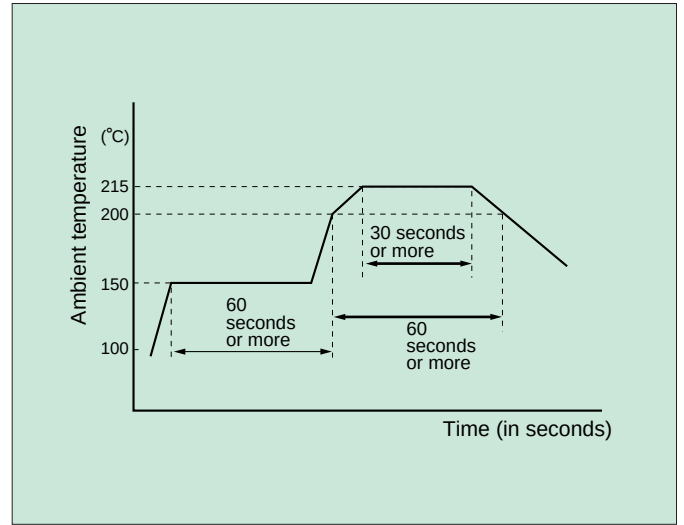


Figure 4

10 Gate Trigger Current Selection Table

	Selection spec.	I _{GT}		Unit	Available Product Numbers
		Min	Max		
10.1	IG1	—	20	μA	SF0R3G42 SF0R5J43 Series SF5J42 Series
	IG2	—	100		
	IG3	3	40		
	IG4	20	200		
	IG5	10	50		
	IG7	3	30		
10.2	A1	—	3*	mA	SM1G43
	A3	—	7	mA	SM1J43

* Only applies to II and III quadrants

Note: I_{GT} values may differ from what is listed in the table. For further details, please refer to the technical data sheets available for each product.

11 Holding Current Selection Table

Selection spec.	I _H		Unit	Available Product Numbers
	Min	Max		
HC1	—	3	mA	SF0R3G42 SF0R5J43 Series

(R_{GK} = 1 kΩ)

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